DOE/EIS-0165-D
VOLUME 1 of 3:

DRAFT
ENVIRONMENTAL IMPACT STATEMENT
ON THE EXPANSION OF THE
Strategic Petroleum Reserve

Alabama, Louisiana, Mississippi, and Texas

VOLUME 1 OF 3:
CHAPTERS 1-5

October 1992
U.S. Department of Energy

UNITED STATES DEPARTMENT OF ENERGY
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WASHINGTON, DC 20585

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DRAFT ENVIRONMENTAL IMPACT STATEMENT
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AGENCY: U.S. Department of Energy
Washington, DC

PROPOSED ACTION: Plan to expand the Strategic Petroleum Reserve to one billion barrels.

LOCATION: Five candidate sites for developing new storage are located in Brazoria and Jefferson Counties, Texas; Iberia and St. Mary Parishes, Louisiana; and Perry County, Mississippi.

In addition, developing associated pipelines and terminals could involve the following: Chambers and Harris Counties, Texas; Vermilion, St. Martin, Assumption, and St. James Parishes, Louisiana; Amite, Pike, Walthall, Marion, Lamar, Forrest, Jones, Greene, George, and Jackson Counties, Mississippi; and Mobile County, Alabama.

CONTACTS: Written comments and questions concerning the project should be directed to: Mr. Hal Delaplane, Strategic Petroleum Reserve (FE-423), U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585, Telephone (202) 586-4730.

For general information on the Department's EIS process, contact: Ms. Carol Borgstrom, Director, Office of NEPA Oversight (EH-25), U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585, Telephone (202) 586-4600 or (800) 472-2756.

ABSTRACT: The proposed action entails the development of a plan for 250 million barrels of new crude oil storage capacity in two Gulf Coast salt domes to expand the Strategic Petroleum Reserve pursuant to Congressional directive (PL 101-383 and PL 101-512). Storage capacity would be developed by solution-mining the salt which would require about two billion barrels of surface water and would generate about two billion barrels of salt brine. The brine would be disposed of primarily by ocean discharge and alternatively by deep underground injection. Crude oil fill and distribution systems would require new pipelines and terminal facilities. This EIS assesses the impacts of construction and operation for the range of alternatives being considered and focuses on oil and brine spill risk and impacts of brine disposal, water and land use, groundwater contamination, hydrocarbon emissions, and involvement with wetlands and floodplains.

HEARINGS: Public hearings will be held on dates to be announced at Lake Jackson and Beaumont, Texas; New Iberia, Louisiana; and Hattiesburg and Pascagoula, Mississippi.

COMMENT PERIOD: Comments must be received by December 29, 1992.

EXECUTIVE SUMMARY

The Strategic Petroleum Reserve (SPR) was created to provide the United States with sufficient petroleum reserves to reduce the impacts of any future oil supply interruption and to carry out the obligations of the U.S. under the International Energy Program. Congress mandated the creation of the SPR in the Energy Policy and Conservation Act of 1975 and established as a national goal the storage of up to one billion barrels of crude oil and petroleum products. In the early stages of the SPR program, plans were approved for the development of facilities and systems for a 750-million-barrel Reserve, able to sustain a 180-day drawdown at a rate of up to 4.5 million barrels per day (MMBD). Decisions on developing the final 250-million-barrel increment were deferred.

Current SPR underground storage facilities are centralized in three oil distribution complexes: (1) the Capline Complex, located in south-central Louisiana (Weeks Island and Bayou Choctaw); (2) the Texoma Complex, located in western Louisiana and eastern Texas (Sulphur Mines and West Hackberry, Louisiana, and Big Hill, Texas); and (3) the Seaway Complex located in Texas (Bryan Mound). As of May 1992, there were about 570 million barrels (MMB) of crude oil in storage. Sulphur Mines is being decommissioned and its oil moved to Big Hill. In addition to the storage facilities, the SPR also includes a marine terminal on the Mississippi River at St. James, Louisiana, and an administrative facility in New Orleans.

Congress enacted two laws in 1990 (P.L. 101-383 and P.L. 101-512) mandating the U.S. Department of Energy (DOE) to undertake the planning activities necessary to expand the SPR to one billion barrels. DOE's approach to an SPR expansion would be to store government-owned crude oil at government-owned underground salt dome storage caverns in the U.S. Gulf Coast region. The current drawdown scenario for the SPR is 180 days at a rate of 4.5 MMBD. To ensure a cost-effective national energy policy as well as maintain flexibility in the event of an energy emergency, DOE is assessing both 270-day and 180-day drawdown criteria at the minimum rate of 4.5 MMBD for an expanded one billion barrel Reserve.

DOE has used a comprehensive three-phased site screening procedure to reduce over 550 onshore and offshore salt domes in the Gulf Coast to specific candidate sites for further environmental assessment under the National Environmental Policy Act (NEPA). The initial site screening process was performed in 1988 and resulted in a long list of 30 and a short list of seven salt dome candidates. The site screening procedure included technical, environmental, and cost criteria and is detailed in DOE's 1989 Report to Congress on expansion of the SPR. In 1990, the long list of 30 salt dome candidates was re-assessed in terms of the SPR's expansion and distribution objectives, geotechnical characteristics, and environmental aspects. This screening process yielded eight candidate sites: four in Texas and four in Louisiana, which were discussed in DOE's 1991 Report to Congress on candidate sites for expansion of the SPR to one billion barrels.

In compliance with Council on Environmental Quality (CEQ) regulations, DOE conducted the following scoping activities. On May 3, 1991, DOE published a Notice of Intent (NOI) to Prepare an Environmental Impact Statement in the *Federal Register* (56 FR 20417) for the Proposed Expansion of the Strategic Petroleum Reserve. Also in May, DOE published a fact sheet entitled "Site Selection for Proposed SPR Expansion: Information and Opportunities for

Public Involvement." Both documents invited written comments until June 17, 1991, and announced two public scoping meetings to provide information to the public on the proposed action and to elicit input from the public regarding sensitive issues and concerns. DOE distributed fact sheets to news media in the potentially affected areas, state and Federal agencies, local, state, and Federal government representatives, environmental groups, selected industries, local libraries, and concerned individuals. DOE also published a public notice announcing the scoping meetings in the New Orleans Times Picayune and the Houston Chronicle newspapers. After this publicity, DOE held the two public scoping meetings on June 4, 1991 in Lake Jackson, Texas and on June 6, 1991 in Thibodaux, Louisiana.

During the EIS scoping process, DOE narrowed the number of candidates of candidate sites for the EIS to four based on cost and distribution factors: Big Hill and Stratton Ridge in Texas for expansion in the Seaway Complex, and Weeks Island and Cote Blanche in Louisiana for expansion in the Capline Complex. An additional site, Richton, Mississippi (that would also provide for expansion in the Capline Complex), was added during the scoping process, which was protracted, lasting from May 1991 until the publication of the EIS Implementation Plan in March 1992. During that time period, DOE held meetings with Federal and state regulatory agencies to further describe the proposed action, to receive feedback on alternative pipeline routings, to discuss preliminary mitigation measures, and to ensure proper coordination throughout the EIS process. Ten meeetings were held prior to the release of the EIS Implementation Plan, and DOE has continued the coordination process through phone contacts.

In this Draft Environmental Impact Statement (DEIS), DOE is assessing five sites: Big Hill and Stratton Ridge in Texas for expansion in the SPR Seaway Complex, and Weeks Island and Cote Blanche in Louisiana and Richton in Mississippi for expansion in the SPR Capline Complex. No preferred alternative(s) has been selected at this time. This Draft EIS is a decision making document which DOE will use to select the preferred alternative(s). In accordance with CEQ 40 CFR Part 1500, a preferred alternative(s) will be identified in the Final EIS.

Typical Site Configuration and Construction

A prototype SPR facility in Louisiana or Mississippi would include up to sixteen 10 MMB caverns on a 300 acre site. A prototype SPR facility in Texas would consist of up to ten 10-MMB caverns on a 200-acre site. These caverns would be created in rock salt 2,000 to 5,000 feet below the ground by solution mining, with the resulting brine disposed of by underground injection wells or by diffusion into the Gulf of Mexico.

A typical SPR site would be constructed in steps. First, there would be site preparation including clearing, grubbing, grading, and stabilization. Next, the raw water intake system, located on a nearby waterway with sufficient flow to support cavern leaching and site drawdown requirements would be constructed. Wells would then be drilled into the dome at selected cavern locations (two per cavern), and raw water injected into one well as brine is extracted from the other well to create a cavern. About seven barrels of brine would be produced for each barrel of storage capacity created. As the cavern is created, surveys, monitoring, and computer modeling systems would be used to ensure the cavern has the right size and shape. The caverns would be tested for structural integrity in hydrostatic and nitrogen well leak tests. Crude oil would then be pumped into the caverns for storage. During drawdown, water would be introduced into caverns to displace the oil for distribution.

The brine disposal system would include clarifier ponds and brine pumps prior to discharge through a diffuser system in the Gulf of Mexico. Underground injection is also being considered as a brine disposal alternative at three of the five candidate sites. Historically, a small fraction (approximately 6 percent) of the SPR brine has been discharged underground at four sites via a pretreatment and injection well system. Other site support structures and equipment would include administrative facilities, laboratories, security buildings, warehouses, roads, an electrical substation, and a fire-safety system. Site maintenance would include inspecting equipment, preparing log sheets, documenting data for performance evaluation, reporting safety hazards, making environmental checks, preforming lab work, requesting maintenance, and monitoring cavern structural integrity.

A typical SPR site would also have a series of pipeline systems for raw water intake, brine disposal, and crude oil fill and distribution. Pipelines would be constructed using one of four basic methods: conventional land lay; conventional push ditch; flotation canal; and modified push ditch. In addition, directional drilling would be used for pipeline crossings of major waterways. Maintenance of pipelines would include integrity inspection as well as painting, coating, pigging and spraying with defoliants to maintain rights-of-way (ROWs).

Under a 180 day drawdown criterion, expansion of the St. James Terminal may be required, including construction of up to two new docks, new metering facilities, and two new 400,000-barrel tanks. Each dock would be designed to load or unload one tanker under all weather conditions.

Regional Environmental Characteristics

The regional environment surrounding the five candidate SPR expansion sites is defined by a number of characteristics, including geological, hydrogeological, ecological, and socioeconomic characteristics, the surface water environment, climate and air quality, natural and cultural resources, ambient noise, and land and water use plans.

The formation of salt domes and coastal subsidence are the two prominent geologic characteristics in this region. All existing and proposed SPR storage facilities lie within the subsurface region of the Gulf Coastal Plain Province that encompasses the Louann Salt Basin. The salt in the Louann Salt Basin was originally deposited approximately 200 million years ago from the broad shallow sea that covered the entire region. Subsequently, the area was covered by sediments that became rock and began sinking into the less dense salt layer, which rose to compensate for the sinking overburden. The movement continued until the density of the rock was equal to that of the salt, creating the salt domes. Salt dome creation continues at an almost imperceptible rate. Subsidence has been occurring throughout the Gulf region as groundwater has been overpumped and hydrocarbons have been extracted. Erosion, global sea rise, and natural sediment deposition also play a role in regional subsidence.

Groundwater in the region encompassing the five candidate sites is typically quite shallow, often found just one meter below the land surface. The shallower aquifers typically contain water that is fresh or moderately saline (e.g., salinity of 10 parts per thousand or less). Groundwater at greater depths becomes gradually more saline, with deeper aquifers in the region (at 600 meters or more below land surface) containing primarily brine. In general, there is sufficient fresh and moderately saline groundwater to support most uses, as human use of groundwater represents the major mode of discharge from aquifers. Groundwater uses in the areas around the proposed SPR sites and terminals include municipal water supplies, industrial uses, and irrigation.

The surface waters in the region are complex, consisting of interconnected water bodies of varying types, salinities, and tidal influences. The Gulf of Mexico and the Mississippi River are the dominant hydrologic units in the region. The five candidate SPR sites are within a number of different surface water basins. Water uses and water quality within the Gulf Coastal Plain Province vary considerably from site to site. Generally, the surface water is soft and has an intermediate pH. Brackish waters are common between the Gulf and the intracoastal waterway; fresh waters occur further inland. Surface water uses include commercial fishing, recreation, agricultural, and industrial uses. Surface water, however, provides only a small portion of the drinking water supply.

The climate of the area surrounding the SPR candidate sites is humid subtropical with a strong maritime influence. The potential for regional air pollution events is typical of Gulf Coast and Atlantic Coast areas of the southeastern U.S. Air quality data indicate that the National Ambient Air Quality Standard for ozone has been exceeded at locations of large petrochemical industries and urban areas.

Ambient noise levels in the areas of the proposed sites are produced by diverse sound sources. In general, noise sources near the sites include salt mines, barge traffic on the ICW, industrial and other human activity, and existing SPR site operations. Quantitative sound level values directly correlate with land use activity and/or population densities.

The SPR candidate sites lie within three ecological regions: the Outer Coastal Plain Forest Province (Weeks Island, Cote Blanche, and Richton), Southeastern Mixed Forest Province (Big Hill), and Prairie Parkland Province (Stratton Ridge). There are abundant wetlands along the coastal areas. The dominant wetlands in the region are estuarine intertidal and both forested and emergent palustrine. Forest statistics indicate that several million acres of land in the area are timberland. Crops in the region include sugar cane, rice, cotton, soybeans, and various truck crops. Cattle are also commercially important. Agricultural lands are a food source for some wildlife but not to the same extent as natural systems.

The region supports a wide variety of terrestrial wildlife species including large bird populations, common small mammals, large mammals (including deer and black bear), amphibians, and reptiles. The aquatic populations vary by habitat type. Some species are found only in higher salinity waters, while others occur only in freshwater riverine systems. Biological communities in the Gulf of Mexico include plankton (both phytoplankton and zooplankton), benthos, and nekton. There are a number of biologically sensitive, unique, or important habitats including species spawning grounds, tidal passes, reefs and hard banks, areas associated with the mouths of rivers, and habitats of rare shelf species.

There are also a number of threatened or endangered species that may occur in the area. There are at least 20 threatened or endangered bird species, a number of large and small threatened terrestrial and aquatic mammals, and several endangered or threatened reptiles. There are at least fourteen species of marine vertebrates inhabiting the northern Gulf of Mexico that are listed as endangered or threatened. These include five species of sea turtles, five species of whales, and the manatee.

Commercially important species in the area include shellfish (shrimp, blue crab, and oysters) and finfish (both sport and commercial fish). These aquatic species account for significant revenue to Texas, Louisiana, and Mississippi. Hunting and trapping of terrestrial species also generates revenue. Fur industry revenues have dropped in recent years, but controlled alligator harvests constitute a ten-million dollar industry in Louisiana. Texas also has controlled alligator harvests. Recreationally important waterfowl include several species of duck, goose, bobwhite, and turkey.

Texas, Louisiana, and Mississippi are rich in natural and scenic resources including coastal wetlands, timberland, and agricultural land. There are a number of protected areas in the region. The Gulf Coast region is also rich in archaeological, historical, and cultural resources.

The demographic patterns in the proposed project areas are characterized by a general increase in the population until 1984. The ensuing downturn in growth can be linked to the economic downturn in the oil and gas industry. Utility capabilities and transportation systems (both aquatic and terrestrial) are adequate to support the SPR project. The social infrastructure for housing, medical, and educational facilities is well-established throughout the region. Currently, due to the economic downturn, housing utilization is low.

All the candidate sites are reasonably close to urban centers and medical facilities. A substantial number of schools serve communities nearby each of the sites. Economic activities in the area include manufacturing, service sectors, and the public sector. In Louisiana, mining is strong. Forestry fuels the economy in Mississippi. Fishing is an important industry in both Texas and Louisiana.

Proposed Alternatives

Big Hill

Big Hill is located in Jefferson County, Texas. The existing site encompasses approximately 250 acres and is in an upland area approximately 17 miles southwest of Port Arthur and 70 miles east of Houston. The surrounding area is predominantly rural. Agricultural production is the primary land use although there is some oil and gas production.

The current facility has 14 oil storage caverns, a brine disposal system (pond complex, underground pipeline, and diffuser in the Gulf), a raw water intake system on the ICW, and a crude oil distribution pipeline to commercial facilities in Nederland, Texas. The site also contains various support facilities including a heliport, diesel oil storage facilities, various laydown yards, a maintenance yard, and control, service, and administration buildings.

A proposed expansion of the Big Hill site would entail construction of nine additional storage caverns. The proposed expansion area is currently owned by Sabine Pass Terminal, although Amoco Oil Company retains mineral rights. Neither company has any active operations on the site. The candidate construction site is a disturbed/regrowth area with a heavy concentration of herbs and shrubs.

Because Big Hill is currently an SPR facility, any site expansion would make use of the existing infrastructure, including the raw water intake and the brine disposal systems. Construction necessary to expand the facility would be limited primarily to preparation of the site, leaching of the new storage caverns, and construction of a new anhydrite pond (to settle insoluble solids in the brine). Under a 270-day drawdown criterion no oil distribution enhancements would be required; however, under a 180-day drawdown criterion, a new crude oil distribution pipeline connecting Big Hill to East Houston would be required. Two pipeline routes have been proposed, one crossing Trinity Bay and one generally following highway I-10.

Surrounding the Big Hill salt dome is a plain of fluvial and deltaic origin, with an average elevation of approximately three meters above mean sea level. Beaumont clay and Lafayette gravel in particular have been identified as major sediments overlying the dome. The salt dome is a moderately elliptical piercement dome, with a nearly circular horizontal cross section, irregular top, and steep sides. The top of the caprock lies at a depth of approximately 100 meters below the surface and covers the majority of the salt mass. At the proposed Big Hill expansion site, the groundwater surface varies from a depth of approximately two meters below land surface to almost ground level (eight meters above mean sea level). Well use in the immediate area appears to be limited to industrial uses by oil companies in adjacent oil fields, livestock use at nearby ranches, and rice cultivation on the tight soils away from the dome. There are no municipal wells within five miles downgradient of the Big Hill site.

The site itself is dry, with the exception of two ponds, ten to 20 acres in size, located on the north and east edges of the dome. Within five miles of the site, there are seven significant water bodies, but the closest permanent body of water (Willow Slough) is almost two miles away. In general, the water bodies in the vicinity of the proposed expansion site are freshwater or brackish systems used for irrigation of surrounding rice fields. The site is not within a floodplain area and is characterized predominantly by scrub-shrub uplands with interspersed meadows (old fields) in the early stages of secondary succession. Mature trees are scattered throughout the area. There are no documented occurrences of endangered or threatened species at the proposed site; however, several bird rookeries (breeding grounds) near the site are of concern.

An extensive system of coastal wetlands, which serve as important waterfowl wintering areas, is found in areas adjacent to the site, extending from Sabine Lake to East Bay. Federal and state authorities have preserved a number of refuges and wildlife areas near the proposed site. There are no recorded archeological or historic sites located within the Big Hill salt dome project area nor any listed sites that would be affected by the construction of expanded storage capacity at Big Hill. The Alabama-Coushatta Native American Reservation is 45 miles northwest of the Big Hill expansion site. However, because of the distance, Native Americans are not expected to have any concerns regarding site development. The proposed I-10 and Trinity Bay pipeline routes both cross through wetland areas but do not cross any areas identified as potential breeding grounds or nurseries for any endangered species, nor do they cross any wildlife refuges. Trinity Bay itself is a large, shallow, middle-to-low salinity estuary that supports important stands of submerged aquatic vegetation and a wide variety of organisms.

The service, manufacturing (e.g., petroleum refining), and retail trade sectors generate the majority of economic activity in Jefferson County. The region is served by numerous well-developed transportation systems. Interstate Highway 10 (I-10), a major national east-west highway, passes ten miles to the northwest of the Big Hill site. Gulf State Utilities, an investor-owned electric utility company headquartered in Beaumont, Texas, currently supplies electrical power to the Big Hill facility. Jefferson County is a nonattainment area for ozone. The Texas Air Control Board maintains a monitoring station in Port Arthur, located approximately 17 miles northeast of the site. The primary noise source near the proposed expansion site is the existing

SPR facility. The raw water and brine disposal pumping stations are approximately one quarter of a mile away.

Stratton Ridge

Stratton Ridge is located in Brazoria County, Texas. Site development would include the leaching of ten storage caverns, each with a capacity of ten MMB, construction of a raw water intake system on the ICW, a raw water leaching/drawdown system, a brine settling and disposal system (pipeline and diffuser in the Gulf), a crude oil distribution pipeline (a one-mile spur to connect Stratton Ridge to the existing Bryan Mound-Texas City pipeline), access roads, and operation, maintenance and security buildings. Oil fill would be from the ARCO terminal in Texas City, Texas.

The proposed Stratton Ridge site is in an upland area approximately three miles east of Clute and Lake Jackson and six miles north of Freeport. The surrounding area is predominantly industrial and is fairly heavily populated. The economy of the area centers on the petrochemical industry. There are several wetlands, old-growth forests, and cattle grazing fields adjacent to the site. Currently the salt dome has 57 brine and storage caverns, with a total volume of 150 MMB, operated by Dow, Amoco, Conoco, and Occidental.

The site ranges from three to four meters above mean sea level with a local topography characterized by the surrounding marshes, bayous, lakes, and creeks. The salt dome is irregular in shape with a trough-like depression that extends generally in a north-south direction on the east-central part of the dome. Fairly tight Beaumont clays extend throughout Brazoria County as the dominant surface or subsurface soil. Development of groundwater resources in the area appears more widespread than near Big Hill. A significant number of industrial and irrigation/agricultural uses are represented in the immediate area, but municipal groundwater use is the principal source of groundwater discharge.

Although there are four ponds located within the candidate site boundaries, none of the ponds have significant tributaries or outflows, and are all less than four acres in size. There are 28 named water bodies within five miles of the site. The closest body of water is Oyster Creek, which runs along the southern border of the candidate site and has been designated by the state as high quality aquatic habitat. Part of the site is within a floodplain area. The site is characterized by emergent wetlands, open parkland forests with extensive stands of mature live oak, and abandoned farmland and orchards. There are no reported occurrences of endangered or threatened species at the proposed site, but two bird rookeries that were active in 1990 occur nearby.

The Brazoria National Wildlife Refuge in Angleton, Texas, is located nearby, but there are no recorded archeological or historical sites located within the project area nor any sites that would be affected by the construction of an SPR facility at Stratton Ridge. The Alabama-Coushatta Native American Reservation is 110 miles north of Stratton Ridge and because of the distance, Native Americans are not expected to have any concerns with site development or expansion. The proposed diffuser location does not enter Federal waters but lies within the Texas Natural Resources jurisdictional boundary. The shallow nearshore Gulf region in which the proposed diffuser site is located is characterized by a highly variable environmental regime. Not only do temperatures show a wide seasonal range, but also the sediment system is continually disturbed, by both weather-related phenomena and shrimp trawling. The most prominent nearshore features of the Stratton Ridge area include shallow bays, barrier islands, sand dunes, and relatively flat marshland that is dissected by man-made flood control structures. One offshore oil platform exists approximately one mile southwest of the proposed Stratton Ridge diffuser site.

The dominant industrial sectors in Brazoria County in terms of employment and earnings are manufacturing, services, retail trade, and government services. The area surrounding the site is interconnected by a number of Texas State highways and county roads. Houston Lighting and Power Company, an investor-owned utility, would supply electric power to Stratton Ridge. Brazoria County is a nonattainment area for ozone. There is a monitoring station nearby in Clute/Freeport, located three miles southwest of the Stratton Ridge site. The existing industrial operations on the salt dome, the presence of a Missouri Pacific main track that lies adjacent to the proposed site, and the proximity of the site to the towns of Clute and Lake Jackson are estimated to produce a noise level comparable to an urban industrial area.

Weeks Island

Weeks Island is located in Iberia Parish, Louisiana. At this site, DOE would create up to 16 storage caverns, with a total storage capacity of 160 MMB, on the eastern portion of the salt dome. The existing Weeks Island facility is on the southwest slope of the island and occupies about 1.8 surface acres. The island is on the eastern edge of Weeks Bay and is nine miles south of Lydia, 14 miles south of New Iberia, and 95 miles west of New Orleans. The island is virtually uninhabited and the surrounding area is sparsely populated. The major economic activities in the parish are mineral production, manufacturing, construction, shipping, and agriculture. The island has the highest elevation in Louisiana and is mostly covered with forest, although there is some sugar cane farming. Morton Salt produces some table salt, and Shell Oil Company has an oil and gas production facility on the north overhang.

The existing facility is a component of the Capline Complex and is connected to DOE's St. James Terminal. The Weeks Island site consists of the main site, fill site, laydown yard, fire protection site, service shaft, and protection shaft. Key features at the facility include eleven submersible electric pumps, three mainline pumps, an oil sump, a flow metering facility, and a collection pond. The site also contains various support facilities including a heliport, a maintenance yard, and control, service, and administration buildings. The storage capacity of the site is about 76 MMB. Since the storage cavity was formerly a "room-and-pillar" salt mine, no raw water intake or brine disposal systems were required.

An expansion of the Weeks Island site would entail construction of up to 16 additional storage caverns, each with a ten-MMB storage capacity. The area is currently owned by Morton International, Inc., although Benjamin Minerals retains mineral rights to the salt. The salt in the expansion area is not being considered for future mining.

Although Weeks Island is currently an SPR facility, site expansion would require substantial facility development. Along with construction of the storage caverns, additional facilities required would include a raw water intake structure on the ICW, a raw water leaching/drawdown system, a brine settling and disposal system (pipeline routed to the west of Marsh Island across the Southwest Pass Peninsula with a diffuser in the Gulf or underground injection), using the existing Weeks Island to St. James pipeline with one additional pump station for crude oil receipt and distribution, access roads, and operation, maintenance and security buildings. Under a 180-day criterion, the existing DOE pipeline would be further upgraded by adding an additional pump station plus the addition of docks to DOE's St. James Terminal and a pipeline spur connection to Texas 22" pipeline reversed to the LOOP Clovelly Terminal.

The salt dome is roughly circular and has a diameter of approximately two miles. There is no caprock over the dome, with the exception of a minor cap found on the periphery. The unconsolidated sedimentary deposits between the top of the salt and the land surface are composed of a series of Pleistocene to Recent sands and gravels with discontinuous lenses of clays and silts. Depth to groundwater varies from approximately five meters below land surface in some perched water tables to near sea level (50 meters below land surface). Groundwater at the site is typically fresh down to a depth of approximately 240 meters beneath the ground. The fresh groundwater is separated from brine-containing aquifers by a 90-120 meter thick clay layer. Although there are no population centers within nine miles of Weeks Island, 21 wells exist within three miles of the site.

Weeks Island is completely surrounded by brackish marsh, bayous, man-made canals, and bays. Within five miles of the candidate construction site there are 31 water bodies, which are generally fresh or brackish and tidally influenced. The closest water body is Warehouse Bayou, which wraps around the northern and eastern edges of the site at a distance ranging from 50 to 760 meters away. None of the water bodies presently serve as a public water supply source, but many are used for recreation and some are used for oil field service, small boat traffic, and/or barge traffic. Vermilion Bay and West Cote Blanche Bay, just offshore from Weeks Island, are state-designated oyster seed areas.

The site is predominantly agricultural fields (primarily sugarcane) and hardwood forests. Two recorded archeological sites lie within the impact area of the Weeks Island project. There are two Native American Reservations in or near the Weeks Island region. One is 75 miles from the site and because of the distance, is not expected to have any concerns with site development. The second, the Chiti Macha Native American Reservation, is 20 miles northeast; however, development of the site is not expected to have any impact on the reservation. The bald eagle, a Federal endangered species, and the black bear, a Federal and state threatened species, are believed to occur on Weeks Island. Part of the site is within a floodplain area. Avery Island Bird Sanctuary is located ten miles north of Weeks Island, and Marsh Island National Wildlife Refuge is located 17 miles to the south. Off the southern shore of Marsh Island is Shell Keys National Wildlife Refuge. Directly west of Marsh Island across Southwest Pass is State Wildlife Refuge and Paul J. Rainey Wildlife Refuge.

A large portion of the existing crude oil pipeline route to the St. James Terminal crosses through wetlands. One of the proposed new pump stations would be located near Lake Verret, one of several moderately large lakes known to have concentrated breeding populations of the Federal endangered bald eagle. The assessed Texas 22" pipeline spur does not cross through any wildlife refuges, although the wetlands it crosses may be used as breeding grounds by birds. Vermilion Bay, Atchafalaya Bay, and Marsh Island are the dominant nearshore features at the proposed brine disposal pipeline and diffuser site. An active oil and gas area lies close to the proposed Weeks Island diffuser site. A brine disposal alternative is injection into disposal wells along the first five miles of the existing pipeline ROW to the St. James Terminal. There are no known endangered species nesting areas or other unique ecological areas along this segment of the pipeline.

Although there is no single dominant industry in Iberia Parish, the top four sectors - manufacturing, service, retail trade, and government -- employ about 61 percent of the workforce and account for 64 percent of earnings. Settlement patterns and transportation systems in the Weeks Island region have, to a large extent, been determined by topography and drainage. In the low lying regions, natural levees have provided areas for development and have allowed access to the waterways that at one time were the main means of local transportation. Gulf State Utilities provides power to South Central Louisiana as well as Southeast Texas, and currently services the Weeks Island facility. Iberia Parish is an attainment area for ozone. The Louisiana Department of Environmental Quality maintains a monitoring station in Morgan City, located approximately 35 miles southeast of the Weeks Island site. Primary noise sources at Weeks Island are operations of the existing SPR site and the Morton Salt mine adjacent to the SPR site. The proposed expansion site is nearly a mile away. The most immediate noise source at the proposed expansion site is traffic noise from State Route 83, which is immediately adjacent to the site.

Cote Blanche

Cote Blanche is located in St. Mary Parish, Louisiana. At this site, DOE would create up to 16 storage caverns with total storage capacity of 160 MMB, on the east-northeast portion of the salt dome. The Cote Blanche salt dome is in an upland area on the north shore of West Cote Blanche Bay, approximately two miles southeast of Weeks Island. The site is eleven miles southwest of Franklin, 18 miles southeast of New Iberia, and twelve miles south-southeast of Lydia. A salt mine operated by the Carey Salt Company is north-northwest of the dome. The proposed site would be located on 300 acres, east of the existing salt mine.

Development of the salt dome at Cote Blanche would require considerable construction including storage caverns, a raw water intake structure on the ICW, a raw water leaching/drawdown system, a brine settling and disposal system (pipeline and diffuser or underground injection), pipeline connection to DOE's Weeks Island to the St. James pipeline for crude oil receipt and distribution to the St. James Terminal (distribution options are similar to those for Weeks Island), access roads, and operation, maintenance, and security buildings. In addition, a bridge would have to be built across the ICW for access to the island.

The Cote Blanche salt dome forms a geographic high point that rises to approximately 23 meters above mean sea level. The dome is elliptical in shape, with diameters of about three miles north to south and nearly two miles east to west. There are perched freshwater and saline water-bearing aquifers just below the land surface, although the majority of freshwater is in deeper aquifers down to about 240 meters below land surface. The Cote Blanche area is an undeveloped, swampy area where no public wells are in use.

The Cote Blanche site lies on the north shore of Cote Blanche Bay and is surrounded on three sides by fresh to brackish water, marsh, and the ICW. There are 14 sizeable water bodies within five miles of the site, the closest being West Cote Blanche Bay, approximately 300 meters to the south and the ICW about 800 meters to the north. All of West Cote Blanche Bay is a state-designated oyster seed area.

The ecological characteristics of the proposed Cote Blanche site include dense stands of very young forest with a moderately heavy understory. There are three endangered plant species found within one mile of the proposed site. Avery Island Bird Sanctuary is located approximately 15 miles northwest of Cote Blanche. The natural uninhabited wilderness at Cote Blanche Island is considered to be unique. The storage site would be located in a floodplain, but it is possible that all construction will occur outside the 100-year floodplain. There are no wetlands within the proposed site boundary. There are no recorded archeological or historical sites located within the proposed Cote Blanche project area, pipeline corridors, or raw water intake structures. Three recorded archeological sites, however, lie on Cote Blanche Island near the project boundaries. One Native American Reservation is located 85 miles away and because of the distance, Native Americans from this reservation are not expected to have any concerns with site development. The other reservation, the Chiti Macha Native American Reservation is 20 miles northeast; however, site development is not expected to impact the reservation. The proposed pipeline route, diffuser location, and injection well locations are the same as the options being considered for Weeks Island.

Land is used in St. Mary Parish primarily for agriculture and forestry. The primary crops in the parish are sugarcane, soybeans, wheat, and freshwater fisheries. St. Mary Parish is a nonattainment area for ozone. The only existing activity near the proposed SPR site is a room-and-pillar salt mine operated by the North American Salt Company. It can be assumed that the mining activity produces noise levels comparable to a suburban or an urban industrial area.

Richton

The Richton salt dome is located in Perry County, Mississippi. The proposed site is located on bottom land, 18 miles east of Hattiesburg and three miles from the town of Richton. This alternative would have crude storage capacity of up to 160 MMB and would require structures and systems similar to those described for the other proposed grassroots sites at Stratton Ridge and Cote Blanche. The land for the proposed site is privately owned and is used primarily for forestry and agriculture. Less than one percent of the land on the dome is residential.

Development of the Richton site would require substantial facility development, including up to 16 ten-MMB storage caverns, a raw water intake structure on the Leaf River, a raw water leaching/drawdown system, a brine settling and disposal system (pipeline, diffuser, and underground injection), a dual-purpose pipeline (initially for brine disposal and convertible to a crude oil distribution line), pipelines for crude oil receipt and distribution, a DOE-owned and operated storage terminal, metering and pump stations, access roads, a blanket oil pipeline, and operation, maintenance, and security buildings. Three alternatives are being considered for crude oil distribution under a 270-day criterion; first, the construction of a pipeline to Liberty Station for distribution through Capline and the dual-use pipeline to Pascagoula; second, the construction of a pipeline east to connect with commercial facilities for distribution through the Port of Mobile, Alabama in addition to the pipeline to Pascagoula; and third, distribution only via the dual-purpose pipeline to Pascagoula, with connection to two proposed docks at Greenwood Island in addition to commercially owned docks. All three options would include a pipeline to allow for brine disposal during normal storage operations and refill via underground injection. To meet a 180-day drawdown criterion, option one would be enhanced by adding a pump station and an additional dock at the St. James Terminal; option two would be enhanced by constructing connections from the Pascagoula area to the Greenwood Island docks; and option three would be enhanced by adding pipeline connections and meter stations to the Port of Pascagoula Public Terminal dock G and to a reversed Cal-Ky pipeline to Empire, Louisiana.

The terrain surrounding the Richton salt dome is flat to gently rolling. The dome is a large, oblong piercement dome. Hydrogeology at the site is characterized by the predominantly fresh Upper Aquifer, which begins just below the land surface and extends to a depth of 345 meters below land surface, just above the domal caprock. Groundwater beneath this aquifer is moderately saline and grades to brine. Brine generated from cavern maintenance and refill would be injected into the highly saline Wilcox Formation, at least 600 meters below the ground. Eight wells in a 6-mile radius around the site tap the Upper Aquifer for a variety of uses. Both municipal and domestic wells are developed in the area, as well as some wells for agricultural and industrial purposes.

There are 26 named water bodies and numerous other small, unnamed ponds located within five miles of the proposed site. Harpers Branch, an intermittent stream, runs from the center of the Richton site to the southeast. The most significant water bodies in the area are Thompson Creek and Bogue Homo, which drain the area over the dome into the Leaf River. The Leaf River is a major tributary of the Pascagoula River and passes approximately eight miles south of the proposed site.

Natural vegetation in the area is characterized by longleaf pine and slash pine forest. Small pockets of agricultural fields occur sporadically throughout the managed timber stand. The proposed site area likely provides habitat for a variety of terrestrial wildlife species. Four state endangered animal species are reported to occur within a one-mile radius of the Richton site, and three of the four could potentially inhabit the site. The site is entirely outside any floodplains. No cultural resource investigations are known to have been conducted within the dome area or the immediate vicinity. Various physical and cultural factors suggest that the potential for archaeological, cultural, and historic resources to be located in the dome area is low. The Choctaw Native American Tribal land is located primarily 80 miles northwest of Richton. One portion of tribal land is 25 miles northeast of the site, but Native Americans are not expected to be concerned with SPR development.

The Leaf River in the area of the proposed raw water intake is a freshwater body, averaging 200 feet wide and eight feet deep, with a variable flow. In the past, industrial and municipal outfalls at Hattiesburg, upriver from the proposed raw water intake structure, were the major sources of pollution to the river. The Leaf River contains a fish community that is typical of southern freshwater rivers. The proposed diffuser pipeline route runs southwest from Pascagoula, Mississippi through Mississippi Sound and Horn Island Pass to a diffuser approximately 14 miles off the coast. The Mississippi Sound and offshore areas are used extensively for marine transportation, dredge material disposal, and offshore oil and gas drilling, resulting in a complex chemical environment. There is currently no active oil or gas activity in the immediate vicinity of the proposed diffuser site, but the diffuser would be in a Corps of Engineers dredge material disposal area south of Horn Island.

The terminal in Pascagoula would be located on the northeast quadrant of the Jackson County Airport. This area is comprised of the most highly concentrated industrial development along the Mississippi Coast. There are plans to convert the airport site itself into an industrial park, including a plan by the Jackson County Port Authority to dispose of dredge spoils from construction of the proposed Greenwood Island Terminal in the southwest quadrant of the airport. Despite the extent of existing industrial development, the area contains substantial acreages of intertidal wetlands subject to the Corps of Engineers' regulatory control. There are wetlands immediately to the east of the proposed Pascagoula Terminal and the northern tip of

Bangs Lake and associated wetlands lie about one mile southeast from the proposed terminal. The Bangs Lake area is ecologically significant and is presently protected as the Bangs Lake Wildlife Management Area and the Grand Bay National Wildlife Refuge.

Forestry and the manufacture of wood products are the dominant industries in the Richton region, particularly in Perry County, where the town of New Augusta has been the regional center of commercial timber activity for many years. The salt dome lies two to three miles west of the town of Richton on Route 42. Electrical power to Richton is currently supplied by Southern Mississippi Electric Power Association (SMEPA), a rural electric generation and transmission cooperative, and distributed through Dixie Electric Power Association, one of SMEPA's eleven distribution members. The Richton site is in an attainment/unclassified area for ozone. The Mississippi Department of Environmental Quality's Bureau of Pollution Control maintains ozone monitoring stations in Lamar County (approximately 35 miles from the site) and at Pascagoula. The primary noise source in the area is Route 42, and noise levels at the site are roughly comparable to a suburban area.

St. James Terminal

The St. James Terminal is a DOE-owned facility located in St. James Parish, Louisiana, approximately 45 miles north of New Orleans and 30 miles southeast of Baton Rouge, on the west bank of the Mississippi River. It is part of the Capline Complex and serves as the fill and distribution terminal for the Bayou Choctaw and Weeks Island SPR facilities. There are two existing docks at St. James. Under a 270-day drawdown criterion, no expansion of St. James would be required; however, under a 180-day drawdown criterion St. James would have to be expanded to meet increased drawdown demands for any of the proposed Capline sites. The expansion would include the construction of up to two new docks and two new 0.4-MMB tanks to handle additional marine outloading capability. Expansion of St. James would also entail installation of custody transfer meters, additional pumps, and fire protection and electrical facilities.

The proposed St. James Terminal expansion site is located in St. James Parish on the west side of the Mississippi River, approximately two miles north of the town of St. James on Highway 18, and about halfway between Baton Rouge and New Orleans. The area is typical of the lower Mississippi River region with very little topographic relief and thick layers of sediment deposited within the floodplain. There are 51 groundwater wells within a three-mile radius of the St. James Terminal site, 33 of which are on the western side of the Mississippi River (the same side as the terminal site).

The Mississippi River itself is bordered by man-made levees. The hydrology of the Mississippi River system has been significantly altered in an attempt to reduce the risk of flooding and the resulting loss of land and increased salinity of adjacent wetlands. Water quality in the basin has been adversely affected by pesticides, priority and non-priority organics, siltation, pathogens, and suspended solids. Suspected sources of this contamination include numerous industrial and municipal discharges, agriculture, urban runoff, land disposal of wastes, hydromodification, miscellaneous material spills, in-place contaminants, and heavy barge and ship traffic from the Gulf of Mexico and New Orleans.

The aquatic biological community of the lower Mississippi River is composed principally of nongame fish of little commercial or recreational value. There are no endangered plant or animal species occurring at or within a one-mile radius of the St. James Terminal and no recorded archeological or historical sites. The terminal is in a floodplain area. Adding two new docks will require dredging of up to one million cubic yards of spoil per dock. The proposed tank expansion would occur within the current facility. The vegetation in this area is currently maintained by DOE and consists of rye grass, white clover, and Bermuda grass. The area surrounding the facility is primarily agricultural: sugar cane cultivation and pasture/cattle grazing. There are no wetlands within the storage tank facility.

The St. James Parish economy was once dominated by agricultural interests, which have recently been supplanted by a significant industrial concentration. Petroleum, chemicals, sugar, and aluminum, as well as trapping and commercial catfish and crawfish production are significant industries in the parish. Major transportation routes running close to the site and connecting Baton Rouge to New Orleans are Interstate 10 and U.S. 61. The St. James Terminal is located in a nonattainment area for ozone. An ozone monitoring station is located in Convent, which is one mile east of the terminal, across the Mississippi River. Ambient background noise levels when the terminal is in an operational mode would likely be comparable to an urban-industrial area. No Native American Reservations are in the vicinity of the proposed terminal expansion.

No Action

The No Action alternative to the proposed expansion would limit SPR storage capacity to the currently available 750 MMB and would limit distribution during an SPR drawdown to a maximum of 4.5 MMBD. Since no further site development would occur under this alternative, SPR facility development would remain as presently configured and would continue to undergo maintenance to sustain a remaining life of 20 years. Therefore, environmentally, the No Action alternative would limit the impacts from SPR construction and operation to those that have already occurred or that will occur as part of the 750 MMB program at the existing SPR sites in the Capline, Seaway, and Texoma Complexes. Annual environmental reports of the SPR would continue to detail these impacts. Environmental impacts at the Cote Blanche, Stratton Ridge, and Richton proposed sites and portions of the Big Hill and Weeks Island sites would not occur and these sites would remain with the existing private owners.

Environmental Risks and Public and Occupational Safety and Health

There are a number of environmental risks and public and occupational safety and health issues associated with the expansion of the SPR. Some of these risks and their potential impacts could be reduced with mitigation measures.

Oil Spills

Releases of oil to the environment, whether from accidental or operational discharges, could occur during transport of oil by vessel or pipeline or during transfer of oil at terminals or storage sites. Filling newly constructed caverns with 250 MMB of crude oil would result in incremental movements of crude oil in tankers and pipelines to the candidate storage sites. Increases in pipeline use and tanker movements would increase the probabilities of associated oil spills. If drawdown is required, the SPR would have to be refilled; the oil spill risks of refill would be comparable to those of fill. Drawdown itself is complicated because the SPR crude oil is a replacement for imported oil. Drawdown and distribution result in shifts between transportation modes rather than incremental movements.

Oil spill risks have been evaluated based on historical data, and both the size and frequency of oil spills from proposed SPR facilities are expected to be low. The probability of a tanker spill is estimated to be about three spills per 100 MMB transferred. At terminals, the risk of a spill is estimated to be 3.3 spills per 100 MMB transferred across the docks and 0.43 spills per year per MBB of oil stored in aboveground tanks. For pipelines, it is estimated that 0.0021 spills would occur per 100 MMB miles. Spills at storage sites are estimated to be about 2.7 spills per 100 MMB transferred. Aggregate spill size data suggest that about 40 percent of all oil spills are less than ten gallons and three-fourths are less than 100 gallons (2.4 barrels).

The number of expected spills during fill or refill for both of the Seaway Complex candidate sites would be approximately nine, and for the Capline Complex sites, the number of spills would be about 16. The number of expected spills during drawdown is affected by changes in the distribution of oil from existing sites and by the particular drawdown criterion or pipeline route chosen. Under the current configuration, the Bryan Mound site in the Seaway Complex would have an expected 13.4 spills during drawdown. If the Big Hill site were chosen, the total number of spills for the Seaway complex could increase to 16.6; if Stratton Ridge were selected, a total of 16.5 spills could be expected. For the Capline Complex, the expected total number of spills for Weeks Island or Cote Blanche is about 10, and for Richton, about 10 spills could be expected if oil is routed to Liberty, approximately 13 spills could be expected if oil is routed to Mobile, and 15.4 spills could be expected if oil is routed to Pascagoula.

To mitigate any damage that might be caused be an oil spill at expansion sites would have a range of spill containment equipment. All new pipelines would be buried underground except where terrain makes burial impractical. Each SPR site would also have a comprehensive Spill Contingency Plan.

Brine Spills

Accidental releases of brine to the environment could occur from three primary sources. First, there could be releases from the brine pipeline systems brought about by erosion, corrosion, overpressurization, or failure of valves and joints. Based on a review of historical brine spill statistics at SPR sites, approximately one to nine small brine spills per year (on the order of 75 barrels or less each) would be expected from the pipeline systems at each of the five candidate sites. In addition, it appears that proposed operations at Big Hill or Stratton Ridge would result in one large pipeline spill of 74,000 barrels or more, and that Weeks Island, Cote Blanche, or Richton operations would result in two large brine spills of this magnitude.

Second, there could be releases from the on-site brine ponds either due to failures of the liner and underdrain systems or due to overtopping and failure of surrounding dikes. Although such releases have been observed at SPR sites in the past, brine ponds that would be used at the SPR expansion sites would be better designed, monitored, and maintained than some of the existing ponds that have leaked. In general, significant releases from the brine ponds are not expected, but if they occur, they would most likely involve chronic, low-level seepage to groundwater.

Third, there could be accidental releases of brine to shallow aquifers due to injection well operations (e.g., injection well failures, or upward migration of brine through fractures, faults, or abandoned wells). Spill statistics for brine injection within the oil and gas industry, which is similar to the proposed SPR brine injection, indicate that the potential for injection well failures to contaminate shallow aquifers would be very remote (a one in 1,000,000 chance for every year that an injection well operates). Migration of brine to shallow aquifers through fractures, faults, or abandoned wells would also be unlikely, due to the engineering design and operational controls that would be employed.

Fires

The risk of fire at an SPR site is relatively low. Historically, the only reportable fire that resulted in a fatality took place at a well-pad at the West Hackberry site in 1978 and was caused by a combination of malfunctioning equipment and human error. Due to subsequent changes in operating procedures, this type of fire is unlikely to reoccur.

In the case of a fire in the crude oil surge tank, either at the seal or in a "boil over" scenario where the tank could erupt and send a fire ball several hundred feet into the air, foam could be applied from ground level, extinguishing the fire. The only likely environmental damage might result from slightly saline water used for fire suppression that would be provided through the raw water intake system. All fire scenarios, although potentially serious, would be extremely unlikely to occur. A pump fire might occur through human error, but since pumps can be shut off automatically or manually from a variety of locations, damage would be minimal.

Contingency planning and fire protection and extinguishing equipment are necessary and important parts of SPR site operations. The Big Hill Prefire Plan provides the Emergency Response Team (ERT) with the primary tactics and strategies for combating fire emergencies. This plan contains specific information on each facility, structure, and potential hazard area on the site. This information is provided to help the ERT Leader make quick decisions concerning fire fighting objectives and priorities during a fire emergency. The potential for loss of life and personal injury is the first consideration during fire. In the unlikely event of a major fire involving a building or structure, the local fire department is immediately notified.

If a pressured oil storage cavern and well head failure are involved, a controlled burn would be allowed from the well head until the pressure is relieved via the site's emergency shutdown system and aqueous film forming foam is used to blanket and extinguish all crude oil ground fire and maintain foam protection. Automatic sprinkler systems would be installed in all major structures. The crude oil pumps, meters, and related facilities would be protected by automatic foam deluge systems. The Operations Control Room would be protected with Halon 1301 as well as sprinklers. Oil storage cavern wellpads would be protected with fixed monitors. Hose reels would be interconnected into the foam system protecting the crude oil pumping facilities and surge tank to provide foam solution for hand line applications as required.

Natural Disasters

At the proposed Texas and Louisiana sites, the probability that a cyclone would occur in any year is six percent or more. In an inland area such as Richton, MS, hurricane force winds would be unlikely to occur. There are an average of 60 or more thunderstorms per year in the region. Flooding during extreme storm events could affect all proposed sites, particularly Stratton Ridge and Weeks Island.

Examples of preparations for cyclones, hurricanes, thunderstorms, and flooding have been taken from the procedures developed for the existing Big Hill facility, which would be analogous to those at expansion sites. The basis of the Big Hill hurricane preparation plan is the Emergency Planning Group, consisting of site management, the shift supervisor, and the site manager. The emergency plan at the Big Hill site also contains certain precautions for avoiding damage from lightning associated with thunderstorms. The emergency plan includes preparations for flooding as well, which consist primarily of monitoring activities to ensure that any floods are reported and that employees are removed from potential flood areas.

Hazardous Chemical Spills or Releases

The volumes of hazardous chemicals used at the existing SPR sites are relatively low and spills have been rare. Potential accidents could result from improper storage, handling, or transport. Human error, container failure, or equipment malfunction are also sources for accidents.

Aqueous film forming foam (AFFF) would be stored on-site and would be used to cover and extinguish hydrocarbon liquid-based fires. In the event of a fire, any AFFF would released would be captured in collecting ponds. AFFF would pose no threat to humans but could be environmentally harmful as it has a high biochemical oxygen demand and chemical oxygen demand.

Pesticides and herbicides would be used on-site in specific areas in small quantities. A maximum spill scenario would involve the spill of one or two gallons of a compound during manual application. A spill would require relatively uncomplicated cleanup consisting of soil collection and removal. There would be no long term impacts.

Visco 1152, a quaternary amine, would be used to control corrosion in oil systems by killing bacteria that live in the interface between the oil and the small amount of water in the pipelines. These bacteria would digest the oil and excrete acid and oxygen leading to the corrosion of unlined pipes. The biocide would be stored in 250-gallon drums and diluted using a metered water system. A potential accident would most likely involve one drum and would be relatively easy to clean up. No impacts to groundwater or surface water would be expected.

Ammonium bisulfite would be used in the brine disposal lines as an oxygen scavenger. At Big Hill, a 50 percent solution is stored in 5,000 gallon tanks located next to the brine ponds. Ammonium bisulfite would be injected in small quantities into the brine as it leaves the brine pond and enters the pipeline. A maximum spill accident would involve the rupture of a storage tank. Any spill would likely be contained in the brine ponds which border the tank. If ammonium bisulfite reached adjacent vegetation (either by overflowing the ponds during a rainstorm or by dispersion during a wind storm), there could be localized impacts to nearby vegetation (e.g., burning). If a spill was contained in the pond, the brine might have to be aerated to ensure the presence of oxygen prior to disposal. No long term impacts would be anticipated.

Hazardous chemicals would generally be purchased on an as-needed basis. Distribution of all hazardous chemicals on the site would be controlled by property procedures in which warehouse personnel issue working quantities of chemicals with records to account for them at all times. Material Safety Data Sheets would be kept on the site for each hazardous chemical. All site personnel who are on-site ERT members or who encounter hazardous chemicals in their work areas would receive training in spill response.

Environmental Impacts Associated with the Alternatives

There would be a number of environmental impacts associated with the development and operation of each of the five candidate sites. Some of these impacts would be minimized through mitigation measures, however, there would be some unavoidable impacts. These unavoidable impacts are discussed in Chapter 9. In the subsections below the five candidate sites are compared to each other with respect to each of the impact areas. The St. James Terminal expansion is a distribution enhancement for the proposed Capline Complex sites, and, therefore, the potential impacts of its expansion are summarized under the Capline Complex sites.

Geological Impacts

Geological impacts associated with the five candidate sites are expected to be limited to local subsidence over the storage caverns. If caverns were leached slowly and filled expeditiously to avert sudden imbalances of pressure there would be reduced subsidence. Because a site in the Capline Complex would have more storage caverns than a site in the Seaway Complex, the area affected by subsidence would be proportionally greater. No significant geological impacts related to pipeline and terminal construction are expected.

Hydrogeological Impacts

Site development, pipeline construction, and terminal construction (where needed) at each of the five candidate sites under either drawdown criterion would not be expected to cause significant impacts to groundwater quality or flow. There could be unique hydrogeological impacts at Weeks Island or Cote Blanche, however, if underground injection is used as an alternative to Gulf discharge for brine disposal at these sites. This brine injection would emplace one MMBD of brine in a highly saline formation that is at least 1,200 feet below the ground and separated from shallow fresh groundwater by a 300 to 400-foot thick layer of highly impermeable clay. Smaller quantities of brine generated from cavern maintenance and refill at Richton also would be injected in a highly saline formation at least 2,000 feet underground. The injection at each of these sites would result in an increase in pressure in the receiving formation, but it would not be expected to significantly affect groundwater quality or local seismicity. Injection controls, intermediate and surface casing, periodic mechanical integrity tests, and monitoring would reduce the impact from injection wells.

In terms of site operations and maintenance, the potential for groundwater contamination and impacts would also be low at all five candidate sites. There are minor differences between the sites in terms of hydrogeological conditions and distances to surface waters that could receive contaminated groundwater discharges in the event of a release to shallow groundwater; however, these differences are generally immaterial recognizing that the engineering design and monitoring of pipelines, ponds, caverns, and other possible release sources make the potential for significant releases to groundwater very low at all five sites. The principal distinguishing feature among the sites is the substantially longer crude oil and brine discharge pipelines that would be required at Richton, which would make the potential for releases to groundwater from these pipelines somewhat greater at Richton than at the other sites.

Surface Water and Aquatic Ecology Impacts

Under a 270-day drawdown criterion, the principal differences that exist between the candidate sites in terms of potential surface water and aquatic ecology impacts would be associated with site and pipeline construction. In general, adverse effects to surface water and aquatic ecology due to construction would be expected to be substantially less at Big Hill than at the other sites because Big Hill would require the least amount of construction. Site construction at Big Hill, for example, would be very unlikely to result in enhanced sediment loads to surface waters. In contrast, if not controlled, erosion due to site construction would be a potential concern at Weeks Island, where nearby Warehouse Bayou could receive large sediment loads, and at Stratton Ridge, where adjacent Oyster Creek presently provides high quality aquatic habitat. Sediment control measures would reduce the erosion associated with site development.

Similarly, no new pipelines would be needed at Big Hill under a 270 day drawdown criterion. Construction of new crude oil, brine discharge, and raw water pipelines at the other sites, however, would temporarily affect water quality and benthic habitat in a number of water bodies. Of particular note would be the large number of fresh waters that would be temporarily affected by the crude oil and brine pipelines at Richton, and the 22-mile stretch of Vermilion Bay that would be crossed by the proposed brine discharge pipeline from Weeks Island or Cote Blanche. Potential impacts in Vermilion Bay would be a particular concern because the Bay serves as an oyster seed ground. Push-ditch construction, water control structures, restoration of hydrology (removing dikes and levees) would reduce the impact associated with pipeline and terminal construction.

In terms of other categories of surface water and aquatic ecology impacts under a 270-day drawdown criterion, the five candidate sites would be substantially similar. For example, brine discharge into the Gulf from each site would cause minor (+1 part per thousand) increases in salinity in approximately 5,000 to 7,700 acres without significant impacts to biological communities or commercial fisheries. In addition, raw water intake at each site would cause only minor changes in hydrology, water quality, and biology in the supplying water body — the ICW in the case of Big Hill, Stratton Ridge, Weeks Island, and Cote Blanche, and the Leaf River in the case of Richton.

Under a 180-day drawdown criterion, proposed pipeline construction at Big Hill would pose a greater surface water and aquatic ecology threat than the proposed system enhancements at the other sites. Construction of the Trinity Bay crude oil pipeline from Big Hill to East Houston would temporarily affect water quality and benthic habitat in 19 water bodies, including Trinity Bay. The crossing of Trinity Bay would be of particular concern because it would disturb one the few remaining seagrass beds in the Bay and because care would have to be taken not to puncture any of the innumerable pipelines that already traverse the Trinity Bay floor. Push-ditch construction, water control structures, and restoration of hydrology would reduce the impact to water quality, and conducting a biological survey and using existing ROW would result in reduced habitat destruction. The potential impact of puncturing an existing submerged pipeline could be reduced by conducting a magnetometer survey, and using horizontal directional drilling under waterways and roads.

As an alternate to the Trinity Bay route, construction of the I-10 crude oil pipeline at Big Hill would temporarily affect 26 water bodies, but none of these waters are believed to contain any sensitive resources like Trinity Bay. Impacts from construction of I-10 crude oil pipeline could be minimized by push-ditch construction, water control structures, and restoration of hydrology.

The expansion of the St. James Terminal that would be required to meet a 180-day drawdown criterion at Weeks Island, Cote Blanche, or Richton would not be expected to cause significant surface water or aquatic ecology impacts. The minor impacts of the expansion could be mitigated to reduce the water quality impact to the Mississippi River through the use of water control structures and restoration of hydrology. Similarly, construction of the terminal at Pascagoula, being considered for one of the development alternatives at Richton, would result in enhanced erosion of soil to the wetlands east of the site. The impacts associated with this enhanced sediment loading, however, would be minimized by the use of controls (ditches, erosion netting) that would direct and retain eroding soil.

Air Quality Impacts

Major air quality impacts associated with site development or pipeline and terminal construction are temporary fugitive dust emissions from site clearing, facility construction, and use of unpaved roads. These particulate emissions would be reduced using state-of-the art dust suppression techniques. The Big Hill site would require the least amount of clearing, and Cote Blanche and Richton the most. Pipeline construction would not be needed for Big Hill under a 270-day drawdown criterion, but some construction would be required under either a 270-day or a 180-day drawdown criterion for all other sites; the greatest amount of pipeline construction would be required for Richton. Construction of up to two new docks and tanks may be needed under a 180-day drawdown criterion for any of the Capline Complex candidate sites. Substantial volatile hydrocarbon emissions would be expected at the St. James Terminal and the Pascagoula Terminal during drawdown and distribution, but predicted effects on ozone concentrations would be temporary and limited in geographic extent. Emissions from the storage sites and from the terminals during standby or fill would be much smaller. Air emissions controls and scheduling of tanker loading to minimize ozone production would result in reduced air emissions and air quality impacts.

Terrestrial Ecology and Wetlands Impacts

The most significant predicted ecological impacts would be those of wetland and habitat loss associated with site construction. The primary impacts to vegetation from construction of the site are destruction of on-site vegetation and impacts to off-site vegetation from soil erosion and sedimentation. Sediment controls, revegetation, avoidance of activity during breeding seasons, and conducting endangered species surveys would reduce the loss of flora and fauna at the sites. Weeks Island and Stratton Ridge are located in more unique habitats than the other sites. At Stratton Ridge, there are several diverse ecological communities, including emergent and forested wetlands, open parkland forest, and abandoned farmland and orchards. The Weeks Island site is comprised of a combination of agricultural land and mature live oak and magnolia forest. The proposed site locations at Big Hill, Cote Blanche, and Richton are located in areas with few, if any, unique ecological communities.

Potential impacts to wildlife from construction of the proposed sites could include destruction of individuals of smaller or less mobile species of wildlife, displacement of wildlife, and disruption of behavior due to increased traffic and human activity. The diverse vegetative communities at Stratton Ridge and Weeks Island probably support a wider diversity of wildlife than at the remaining sites, and, therefore, impacts to wildlife would likely be greatest at these sites. In addition, nearby suitable habitat would be more readily available at Big Hill, Cote Blanche, and Richton. At Stratton Ridge, much of the area surrounding the proposed site is already cleared and used for livestock grazing, and would be of marginal value to displaced wildlife. At Weeks Island, available habitat is already limited due to commercial and agricultural development on the island. Although the incremental impact of the development of the proposed site would be insignificant, the cumulative loss of habitat could have adverse impacts.

There are two types of on-site ecological resources that are of particular concern: (1) wetlands and (2) species that are threatened or endangered. At two sites, Stratton Ridge and Richton, there are more on-site wetlands (46 and 30 acres, respectively) than at the remaining sites (Weeks Island has six acres, and Big Hill and Cote Blanche have none). At Weeks Island and Cote Blanche, however, impacts to nearby off-site wetlands from increased sedimentation would be more likely. There may be threatened or endangered species that could be impacted during site development; DOE would conduct site specific endangered species surveys prior to any site-preparation. At three of the sites (Weeks Island, Cote Blanche, and Richton), existing documentation indicates the possible presence of terrestrial threatened or endangered species. The Louisiana black bear may inhabit Weeks Island and Cote Blanche. At Richton, there are three threatened or endangered species which may occur on or near the site: eastern indigo snake, black pine snake, and gopher tortoise. Although at Stratton Ridge there are no known terrestrial threatened or endangered species on-site, threatened bald eagles reportedly nest on Oyster Creek near the site. Thus, Big Hill is the only site where current documentation does not indicate the possible presence of such species.

The primary impact assessed from pipeline construction would be disturbance of wetlands in the 150-foot construction ROW. Because these wetlands would be restored and revegetated, impacts would likely be temporary. The impact on wetlands would also be reduced by wetland enhancement and the use of double-ditching, grading, diking, interceptor ditches, push-ditch construction, water control structures and removal of temporary obstructions. The greatest amount of wetland acreage would be associated with Richton (slightly more or less than 500 acres, depending on the selected option). The least wetland acreage would be associated with Big Hill under a 270-day drawdown criterion where no pipeline construction would be required. For the remaining sites (Big Hill under 180-day drawdown; Stratton Ridge, Weeks Island, and Cote Blanche under either drawdown criteria), the wetlands acreage affected would range from approximately 100 acres to approximately 200 acres. Of these options, Big Hill with construction of the I-10 crude oil pipeline has the greatest wetland acreage (235 acres potentially affected) and Cote Blanche under a 270-day criterion has a similar amount of acreage (223 acres). The Trinity Bay route from Big Hill has the greatest potential for salt water intrusion with four newly constructed crossings between fresh and salt water areas. Pipeline construction for other sites and for the I-10 route from Big Hill would require only one or two such crossings. Because threatened or endangered species surveys have not been conducted for pipeline ROWs, a biological assessment of potential impacts at this time has been limited to species that USFWS has identified as likely to be of concern. Any potential impacts could be reduced by conducting an endangered species survey, avoiding any threatened and endangered plant species by altering pipeline routes or moving and preserving species, and by avoiding construction during critical breeding/pollination seasons.

Potential impacts associated with operation and maintenance of the sites and pipelines would include continued loss of habitat for wildlife due to restricted access and lack of vegetation on the site; disruption of wildlife surrounding the site due to increased traffic, noise, and human activities; loss or impairment of vegetation and wildlife from leaks or spills; and disruption and temporary displacement of wildlife during inspections. These impacts would be of generally lower magnitude than those associated with site development, and as discussed above, could be more significant at Stratton Ridge and Weeks Island due to the ecological diversity of these sites. Potential impacts associated with operations and maintenance could be minimized by reduced construction during periods of wildlife sensitive behavior, use of oil spill controls on and around well pads, brine ponds, and pipelines, wetlands mitigation, and the use of water control structures and existing ROWs.

Floodplains

If a site were to be selected solely on the basis of floodplain location, Big Hill in Texas and Richton in Mississippi would be the preferred sites. Big Hill and Richton are located in a non-floodplain areas and therefore are preferable to Stratton Ridge, Weeks Island, and Cote Blanche which are in floodplain areas. Although the length of pipeline construction varies significantly among sites, pipeline construction and operation are not major concerns in terms of floodplain impacts. Construction impacts would be temporary and the maintenance of underground pipelines would not have long-term impacts on floodplains. Any changes in elevation and drainage patterns at either the site or on pipeline ROWs could be reduced by the creation of banks in spoil breaks, the restoration of natural contours, retention of removed topsoil, restoration of hydrology, grading to correct elevation, restoration of natural topography, and restoration of river and lake shores to original contours.

Natural and Scenic Resources

None of the proposed sites would be located on or in the immediate vicinity of significant natural and scenic resources. Several of the proposed pipeline ROWs, however, would cross through such areas. For Stratton Ridge, the proposed raw water and brine disposal pipelines would be located near the Brazoria National Wildlife Refuge. The proposed brine disposal pipeline from Weeks Island and Cote Blanche (note that the same ROW applies for the two sites) would cross the P.J. Rainey Wildlife Refuge owned by the National Audobon Society and the State Wildlife Refuge. The proposed crude oil pipeline from Richton to Liberty would cross through a short portion of Percy Quin State Park; the route would use an existing ROW. The impacts to these resources are predicted to be insignificant.

Historical and Cultural Resources Impacts

According to State Historical Preservation Officers in Texas, Louisiana, and Mississippi, no impacts to any identified historical and cultural resources would be expected during site development or pipeline and terminal construction, but a cultural resources survey would be needed to identify possible additional resources at any of the Capline sites and pipeline routes.

Socioeconomic Impacts

Socioeconomic impacts are expected to vary only slightly across the five alternate sites. In all cases, the overall economic impact is expected to be somewhat positive. Development of new or expanded sites would generate between 100 and 300 temporary construction jobs and up to 100 permanent jobs, thus stimulating the local economy, albeit, minimally.

Most of these jobs would be filled by workers currently residing within a commuting distance of the site. Some workers, however, especially permanent workers, might move from another region to a city or town near the site. These workers and their families would place some additional burden on existing public services and will fill vacant housing. The SPR expansion at all candidate sites, however, would lead to regional population increases of only one percent, and these impacts should be minimal. For example, because the entire Gulf region has been strongly affected by the recent economic recession, there would be sufficient vacant housing near the candidate sites to accommodate in-migrating workers. Only at Cote Blanche and Richton would the new residents fill more than 10 percent of the vacant housing even under the high-impact scenario.

The major positive benefit from the SPR expansion would be the increase in personal income generated by the newly created jobs. The estimated levels of additional personal income generated by the SPR expansion would range from $5.7 million at Big Hill to $11 million at Weeks Island and Cote Blanche. Further economic benefits would be generated as these newly employed workers spend their disposable income for locally produced goods and services.

Noise Impacts

Short-term increased sound levels would be expected during construction at any of the candidate sites, with comparable sound levels during pipeline and terminal construction. More potential noise receptors (e.g., residences) would exist at Weeks Island than at other sites but sound levels are expected to be minimal at these receptors. Greatest overall effects may be expected at Richton because of the length of associated pipelines and tank construction. During fill and drawdown, temporary increased sound levels would occur at any of the sites.

Regulatory Requirements and Additional Mitigation Measures

The SPR sites selected for development would establish mitigation plans, as appropriate, to ensure that any potential impacts are minimized. Environmental laws and regulations promulgated by Federal and state governments provide important requirements for permits and environmental monitoring. In addition, based on experience with the existing SPR sites, DOE would establish engineering and operational controls that minimize potential impacts. The laws and regulations that could impact the proposed development of any of the sites are detailed in Chapter 8.

Measures to Mitigate Environmental Impacts

DOE would mitigate impacts throughout construction and operation of the SPR expansion sites. At SPR sites, mitigation techniques can be divided into three categories: impact avoidance, including preventative steps, site selection, and care in locating structures; minimization, meaning the use of low-impact methods or containment measures; and restoration, which includes replanting, rehabilitation, and other post-damage mitigation.

Mitigation in Wetland Areas. To compensate for damage to wetlands resulting from SPR construction and operation, the Corps of Engineers may require that DOE enhance or create wetlands off the site. DOE will use these two mitigation techniques to the extent necessary, as stipulated in the section 404 permit. Enhancement involves selectively modifying an area to upgrade one desirable attribute, such as waterfowl habitat, over another, such as flood control.

Wetland creation is often the most controversial of the mitigation options available because of disagreements within the scientific and regulatory communities as to its effectiveness, long-term viability, and standards for determining the success of these efforts.

Mitigation of Environmental Impacts from Accidents. DOE would take every precaution to prevent accidents from occurring at SPR expansion sites. DOE, however, recognizes the possibility of accidents or equipment failures, and will implement a wide range of engineering design measures to limit environmental damage from such an event.

Air Quality Monitoring. Based on experience at the existing SPR facilities, the predominant air emissions are VOCs from valves, pumps, tanks, tankers, and brine ponds. These would be monitored at expansion SPR sites using an organic vapor analyzer.

Water Quality Monitoring. Water quality would be monitored at SPR expansion sites in order to provide early detection of any surface water quality degradation that may result from SPR operations. Surface water monitoring would consist of sampling at a number of monitoring stations, and testing them for pH, salinity, temperature, dissolved oxygen, and oil and grease. Locations for monitoring stations would ensure testing of discharge from sewage treatment plants, stormwater from well pads, and along canals and sensitive areas in the vicinity. In addition to testing water discharges, DOE would sample surface waters at SPR expansion sites to monitor general water quality. Groundwater monitoring would also be conducted at SPR expansion sites.

Cavern Integrity Monitoring. Because one potential source of adverse environmental impacts would be leakage of crude oil from storage caverns, DOE takes significant steps to ensure that no such leakage occurs. Prior to storage of oil in a newly leached cavern, DOE would conduct a two phase test to demonstrate that total leakage from a particular cavern would be less than 100 barrels per year. Once the caverns are in the long-term storage mode, monitoring would be continued on a quarterly basis and would include surveys to determine the total depth and logging of at least the bottom 100 feet of the cavern.

Relationship Between Local Short-term Use of the Environment and Maintenance and Enhancement of Long-term Productivity and Irretrievable Commitment of Resources

Regardless of the site chosen for an SPR expansion there would be little sacrifice of long-term productivity for short-term use of the environment. There would be no permanent adverse impacts on air and the impacts on water would be minimal and temporary except where structures would actually be emplaced in a water body (i.e., new docks at St. James and a bridge spanning the intracoastal waterway at Cote Blanche). The impact on land by pipelines would not be substantial, as pipelines do not preclude other land use. Although there could be some disruption along a pipeline route (e.g., loss of productivity in wetland areas), pipelines often can and would be routed to avoid sensitive areas. Cumulative impacts of the proposed action are limited to habitat concerns at the Weeks Island site, particularly for the endangered Louisiana black bear, where concurrent development unrelated to DOE sites may also limit available habitats; no other cumulative impacts are predicted due in part to the consideration of mitigation measures that DOE would undertake. The only permanent impact would be to the 200 to 300 acres of land on which a site would be located. Other irretrievable commitments of resources would include: the fresh water used in leaching the brine caverns, the salt lost during leaching, the building materials (including steel and concrete), and the energy requirements and manpower expended for construction, operation, and maintenance of the site and associated pipelines.

Compliance with all Laws and Regulations

In conducting an expansion of the SPR, DOE would comply with all Federal, state, and local laws and regulations. Compliance with applicable laws and regulations would take place at every stage during the development of the EIS. DOE is currently in consultation with the state and Federal agencies who would be involved in the SPR expansion. Consultation meetings already held are listed in the DEIS.

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LIST OF ACRONYMS AND ABBREVIATIONS

AFFF	aqueous film forming foam
API	American Petroleum Institute
AQCR	air quality control regulation
AWQC	ambient water quality criteria
bbl	barrels
bbl/day	barrels per day
bls	below land surface
BOD	biochemical oxygen demand
Ca^{++}	calcium ion
CAA	Clean Air Act
Cd	cadmium
cfs	cubic feet per second
CFR	Code of Federal Regulations
Cl^{-}	chloride ion
CLECO	Central Louisiana Electrical Company
cm	centimeters
cm/sec	centimeters per second
cm/yr	centimeters per year
COE	U.S. Army Corps of Engineers
CO	carbon monoxide
Cr	chromium
Cu	copper
CWA	Clean Water Act
cwt	hundred weight
db	decibel
dBA	A-weighted sound level
DEIS	Draft Environmental Impact Statement
DEQ	Department of Environmental Quality
Dixie EPA	Dixie Electrical Power Association
DO	dissolved oxygen
DOE	Department of Energy
DOT	Department of Transportation
DWT	dead weight tonnage
E_h	oxidation-reduction potential
EIS	Environmental Impact Statement
EPA	(U.S.) Environmental Protection Agency
EPCA	Energy Policy and Conservation Act
EMT	Emergency Medical Technician
F	Fahrenheit (degrees)
FDA	Food and Drug Administration
Fe	iron
FEIS	Final Environmental Impact Statement
FIRMs	Flood Insurance Rate Maps
FR	Federal Register
ft/sec	feet per second
ft^3/sec	cubic feet per second

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

gal/bbl	gallons per barrel
gpm	gallons per minute
GSU	Gulf State Utilities
hazmat	hazardous material
HC	hydrocarbon
HDPE	high-density polyethylene
Hg	mercury
HL&P	Houston Lighting & Power Company
HP	horsepower
ICG	Illinois Central Gulf Railroad
ICW	(Gulf) Intracoastal Waterway
in/yr	inches per year
JTU	Jackson turbidity units
K^+	potassium ion
km	kilometers
km^2	squared kilometers
kV	kilovolts
kVA	kilovolt-ampere
lb	pound
lb/gal	pounds per gallon
L_{eq}	equivalent steady sound level
L_d	day sound level
L_{dn}	day-night sound levels
L_n	night sound level
LEPC	Local Emergency Planning Committee
LOOP	Louisiana Offshore Oil Port
LPG	liquid petroleum gas
m/s	meters per second
m	meters
MB	thousand barrels
MBD	thousand barrels per day
MGD	million gallons per day
mg/l	milligrams per liter
Mg^{++}	magnesium ion
mm	millimeters
MMB	million barrels
MMBD	million barrels per day
MMI	Modified Mercalli Intensity
MMS	Minerals Management Service
MRA	Mississippi River Alluvial
msl	mean sea level
MVA	megavolt-ampere
MW	megawatt
Na^+	sodium ion
NAAQS	National Ambient Air Quality Standard
NEPA	National Environmental Policy Act of 1969

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

NFIA	National Flood Insurance Act
NHPA	National Historic Preservation Act
Ni	nickel
NMFS	National Marine Fisheries Service
NMHC	nonmethane hydrocaron
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NO_x	nitrogen oxides
NO_2	nitrogen dioxide
NPDES	National Pollutant Discharge Elimination System
NWI	National Wetland Inventory
OCS	outer continental shelf
OTTI	Oil Tank Texaco, Inc.
PAH	polycyclic aromatic hydrocarbon
Pb	Lead
PCB	polychlorinated biphenyl
PIRS	Pollution Incident Reporting System
ppb	parts per billion
pphm	parts per hundred million
ppm	parts per million
ppt	parts per thousand
psia	pounds per square inch absolute
ROW	right-of-way
RWI	raw water intake
SLECO	South Louisiana Electrical Company
SMEPA	Southern Mississippi Electrical Power Association
SO_4^{-2}	sulfate ion
SO_2	sulfur dioxide
SPR	Strategic Petroleum Reserve
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
T/SA	threatened due to similarity of appearance
TWC	Texas Water Commission
UAM	Urban Airshed Model
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
USLE	universal soil loss equation
VOC	volatile organic compound
Zn	zinc
μg/g	micrograms per grams
μg/l	micrograms per liter
μg/kg	micrograms/kilograms
μmho	micromho

LIST OF EQUIVALENT MEASURES

To Convert From:	To:	Multiply By:
acres	hectares	4.05×10^{-1}
	square feet	4.35×10^{4}
	square kilometers	4.05×10^{-3}
	square meters	4.05×10^{3}
	square miles	1.56×10^{-3}
barrel (petroleum)	cubic feet	5.61
	cubic meters	1.59×10^{-1}
	gallons (U.S.)	4.20×10^{1}
	liters	1.59×10^{2}
centimeters	feet	3.28×10^{-2}
	inches	3.94×10^{-1}
	meters	1.00×10^{-2}
	microns	1.00×10^{4}
	millimeters	1.00×10^{1}
	yards	1.09×10^{-2}
centimeters/second	feet/minute	1.97
	feet/second	3.28×10^{-2}
	kilometers/hour	3.60×10^{-2}
	knots	1.94×10^{-2}
	miles/hour	2.24×10^{-2}
cubic feet	cubic centimeters	2.83×10^{4}
	cubic meters	2.83×10^{-2}
	liters	2.83×10^{1}
cubic inches	cubic centimeters	1.64×10^{1}
	cubic feet	5.79×10^{-4}
	gallons (U.S. dry)	3.72×10^{-3}
	gallons (U.S. liquid)	4.32×10^{-3}
	liters	1.64×10^{-2}
	milliliters	1.64×10^{1}

LIST OF EQUIVALENT MEASURES
(Continued)

To Convert From:	To:	Multiply By:
cubic yards	cubic centimeters	7.65×10^{5}
	cubic feet	2.70×10^{1}
	cubic inches	4.67×10^{4}
	cubic meters	7.65×10^{-1}
	gallons (U.S. dry)	1.74×10^{2}
	gallons (U.S. liquid)	2.02×10^{2}
	liters	7.65×10^{2}
degrees Celsius	degrees Fahrenheit	Multiply by 1.80 and then add 32
degrees Fahrenheit	degree Celsius	Subtract 32 and then multiply by 5.56×10^{-1}
feet	centimeters	3.05×10^{5}
	inches	1.20×10^{1}
	meters	3.05×10^{-1}
	miles	1.89×10^{-4}
	yards	3.33×10^{-1}
feet/second	miles/hour	6.82×10^{-1}
gallons (U.S. Liquid)	barrels	2.38×10^{-2}
	cubic centimeter	3.79×10^{1}
	cubic feet	1.34×10^{-1}
	cubic inches	2.31×10^{2}
	cubic meters	3.79×10^{-3}
	liters	3.79
grams/square centimeter	atmospheres	9.68×10^{-4}
	millimeters of Hg	7.36×10^{-1}
	pounds/square inch	1.42×10^{-2}
horsepower	b.t.u./minute	4.24×10^{1}
	joules/second	7.46×10^{2}
	kilowatts	7.46×10^{-1}

LIST OF EQUIVALENT MEASURES
(Continued)

To Convert From:	To:	Multiply By:
inches	centimeters	2.54
	millimeters	2.54 x 10^{1}
	feet	8.33 x 10^{-2}
	meters	2.54 x 10^{-2}
	yards	2.78 x 10^{-2}
kilometers	centimeters	1.00 x 10^{5}
	feet	3.28 x 10^{3}
	meters	1.00 x 10^{3}
	miles	6.21 x 10^{-1}
	yards	1.09 x 10^{3}
kilowatt hours	b.t.u.	3.41 x 10^{3}
	joules	3.60 x 10^{6}
	watt hours	1.00 x 10^{3}
knots	centimeters/second	5.14 x 10^{1}
	feet/hour	6.08 x 10^{3}
	feet/minute	1.01 x 10^{2}
	feet/second	1.69
	kilometers/hour	1.85
	meters/minute	3.09 x 10^{1}
	meters/second	5.14 x 10^{-1}
	miles/hour	1.15
meters	centimeters	1.00 x 10^{2}
	feet	3.28
	inches	3.94 x 10^{1}
	kilometers	1.00 x 10^{-3}
	miles	6.21 x 10^{-4}
	yards	1.09
meters/second	feet/minute	1.97 x 10^{2}
	feet/second	3.28
	kilometers/hour	3.60
	kilometers/minute	6.00 x 10^{-2}
	miles/hour	2.24
micrograms	grams	1.00 x 10^{-6}
	milligrams	1.00 x 10^{-3}

LIST OF EQUIVALENT MEASURES
(Continued)

To Convert From:	To:	Multiply By:
miles	feet	5.28×10^{3}
	kilometers	1.61
	meters	1.61×10^{3}
	miles (nautical)	8.69×10^{-1}
	yards	1.76×10^{3}
miles/hour	centimeters/second	4.47×10^{1}
	feet/hour	5.28×10^{3}
	feet/second	1.47
	kilometers/hour	1.61
	knots	8.69×10^{-1}
	meters/minute	2.68×10^{1}
milligrams	grams	1.00×10^{-3}
	ounces	3.53×10^{-5}
	pounds	2.20×10^{-6}
milligrams/liter	grams/liter	1.00×10^{-3}
	parts/million (density of 1 g/ml)	1.00
	pounds/cubic foot	6.24×10^{-5}
nanometers	meters	1.00×10^{-9}
pounds	kilograms	4.54×10^{-1}
	tons	5.00×10^{-4}
ppm (parts per million)	grams/liter	1.00×10^{-3}
	milligrams/liter	1.00
pounds/square inch	atmospheres	6.80×10^{-2}
	grams/square centimeter	7.03×10^{2}
	millimeters of mercury	5.17×10^{1}
square feet	acres	2.30×10^{-5}
	square centimeters	9.29×10^{2}
	square inches	1.44×10^{2}
	square meters	9.29×10^{-2}
	square miles	3.59×10^{-8}
	square yards	1.11×10^{-1}

LIST OF EQUIVALENT MEASURES
(Continued)

To Convert From:	To:	Multiply By:
square inches	square centimeters	6.45
	square feet	6.94×10^{-3}
	square meters	6.45×10^{-4}
	square millimeters	6.45×10^{2}
square kilometers	acres	2.47×10^{2}
	square feet	1.08×10^{7}
	square inches	1.55×10^{9}
	square meters	1.0×10^{6}
	square miles	3.86×10^{-1}
	square yards	1.20×10^{6}
square miles	hectacres	2.59×10^{2}
	square feet	2.79×10^{7}
	square kilomemeters	2.59
	square yards	3.10×10^{6}
tons	kilograms	9.07×10^{2}
	pounds	2.00×10^{3}
	tons (metric)	9.07×10^{-1}
tons (metric)	kilograms	1.00×10^{3}
	pounds	2.20×10^{3}
	tons	1.10

Source: Weast, Robert C., ed., *CRC Handbook of Chemistry and Physics*, 64th Edition, CRC Press, Inc., Boca Raton, Florida, 1983-1984.

SCIENTIFIC AND COMMON NAMES: VEGETATION

Common Name	Scientific Name
PLANTS	
alligatorweed	*Alternanthera philoxeroides*
arrow head	*Saggitaria lancifolia*
beak rush	*Rhynchospora macrostachya*
begger ticks	*Bidens frondosa*
blackrush	*Juncus roemerianus*
bulltongue	*Sagittaria falcata*
bur reed	*Sparganium americanum*
clover grass	*Halophila engelmannii*
common cattail	*Typha latifolia*
common reed	*Phragmites australis*
cutgrass	*Cladium jamaicense*
duckweed	*Lemna spp.*
frogbit	*Limnobium spongia*
greenbrier	*Smilax bona-nox*
groundsel-bush	*Baccharis halimifolia*
knotweed	*Polygonum aviculare*
lizard tail	*Saururus cernuus*
loosestrife	*Lythrum lineare*
marsh fleabane	*Pluchea purpurascens*
milk weed	*Asclepias lanceolata*
morning glory	*Ipomoea purpurea*
narrow-leaved cattail	*Typha angustifolia*
parrot pitcher plant	*Sarracenia psittacina*
pennywort	*Hydrocotyle americana*
pickerel weed	*Pontederia cordata*
regal or royal) fern	*Osmunda regalis*
saltgrass	*Distichlis spicata*
saltmeadow cordgrass	*Spartina patens*
sea lavender	*Limonium carolinianum*
sedge	*Cyperus effusus*
shoalgrass	*Halodule wrightii*
smartweed	*Polygonum amphibium*
smooth cordgrass	*Spartina alterniflora*
soft rush	*Juncus effusus*
soft-stem bulrush	*Scirpus validus*
southern bayberry	*Myrica cerifera*
spider lily	*Hymenocallis occidentalis*
spike rush	*Eleocharis cellulosa*
spike rush	*Eleocharis intermedia*
spike rush	*Eleocharis obtusa*

Common Name	Scientific Name
PLANTS (cont.)	
square leaf spike rush	*Eleocharis quadrangulata*
St. John's wort	*Hypericum walteri*
turtle grass	*Thalassia testudinum*
water hyacinth	*Eichhornia crassipes*
water lettuce	*Pistia stratiotes*
water parsnip	*Sium suave*
wax myrtle	*Myrica cerifera*
white water lily	*Nymphaea odorata*
widgeon-grass	*Ruppia maritima*
wild rice	*Zizania aquatica*
GRASSES	
Bermuda grass	*Cynodon dactylon*
bluestem	*Schizachyrium spp.*
dallisgrass	*Paspalum dilatatum*
longleaf uniola	*Uniola sp.*
maidencane	*Panicum hemitomon*
mesquite	*Panicum obtusum*
prairie wildgrass	*Sphenopholis obtusata*
ryegrass	*Secale cereale*
switchgrass	*Panicum virgatum*
white clover	*Trifolium repens*
SHRUBBY VEGETATION	
American beauty berry	*Callicarpa americana*
American holly	*Ilex opaca*
bitterweed	*Helenium amarum*
blackberry	*Rubus* sp.
blue vervain	*Verbena hastata*
blueberry	*Vaccinium spp.*
butterfly pea	*Centrosema virginianum*
cypress vine	*Ipomoea quamoclit*
dahoon	*Ilex cassine*
day flower	*Commelina erecta*
deer pea	*Vigna luteola*
evening primrose	*Oenothera biennis*

Common Name	Scientific Name
SHRUBBY VEGETATION (cont.)	
devil's walkingstick	*Aralia spinosa*
greenbriar	*Smilax rotundifolia*
haw	*Viburnum nudum*
honey suckle	*Lonicera japonica*
huisache	*Acacia farnesiana*
kudzu	*Pueraria lobata*
milkweed	*Asclepias* spp.
mud plantain	*Heteranthera reniformis*
osage orange	*Maclura pomifera*
passion flower vine	*Passiflora incarnata*
peppervine	*Ampelopsis arborea*
poison ivy	*Rhus radicans*
ragweed	*Ambrosia* spp.
rattle box	*Ludwigia alternifolia*
scarlet catchfly	*Silene subciliata*
shining sumac	*Rhus copallina*
smooth blue-star	*Amsonia glaberrima*
spanish moss	*Tillandsia usneoides*
sweet flag	*Acorus calamus*
trumpet creeper	*Campsis radicans*
viburnum	*Viburnum spp.*
Virginia creeper	*Parthenocissus quinquefolia*
wild petunia	*Ruellia caroliniensis*
yaupon	*Ilex vomitoria*
yellow partridge pea	*Cassia fasciculata*
TREES	
american elm	*Ulmus americana*
bald cypress	*Taxodium distichum*
bitternut hickory	*Carya cordiformis*
black cherry	*Prunus serotina*
blackgum	*Nyssa sylvatica*
blackjack oak	*Quercus marilandica*
black tupelo	*Nyssa sylvatica*
black willow	*Salix nigra*
boxelder	*Acer negundo*
Chinese tallow tree	*Sapium sebiferum*
cottonwood	*Populus spp.*

SCIENTIFIC AND COMMON NAMES: VEGETATION (Continued)

Common Name	Scientific Name
TREES (cont.)	
honey locust	*Gleditsia triacanthos*
laurel oak	*Quercus laurifolia*
live oak	*Quercus virginiana*
loblolly pine	*Pinus taeda*
longleaf pine	*Pinus palustris*
pecan	*Carya illinoinensis*
pond pine	*Pinus serotina*
post oak	*Quercus stellata*
red maple	*Acer rubrum*
Runyon's water willow	*Justicia runyonii*
shortleaf pine	*Pinus echinata*
shortleaf pine	*Pinus taeda*
slash pine	*Pinus elliottii*
southern magnolia	*Magnolia grandiflora*
southern red oak	*Quercus falcata*
swamp chestnut oak	*Quercus michauxii*
sweet bay	*Magnolia virginiana*
sweet gum	*Liquidambar styraciflua*
water elm	*Planera aquatica*
water hickory	*Carya aquatica*
water locust	*Gleditsia aquatica*
water oak	*Quercus nigra*
water tupelo	*Nyssa aquatica*
white ash	*Fraxinus americana*
winged elm	*Ulmus alata*
AGRICULTURAL PLANTS	
cotton	*Gossypium spp.*
rice	*Oryza sativa*
soybeans	*Glycine max*
sugar cane	*Saccharum officinarum*
PHYTOPLANKTON	
blue-green algae	particularly *Trichlodesmium thiebauti*
coccolithophore	particularly *Coccolithus huxley*
diatom	*Nitzschia seriata*

SCIENTIFIC AND COMMON NAMES: VEGETATION (Continued)

Common Name	Scientific Name
PHYTOPLANKTON (cont.)	
diatom	*Thalassiothrix frauenfeldii*
diatom	*Thalassionema nitzshioides*
diatom	*Skeletonema costatum*
dinoflagellate	*Ceratium Glenodinium Gonindoma* and *Pyrocystis*

SCIENTIFIC AND COMMON NAMES: ANIMALS

Common Name	Scientific Name
AQUATIC INVERTEBRATES	
amphipods	*Gammarus* sp.
blue crab	*Callinectes sapidus*
brown shrimp	*Penaeus aztecus*
clam	*Venus spp.*
clam	*Mya spp.*
crayfish	*Cambarus spp.*
crayfish	*Astacus spp.*
grass shrimp	*Hippolyte spp.*
mussel	*Elliptio arcus*
mussel	*Obovaria unicolor*
nemtean	*Cerebratulus*
oligochaete	*Limnodrilus* sp.
oligochaete	*Peloscolex* sp.
oyster	*Ostrea spp.*
polychaete	*Sabellides oculata*
polychaete	*Loandalia fauveli*
sipunculid	*Golfingia*
white shrimp	*Penaeus setiferus*
MARINE FISH	
Atlantic croaker	*Micropogonias undulatus*
bay anchovy	*Anchoa mitchilli*
blackcheek tonguefish	*Symphurus plagiusa*
black drum	*Pogonias cromis*
dwarf sand perch	*Diplectrum bivittatum*
gafftop catfish	*Bagre marina*
Gulf menhaden	*Brevoortia patronus*
least puffer	*Sphoeroides parvus*
redfish	*Sciaenops ocellata*
red drum	*Sciaenops ocellatus*
sand seatrout	*Cynoscion arenarius*
sea catfish	*Arius felis*
sheepshead	*Archosargus probatocephalus*
southern flounder	*Paralichthys lethostigmus*
speckled trout	*Cynoscion nebulosus*
striped anchovy	*Anchoa hepsetus*

SCIENTIFIC AND COMMON NAMES: ANIMALS (Continued)

Common Name	Scientific Name
FRESHWATER FISH	
American eel	*Anguilla rostrata*
banded pygmy sunfish	*Elassoma zonatum*
bigeye chub	*Hybopsis amblops*
blackbanded darter	*Percina nigrofasciata*
black crappie	*Pomoxis nigromaculatus*
blackspotted topminnow	*Fundulus olivaceus*
blacktail redhorse	*Moxostoma poecilurum*
blacktail shiner	*Notropis venustus*
blue catfish	*Ictalurus furcatus*
bluegill	*Lepomis macrochirus*
bowfin	*Amia calva*
brindled madtom	*Noturus miurus*
brook silverside	*Labidesthes sicculus*
bullhead minnow	*Pimephales vigilax*
carp	*Cyprinus carpio*
chain pickerel	*Esox niger*
channel catfish	*Ictalurus punctatus*
cherryfin shiner	*Notropis roseipinnis*
common shiner	*Notropis cornutus*
crystal darter	*Ammocrypta asprella*
dollar sunfish	*Lepomis marginatus*
emerald shiner	*Notropis atherinoides*
freckled madtom	*Noturus nocturnus*
freckled darter	*Percina lenticula*
freshwater drum	*Aplodinotus grunniens*
gizzard shad	*Dorosoma cepedianum*
golden shiner	*Notemigonus crysoleucas*
grass pickerel	*Esox americanus vermiculatus*
gulf darter	*Etheostoma swaini*
harlequin darter	*Etheostoma histrio*
hogchoker	*Trinectes maculatus*
largemouth bass	*Micropterus salmoides*
logperch	*Percina caprodes*
longear sunfish	*Lepomis megalotis*
longnose shiner	*Notropis longirostris*
mooneye	*Hiodon tergisus*
mosquitofish	*Gambusia affinis*
mud darter	*Etheostoma asprigene*
naked sand darter	*Ammocrypta beani*
northern hog sucker	*Hypentelium nigricans*

Common Name	Scientific Name
FRESHWATER FISH (cont.)	
pinfish	*Lagodon rhomboides*
pugnose minnow	*Notropis emiliae*
quillback	*Carpiodes cyprinus*
redear sunfish	*Lepomis microlophus*
redeye chub	*Notropis harperi*
redfin pickerel	*Esox americanus*
river carpsucker	*Carpiodes carpio*
rock bass	*Ambloplites rupestris*
sharpfin chubsucker	*Erimyzon tenuis*
silver chub	*Hybopsis storeriana*
silverjaw minnow	*Ericymba buccata*
smallmouth buffalo	*Ictiobus bubalus*
speckled chub	*Hybopsis aestivalis*
speckled darter	*Etheostoma stigmaeum*
speckled madtom	*Noturus leptacanthus*
spotted bass	*Micropterus punctulatus*
spotted gar	*Lepisosteus oculatus*
striped bass	*Morone saxatilis*
striped mullet	*Mugil cephalus*
tadpole madtom	*Noturus gyrinus*
weed shiner	*Notropis texanus*
white crappie	*Pomoxis annularis*
REPTILES AND AMPHIBIANS	
alligators	*Alligator mississippiensis*
American crocodile	*Crocodylus acutus*
Atlantic green sea turtle	*Chelonia mydas mydas*
coachwhip snake	*Masticophis flagellum*
copperhead	*Agkistrodon contortrix*
coral snake	*Micrurus fulvius*
cottonmouth	*Agkistrodon piscivorus*
green anole	*Anolis carolinensis*
Kemp's ridley sea turtle	*Lepidochelys kempii*
leatherback sea turtle	*Dermochelys coriacea*
loggerhead sea turtle	*Caretta caretta*
Louisiana pine snake	*Pituophis melanoleucus ruthveni*
Mississippi mud turtle	*Kinosternon subrubrum hippocrepis*
northern scarlet snake	*Cemophora coccinea copei*

Common Name	Scientific Name
REPTILES AND AMPHIBIANS (cont.)	
pig frog	*Rana grylio*
rat snake	*Elaphe obsoleta*
ringed map turtle	*Graptemys oculifera*
rough green snake	*Opheodrys aestivus*
snapping turtle	*Chelydra serpentina*
southern painted turtle	*Chrysemys picta dorsalis*
speckled kingsnake	*Lampropeltis getulus holbrooki*
Texas horned lizard	*Phrynosoma cornutum*
timber rattlesnake	*Crotalus horridus*
western smooth green snake	*Opheodrys vernalis blanchardi*
yellow-blotched map turtle	*Graptemys flavimaculata*
BIRDS	
anhingas	*Anhinga anhinga*
Arctic peregrine falcon	*Falco peregrinus*
Attwater's greater prairie chicken	*Tympanuchus cupido*
Bachman's sparrow	*Aimophila aestivalis*
barred owls	*Strix varia*
black-crowned night herons	*Nycticorax nycticorax*
American black duck	*Anas rubripes*
black skimmers	*Rynchops niger*
black vulture	*Coragyps atratus*
blue jay	*Cyanocitta cristata*
boat-tailed grackle	*Quiscalus major*
northern bobwhite	*Colinus virginianus*
cardinal	*Cardinalis cardinalis*
Carolina chickadee	*Parus carolinensis*
Carolina wren	*Thryothorus ludovicianus*
cattle egrets	*Bubulcus ibis*
rufous-sided towhee	*Pipilo erythrophthalmus*
eastern wild turkey	*Meleagris gallopavo*
Florida sandhill crane	*Grus canadensis pratensis*
glossy ibis	*Plegadis falcinellus*
great blue herons	*Ardea herodias*
great egrets	*Casmerodius albus*
green-winged teal	*Anas crecca*
hooded warbler	*Wilsonia citrina*
killdeer	*Charadrius vociferus*

SCIENTIFIC AND COMMON NAMES: ANIMALS (Continued)

Common Name	Scientific Name
BIRDS (cont.)	
least tern	*Sterna antillarum*
lesser snow goose	*Chen caerulescens*
little blue herons	*Egretta caerulea*
mallard	*Anas platyrhynchos*
northern harrier	*Circus cyaneus*
mockingbird	*Mimus polyglottos*
mourning dove	*Zenaida macroura*
night hawk	*Chordeiles minor*
olivaceous cormorants	*Phalacrocorax olivaceus*
pileated woodpecker	*Dryocopus pileatus*
pine warbler	*Dendroica pinus*
northern pintail	*Anas acuta*
piping plover	*Charadrius melodus*
red-cockaded woodpecker	*Picoides borealis*
reddish egret	*Egretta rufescens*
red-shouldered hawk	*Buteo lineatus*
red-tailed hawk	*Buteo jamaicensis*
roseate spoonbills	*Ajaia ajaja*
ruby-throated hummingbird	*Archilochus colubris*
snowy egrets	*Egretta thula*
sooty tern	*Sterna fuscata*
southern bald eagle	*Haliaeetus leucocephalus*
summer tanager	*Piranga rubra*
swallow-tailed kite	*Elanoides forficatus*
tufted titmouse	*Parus bicolor*
white ibis	*Eudocimus albus*
wood stork	*Mycteria americana*
MARINE MAMMALS	
Atlantic spotted dolphin	*Stenella frontalis*
false-killer whale	*Pseudorca crassidens*
killer whale	*Orcinus orca*
rough-toothed dolphin	*Steno bredanensis*
short-finned pilot whale	*Globicephala macrorhynchus*

Common Name	Scientific Name
TERRESTRIAL MAMMALS	
banded armadillo	*Dasypus novemcinctus*
black bear	*Ursus americanus*
bobcat	*Lynx rufus*
eastern cottontail	*Sylvilagus floridanus*
coyote	*Canis latrans*
gray fox	*Urocyon cinereoargenteus*
gray squirrel	*Sciurus carolinensis*
jaguarundi	*Felis yagouaroundi*
mink	*Mustela vison*
muskrat	*Ondatra zibethicus*
nutria	*Myocastor coypus*
opossum	*Didelphis virginiana*
river otter	*Lutra canadensis*
raccoon	*Procyon lotor*
Rafinesque's big-eared bat	*Plecotus rafinesquii*
red wolf	*Canis rufus*
ringtail	*Bassariscus astutus*
swamp rabbit	*Sylvilagus aquaticus*
white-tailed deer	*Odocoileus virginianus*

Documents used to check scientific names:

Correll, D.S., and M.C. Johnston, 1979, Manual of the Vascular Plants of Texas, University of Texas at Austin, Richardson, TX.

Banks, R.C., R.W. McDiarmid, and A.L. Gardner, 1987, Checklist of Vertebrates of the United States, the U.S. Territories, and Canada, U.S. DOI/FWS, Washington, DC.

Lee, D.S., et al., 1980, Atlas of North American Freshwater Fishes, North Carolina State Museum of Natural History.

GLOSSARY

advection — The transport of energy or matter in a fluid stream, such as winds of the atmosphere or currents in the sea.

alluvial — Relating to, composed of, or found in the clay, silt, sand, gravel, or similar detrital material deposited by running water; see detritus.

altricial — Pertaining to young that are born or hatched immature and helpless, thus requiring extended development and parental care.

anhydrite — An insoluble mineral ($CaSO_4$) that occurs, among other places, with rock salt in salt beds and salt domes as a consequence of its precipitation during the evaporation of shallow seas in an enclosed basin. This sand-like material settles out of brine generated during leaching of salt domes.

anisotropic — Exhibiting different properties such as velocity of light transmission, conductivity of heat or electricity, compressibility, and so on, in different directions.

annual — A plant that completes its growth in one growing season.

anticline — An arch-shaped fold in stratified sedimentary rock in which the layers bend downward in opposite directions from the crest. Compare "syncline."

aqueous film forming foam (AFFF) — A water-based fire-fighting agent used to cover and extinguish hydrocarbon based fires. AFFF is generally based on perflorinated and hydrocarbon surfactants.

aquiclude — A stratum of clay or other fine-grained material that is partially or totally restrictive of water.

aquifer — An underground geological formation, or group of formations, containing usable amounts of fresh groundwater that can supply wells and springs. Saline aquifers can occur in coastal regions.

aquitard — A bed of low permeability adjacent to an aquifer. It may serve as a storage unit for groundwater, although it does not yield water readily.

GLOSSARY (Continued)

barotropic — The state of a fluid in which surfaces of constant density (or temperature) are coincident with surfaces of constant pressure.

base flood — The flood which has a 1.0 percent chance of occurrence in any given year (also known as a 100-year flood).

bathymetry — The art or science of determining depths of water.

benthic organism (benthos) — A form of aquatic plant or animal life that is found on or near the bottom of a stream, lake, or ocean.

berm — A horizontal ledge cut between the foot and top of an embankment to stabilize the slope by intercepting sliding earth.

bioassay — Any test in which organisms are used to detect or measure the presence or effect of one or more substances or environmental conditions.

biochemical oxygen demand (BOD) — A measure of the amount of oxygen consumed in the breakdown of organic matter. The greater the BOD, the greater the extent of biological matter that possibly originated from anthropogenic sources (i.e., untreated sewage).

biomass — The dry weight of living matter, including stored food, present in a species population and expressed in terms of a given area or volume of the habitat.

borehole — A hole made by drilling into the ground to study stratification, to release underground pressures, or to construct a production well, a disposal well, or a storage cavern in salt rock.

breccia — A rock consisting of sharp fragments embedded in a fine-grained matrix.

brine — Water containing a higher concentration of dissolved salt than that of the ocean.

brine pond — Lined pond where brine generated by cavern leaching is impounded before disposal to remove settleable solids and contaminants, such as oil.

bulkhead — A retaining wall along a waterfront. A tight-seal partition or structure to protect against water, fire, or gas, as in a mine.

buttressing — The swelling or enlargement of the base of a tree, developed in response to conditions of prolonged flooding or inundation.

caliper pig — An electronically instrumented pig to determine by acoustical means the thickness of a pipeline wall.

canopy — Overhanging plants shading the surface below them (such as large trees).

caprock — Rock often but not always occurring on top of a salt dome that is chemically derived from the action of groundwater and other forces on anhydrite in the salt mass; alteration products typically include gypsum, calcite, free sulphur, and hydrogen sulfide.

casing — Steel pipe used in oil wells to seal off fluids from the borehole and to prevent the walls of the hole from sloughing off or caving. There may be several strings of casing in a well, one inside the other.

casing/borehole annulus — The space between the borehole and the casing in an injection well. Also, the space between a suspended tubing and the casing of an oil storage cavern well.

clay — Soil consisting of inorganic material, the grains of which have diameters smaller than 0.005 mm.

climax community — A mature, stable community in an area which will undergo no further change under the prevailing climate; represents the culmination of ecological succession.

convective activity — Atmospheric motions that are predominantly vertical, resulting in vertical transport and mixing of atmospheric properties (such as heat and moisture).

copepod — Any of a large subclass of usually minute freshwater and marine crustaceans; a major component of the zooplankton.

critical action — Any activity for which even a slight chance of flooding would be too great (for example, storage of highly volatile, toxic, or water reactive materials).

crustaceans — A class of aquatic invertebrate organisms with a hard external skeleton.

dBa — Adjusted decibel level. A sound measurement that adjusts noise by filtering out certain frequencies to make it analogous to that perceived by the human ear.

decibel (db) — A logarithmic scale which comprises over one million sound pressures audible to the human ear over a range from 0 to 140, where zero decibels represents a reference sound level necessary for a minimum sensation of hearing and 140 decibels represents the level at which pain occurs.

demersal — Living near, deposited on, or sinking to the bottom of the sea.

detritus — Any loose material (such as rock fragments or organic particles) removed from its place of origin by mechanical means, such as disintegration or abrasion.

digenesis — Chemical and physical changes occurring in sediments during and after their deposition but before consolidation.

diffuser — The structure at the end of a pipeline that disperses an effluent discharge into a receiving water body by the action of jet dilution through a series of ports.

dinoflagellata — An order of flagellate protozoans; most have fixed shapes determined by thick covering plates.

direct impacts — See primary impacts.

dissolved oxygen (DO) — The oxygen freely available in water. Dissolved oxygen is vital to the respiration of fish and other aquatic life. Traditionally, the level of dissolved oxygen has been accepted as the single most important indicator of a water body's ability to support desirable aquatic life.

dissolved solids — Unfilterable organic and inorganic material, such as salt dissolved in water. Excessive amounts make water unfit to drink or use in industrial processes. Compare "total suspended solids."

dolphin — A mooring post on a wharf.

drawdown — The process of removing oil from a storage cavern by displacing the oil with water or brine.

easement	The strip of land for which permission has been granted by another person for use or passage.
ecoregion	A region containing relatively similar ecological systems. Determined by regional variations in climate, vegetation, and landform.
ecosystem	A complex system comprised of communities of organisms and their physical surroundings.
embayment	Indentation in a shoreline forming a bay.
emergent	An aquatic plant with vegetative growth mostly above the water.
endangered	A species that is in danger of extinction throughout all or a significant portion of its range.
epifauna	Animals that live on the substrate such as mollusks, crustaceans, hydroids, sponges, anemones, and corals.
epipelagic	Of or pertaining to the portion of oceanic zone into which enough light penetrates to allow photosynthesis.
epiphyte	A plant which grows nonparasitically on another plant or on some living structure, such as a building or telephone pole, deriving moisture and nutrients from the air.
episode	An air pollution incident in a given area caused by a concentration of atmospheric pollution reacting with meteorological conditions that may result in a significant increase in illnesses or deaths.
estuarine system	Deep water habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean. Ocean water is at least occasionally diluted by freshwater runoff from the land, and their interplay results in a nutrient trap making the estuarine system more productive than either freshwater or marine systems.
estuary	A semi-enclosed coastal body of water which has a free connection with the open sea and within which seawater is measurably diluted with fresh water.
euphotic zone	The upper layers of a body of water into which sufficient light penetrates to permit growth of green plants.

euryhaline	Pertaining to the ability of some marine organisms to tolerate a wide range of saline conditions, and therefore a wide variation of osmotic pressure, in the environment.
eutrophication	The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication the water body is choked by abundant plant life as the result of increased amounts of nutritive compounds such as nitrogen and phosphorus.
fecal coliform bacteria	Bacteria found in the intestinal tracts of mammals. These bacteria are necessary for normal digestion. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.
floodplain	The lowlands adjoining inland and coastal waters and relatively flat areas and floodprone areas of offshore islands including at a minimum, that area inundated by a 1 percent or greater chance flood in any given year.
fluvial	Pertaining to or produced by the action of a stream or river. Existing, growing, or living in or near a river or stream.
forb	A weed or broadleaf herb.
geomorphology	The study of the origin of secondary topographic features which are carved by erosion in the primary elements and built up of the erosional debris.
geosyncline	A large trough-like downwarping caused by shifts in the of the earth's crust. Thick successions of sedimentary or volcanic rock may accumulate in the depression.
gravel	Rock grains larger than 2.0 mm in diameter.
grubbing	Clearing of land by digging up roots or stumps.
halite	Rock salt, sodium chloride.
halocline	A well defined vertical gradient of salinity in the oceans and seas.
halokinesis	The process of deformation or plastic flow of salt under pressure and/or heat that can result in enlargement or closure of caverns or other spaces in a salt mass.

hydric — Characterized by, relating to, or requiring an abundance of moisture.

hydroclone — A separator in which granular solids are removed from a stream of water by centrifugal force.

hydrostatic test — Test of strength and leak-resistance of a vessel, pipe, or other hollow equipment by internal pressurization with a test liquid.

hypersaline — Geologic material with high salinity.

in-migration — The number of people moving into a given geographic area in a particular period of time.

indigenous — Native; originating in a particular region.

infauna — Animals that live in the substrate such as burrowing worms and mollusks.

interstitial — Relating to or situated in the space that intervenes things. For example, groundwater that occupies the voids, pores, or interstices within rock, sedimentary deposits, or soil is known as interstitial groundwater.

invertebrate — An animal lacking a backbone and internal skeleton.

irreversibly committed resources/ irretrievable resources — Resources that are used in the development of a facility that can not be recovered or recycled.

isobath — A contour line connecting points of equal water depths on a chart.

isohaline — Of equal or constant salinity. A line on a chart connecting all points of equal salinity.

karst terrain — Usually formed on limestone and to a lesser extent on dolomite. These areas normally have developed cavities as a result of dissolution of calcite or dolomite by water which may permit the ready transport of ground water and, if present, contamination.

L_d — Level of noise (measured in decibels) averaged over the daytime period (0700-2200).

L_{dn}	Nighttime noise level (L_n) adjusted to account for the perception that a noise level at night is more bothersome than the same noise level would be during the day.
L_{eq}	Level of noise (in decibels) averaged over a period of time.
L_n	Level of noise (measured in decibels) averaged over the nighttime period (2200-0700).
lacustrine	Belonging to or produced by lakes.
laydown yard	Storage area for equipment and materials to be used for maintenance or construction.
leaching	The process of creating space in rock salt by dissolving the salt with injected water and removing the resultant brine.
lightering	Vessel-to-vessel transfer of cargo.
lithology	The character of a rock formation.
loess	Windblown, homogeneous, nonstratified deposit consisting primarily of silt and subordinate amounts of very fine sand and/or clay.
macrocrustacean	Crustacean larger than 0.5 mm in length (e.g., shrimp, lobsters, crayfish).
macroinvertebrate	Invertebrate larger than 0.5 mm in length.
macroinvertebrate infauna	Invertebrates larger than 0.5 mm in length living within a soft sediment.
marsh	A transitional land-water area, covered at least part of the time by estuarine or coastal waters, and characterized by aquatic and grasslike vegetation, especially without peat-like accumulation.
meroplankton	Plankton composed of floating developmental stages (that is, eggs and larvae) of the benthos and nekton organisms. Also known as temporary plankton.
modified mercalli scale	An arbitrary scale of earthquake intensity ranging from I (detectable only with instruments) to XII (causing almost total destruction).

GLOSSARY (Continued)

nekton — Free-swimming aquatic animals, essentially independent of water movements.

nektobenthos — Those forms of marine life that exist just above the ocean bottom and occasionally rest on it.

neritic — Of or pertaining to the region of shallow water adjoining the seacoast and extending from low-tide mark to a depth of about 660 feet (200 meters).

net migration — The overall change in the population of a given geographic area in a particular period of time that is attributable to in-migration and out-migration. Specifically, net migration equals in-migration minus out-migration.

net primary productivity — The net increase in plant biomass per unit time ($g/m^2/yr$).

out-migration — The number of people moving out of a geographic area in a particular period of time.

overstory — The tallest spatially dominant species in a forest; usually composed of coniferous or deciduous tree species.

palustrine wetlands — All non-tidal wetlands dominated by trees, shrubs, or persistent emergent vegetation. Includes wetlands traditionally called marshes, swamps, or bogs.

passerines — Of or relating to the largest order (Passeriformes) of birds which includes more than half of all living birds and consists chiefly of altricial songbirds of perching habits.

pelagic — Relating to, living in, or occurring in the open sea.

perennial — A plant with a lifespan of two or more years.

permeability — Capacity for transmitting a fluid, measured by a rate that a fluid of standard viscosity can move a given distance through an interval of time.

pig — A cylindrical device (three to seven feet long) inserted in a pipeline for the purpose of sweeping the line clean of water, rust, or other foreign matter.

piercement — A dome or anticlinal fold in which a mobile plastic core (i.e., salt) has ruptured the more brittle overlying rock. Also known as a diapir, dipiric fold, piercement dome, or piercing fold.

phytoplankton Planktonic plant life.

plankton Passively floating or weakly mobile aquatic plants and animals.

plug To fill a well's borehole with cement or other impervious matter to prevent the flow of water, gas, or oil from one strata to another when a well is abandoned.

To place a permanent obstruction at the junction of a saline water body and pipeline ROW to prevent salt water intrusion into freshwater or to prevent the formation of new water courses.

primary impacts The effects of the development of a facility that occur as a direct result of the construction of that facility. Also called direct impacts.

progradation Seaward buildup of a beach, delta, or fan by nearshore deposition of sediments transported by a river, by accumulation of material thrown up by waves, or by material moved by longshore drifting.

right-of-way (ROW) The right held by one person over another person's land for a specific use; rights of tenants are excluded. The strip of land for which permission has been granted to build and maintain a linear structure, such as a road, railroad, pipeline, or transmission line.

riverine Relating to, formed by, or resembling a river.

room-and-pillar salt mine A system of mining where the salt is mined in rooms separated by narrow ribs or pillars; pillars are subsequently worked.

salt dome A nearly vertical columnar or domed mass of salt resulting from upward plastic flow from an underlying salt bed induced by the pressure differentials between it and more dense overburden.

sand Sand consisting of inorganic material, the grains of which have diameters between 0.025 mm and 2.0 mm.

scrub-shrub Areas dominated by woody vegetation less than 6 m (20 feet) tall, which includes true shrubs and young trees.

GLOSSARY (Continued)

shear zone — A tabular area of rock that has been crushed and brecciated by many parallel fractures resulting from shear strain; often becomes a channel for underground fluids and the seat of ore deposition.

sheepsfoot roller — A cylindrical steel drum to which knob headed spikes are fastened; used for compacting earth.

silt — Soil consisting of inorganic material, the grains of which have diameters between 0.0625 mm and 0.2 mm.

skimmers — A self-propelled, boat-like oil spill clean-up device that removes spilled oil from the surface of a water body into a tank.

slabbing — A process that creates loose slabs of salt on cavern walls and roof and occurs as the result of the anisotropic properties of sheared or impure salt.

spoil — Dirt or rock that has been removed from its original location, destroying the composition of the soil in the process.

subgrade — The soil or rock leveled off to support the foundation of a structure.

subsidence — The geological sinking or downward settling of an area on the earth's surface, resulting in the formation of a depression.

succession — A gradual process in an ecosystem brought about by the change in the number of individuals of each species of a community and by the establishment of new species populations which may gradually replace the original inhabitants.

sump — A pit or tank which receives and temporarily stores drainage at the lowest point of a circulating or drainage system.

surfactant — A soluble compound that reduces the surface tension of liquids, or reduces interfacial tension between two liquids or a liquid and a solid.

syncline — A trough or basin-shaped fold in stratified sedimentary rock in which the layers dip toward each other from either side. Compare "anticline."

GLOSSARY (Continued)

threatened — A species that is likely to become an endangered species within the foreseeable future throughout all or part of its range.

total suspended solids (TSS) — The mass of filterable dried particulate organic and inorganic matter per unit volume of liquid in which it floats or is suspended; exclusive of dissolved matter, such as soluble salts.

unavoidable impacts — Those effects that are inevitable, even after mitigation measures, given the construction and development of a facility.

understory — Low lying vegetation growing beneath the overstory of a forest; usually composed of herbaceous plants, shrubs, and small saplings.

vertebrate — An animal having a backbone.

volatile organic compound (VOC) — Any organic compound that participates in atmospheric photochemical reactions.

wetland — As defined by 40 CFR 230.3, wetlands are, "...those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

1.0 NEED FOR AND PURPOSE OF THE PROPOSED ACTION

The Strategic Petroleum Reserve (SPR) was created to provide the United States (U.S.) with sufficient petroleum reserves to reduce the impacts of any future oil supply interruption and to carry out the obligations of the U.S. under the International Energy Program. Congress mandated the creation of the SPR in the Energy Policy and Conservation Act (EPCA) of 1975 and established as a national goal the storage of up to one billion barrels of crude oil and petroleum products. In the early stages of the SPR program, plans were approved for the development of facilities and systems for a 750 million barrels (MMB) Reserve. Decisions on developing the final 250-MMB increment of a one-billion-barrel program were deferred.

In 1990, Congress enacted two bills mandating the Department of Energy (DOE) to undertake the planning and environmental activities necessary to develop the final 250-MMB increment of a one-billion-barrel SPR.[a] The purpose of the proposed action is to implement these applicable statutes.

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[a] The Energy Policy and Conservation Act Amendments (1990), PL 101-383, and the Department of Interior and Related Agencies Appropriations Act for Fiscal Year 1991 (1990), PL 101-512.

2.0 PROPOSED ACTION

DOE proposes to plan for the expansion of the SPR by an additional 250 MMB to a total of one billion barrels pursuant to Congressional directive (P.L. 101-383 and P.L. 101-512). The purpose of this chapter is to set the scope of the Environmental Impact Statement (EIS), which has been prepared in accordance with CEQ regulations in 40 CFR Part 1500 and with DOE NEPA Implementing Procedures in 10 CFR Part 1021. A brief overview is presented of the sites under consideration for storage development and the ways for achieving alternative oil distribution capabilities for each. The phased development of the Reserve's current systems, configuration, and capabilities is reviewed and brief descriptions are provided of major facility components, systems, and operations common to SPR facilities that would bear on the impacts of any of the alternatives.

Chapter 3 presents a more detailed description of the expansion alternatives being considered.

2.1 Background

Current SPR facilities are centralized in three oil distribution complexes: (1) the Capline Complex, located in eastern Louisiana; (2) the Texoma Complex, located in western Louisiana and eastern Texas; and (3) the Seaway Complex, located in Texas (Figure 2.1-1). The complexes are grouped according to the three major interstate common carrier pipelines (which existed in the 1970s) to which the storage sites would connect. In each complex, storage facilities and distribution systems include solution-mined caverns or room-and-pillar salt mine cavities, pipelines, above ground tanks, and marine facilities. The overall SPR system is designed to make maximum use of available commercial facilities. The DOE has, however, constructed such facilities where necessary to enhance distribution.

The SPR currently consists of six underground storage facilities: Bryan Mound, Texas, which is connected to the Seaway Complex; Big Hill, Texas, and Sulphur Mines and West Hackberry, Louisiana, connected to the Texoma Complex; and Weeks Island and Bayou Choctaw, Louisiana, which are located in the Capline Complex. Development of facilities for the 750-MMB Reserve was completed in September 1991 with the completion of storage capacity development at Bayou Choctaw and Big Hill. Currently, about 570 MMB of crude oil are in storage. Sulphur Mines is being decommissioned, and the oil from this facility was transferred to Big Hill during 1991. The storage capacity and current crude oil inventories for each site are shown in Table 2.1-1. The SPR also includes a marine terminal on the Mississippi River at St. James, Louisiana and an administrative facility in New Orleans.

In the course of the development of the 750-MMB Reserve, DOE has prepared a number of EISs. A programmatic EIS, published in 1976, addressed the development of a 500-MMB storage program.[1] The programmatic EIS considered several different storage alternatives: existing solution-mined caverns in salt formations, existing conventional mines, development of new solution-mined caverns in salt domes, existing and new surface tankage, and surplus tanker ships. A supplement to the programmatic EIS, addressing an expansion of the SPR to one billion barrels, was published in January 1979.[2]

The development of the 750-MMB Reserve was implemented in three phases. Phase I consisted of converting 248 MMB of preexisting storage space at five salt domes, constructing a

Figure 2.1-1
SPR Distribution Complexes

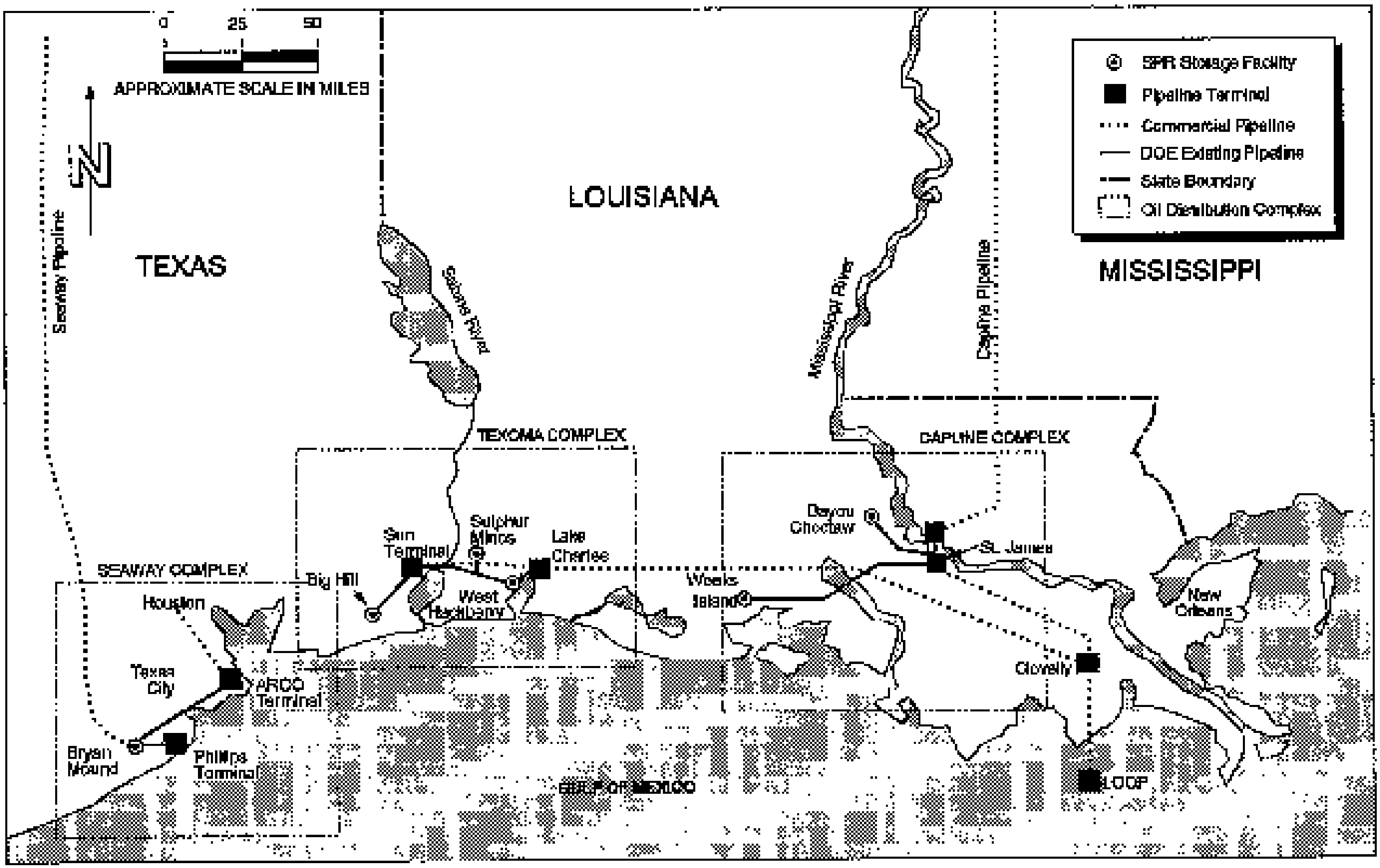


Table 2.1-1
Storage Capacity and Crude Oil Inventory in Millions of Barrels
for Current SPR Facilities

Storage Facility	Distribution Complex	Current Storage Capacity	Current Crude Oil Inventory
Bryan Mound	Seaway	226	218
Big Hill	Texoma	160	24
West Hackberry	Texoma	219	206
Sulphur Mines*	Texoma	0	0
Bayou Choctaw	Capline	72	48
Weeks Island	Capline	73	73
TOTAL		750	569**

* Site currently being decommissioned; inventory transferred to Big Hill.
** Total includes crude oil in pipelines.

Source: *SPR Inventory and Fill Rate Statistics*, November 30, 1991.

DOE-owned marine terminal on the Mississippi River at St. James, Louisiana, and constructing the connecting crude oil pipelines. These facilities -- West Hackberry, Bryan Mound, Weeks Island, Bayou Choctaw, and Sulphur Mines salt domes and the St. James Terminal -- were addressed in eight EISs and Supplements published in 1977 and 1978.[3]

Phase II involved the expansion of the Reserve by 290 MMB to 538 MMB and increasing drawdown capability from 1.7 million barrels per day (MMBD) to 3.5 MMBD. This was done by leaching new storage space in salt domes and disposing of the resulting brine by large-scale discharge in the marine environment. Three separate EISs were published in 1978 to address the Phase II alternatives by Seaway, Texoma, and Capline Complex groupings.[4] Phase II was implemented by expanding three existing SPR sites -- West Hackberry, Bryan Mound, and Bayou Choctaw.

Phase III consisted of expanding the SPR to the present 750 MMB storage capacity and increasing drawdown to 4.5 MMBD by further expansions of West Hackberry and Bryan Mound and the grass-roots development of a new site, Big Hill. This was covered in the Phase III EIS.[5]

During the 1980s, DOE also took actions to expand and modify the SPR's distribution system in response to industry infrastructure changes and to expand two sites, Big Hill and Bayou Choctaw, and decommission the Sulphur Mines facility to reduce long-term operating costs of the Reserve. These actions were considered in a series of four Environmental Assessments prepared between 1985 and 1990.[6]

Projections of petroleum supply and demand in the U.S. have prompted Congress to ask DOE to address the need for an expansion of the SPR. Over the next ten years: (1) U.S. oil consumption is expected to increase slowly; (2) domestic oil production is expected to decline significantly; and (3) petroleum imports, particularly crude oil, is expected to increase greatly to meet the nation's net petroleum supply requirements.[7]

2.1.1 Expansion Approach

The approach to an SPR expansion would be based on those general concepts of development utilized in the implementation of the current 750-MMB SPR which are:

- **U.S. Government-Owned.** The DOE would acquire and maintain both storage facilities and petroleum stocks. DOE would not exercise its discretionary authority under EPCA to create an Industrial Petroleum Reserve requiring industry to store a portion of the Reserve.

- **Centralized Gulf Coast Reserve.** The SPR would continue to be centralized in the U.S. Gulf Coast region. The Gulf Coast region is a primary location because:

    1. The Gulf Coast contains approximately 40 percent of the U.S. refining capacity and is a major crude oil and product distribution center.

    2. The Gulf Coast is the place of entry for approximately 60 percent of crude imports and 45 percent of all petroleum imports.

    3. The Gulf Coast location provides distribution flexibility to respond to a wide range of supply interruptions.

    4. A centralized Reserve minimizes costs.

- **Petroleum to be Stored.** Only crude oil would be stored in the Reserve.

- **Storage Facilities.** The SPR would continue to store petroleum in underground salt dome storage caverns. These facilities provide a combination of large capacities, assured containment, excellent security and safety, low environmental impact, and low development and maintenance costs.[8]

Specifically, a 250-MMB expansion of the SPR would be accomplished by solution mining, or leaching, 150 MMB of new storage capacity in a salt dome in the SPR Capline Complex and 100 MMB of new storage capacity in a salt dome in the SPR Seaway Complex. A larger proportion of the incremental storage is planned for the Capline Complex in order to capitalize on the refinery distribution potential provided through the Capline Pipeline System, a commercial common carrier that is expected to continue to be the dominant import carrier to the Midwest. A further consideration is that the SPR Capline Complex has never been developed to the level of storage capacity envisioned in the original SPR Plan; currently, the Capline Complex comprises only 20 percent of the Reserve.

2.1.2 Drawdown Criteria

In the early days of the SPR's development, the drawdown criterion was that each and all sites would be capable of being drawn down within 150 days. As the Reserve grew in size, the drawdown rate increased but the duration criterion was extended. The drawdown criterion for the 750-MMB Reserve as currently configured is a maximum sustainable rate of 4.5 MMBD with complete drawdown achievable within 180 days (i.e., a 180-day criterion).

In DOE's March 1991 Report to Congress on candidate sites for the one billion-barrel Reserve, DOE projected the need to increase the drawdown rate to 6.0 MMBD which corresponded to the current 180-day criterion. Subsequently, consideration has been given to the cost-effectiveness of retaining the high rate, short duration approach. In this review, the Department considered the likely costs of alternative initial distribution rate capabilities, the potential need for alternative rates, and the likelihood that further decisions will be needed to reflect changes in industry patterns.

Consequently, DOE is now proposing to establish a minimum drawdown rate capability of 4.5 MMBD for the one-billion-barrel Reserve and a 270-day criterion for full drawdown of the expansion sites. This expansion approach for the Reserve is projected to augment the SPR's drawdown capabilities as shown in Figure 2.1-2. However, in consideration of the uncertainty in future supply and demand and distribution patterns, DOE recognizes that future national policy decisions could reasonably be expected to change the SPR drawdown rate for some or all sites. Therefore, this EIS also assesses the actions required to change the drawdown criterion from a 270-day capability to a 180-day capability which corresponds to a 50 percent increase in the drawdown rate capability.

2.2 Site Selection Approach

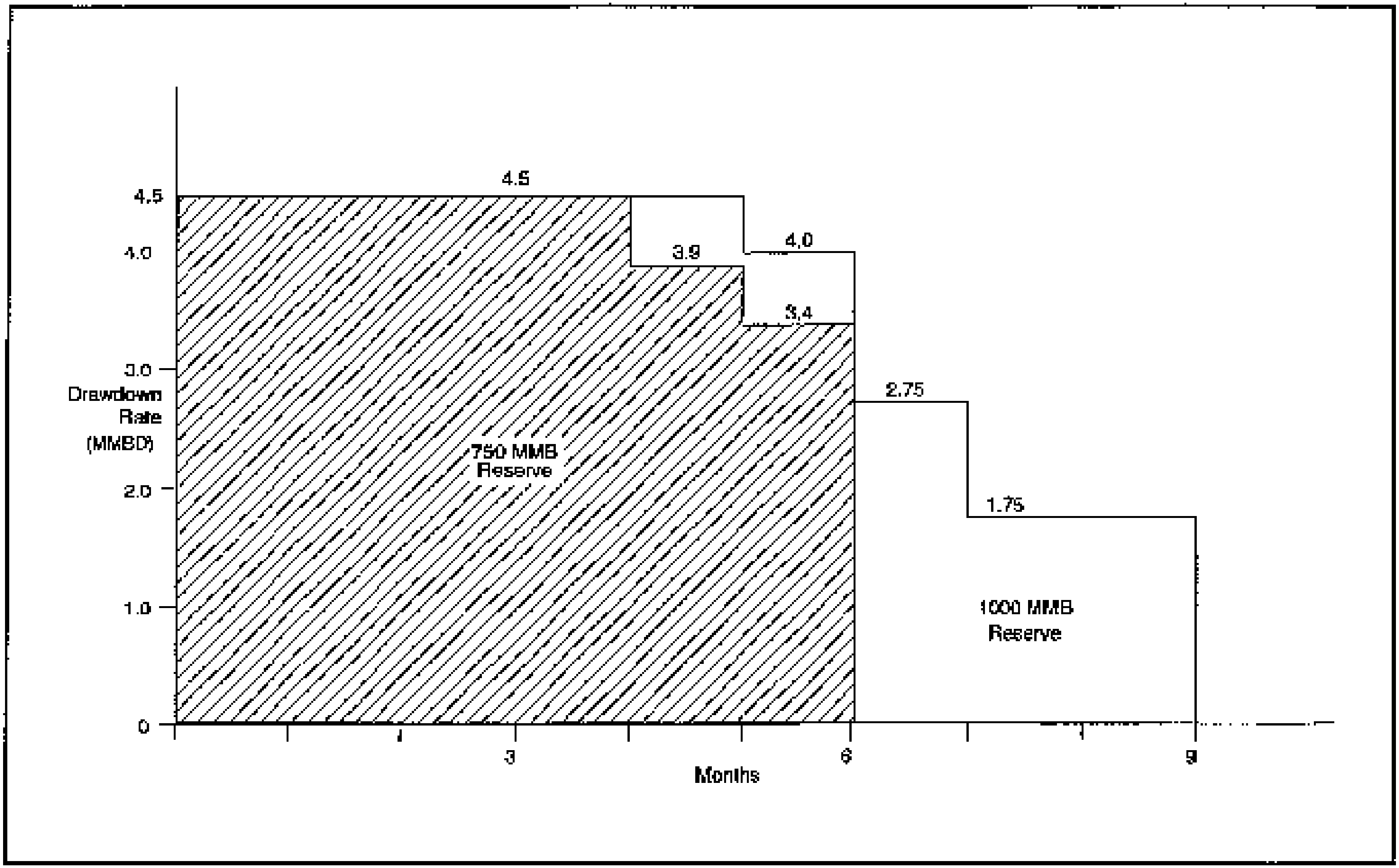
The DOE screened more than 550 onshore and offshore salt domes in the Gulf Coast to identify specific candidate sites for further environmental assessment under NEPA.

The initial site screening process was performed in 1988 and resulted in a long list of 30 and a short list of seven salt dome candidates. The site screening procedure included technical, environmental, and cost criteria and is described in DOE's 1989 Report to Congress on expansion of the SPR.[9]

In 1990, the long list of 30 salt dome candidates was re-assessed in terms of the SPR's expansion and distribution objectives, geotechnical characteristics, and environmental aspects. This screening process yielded eight candidate sites: four in Texas and four in Louisiana. These candidates were described in DOE's 1991 Report to Congress on candidate sites for expansion of the SPR to one billion barrels and were considered at public scoping meetings in Texas and Louisiana in June 1991.[10]

During the EIS scoping process (see Appendix A), DOE narrowed the number of candidate sites for the EIS to four based on cost and distribution factors: Big Hill and Stratton Ridge in Texas for expansion in the Seaway Complex, and Weeks Island and Cote Blanche in Louisiana for expansion in the Capline Complex.

Figure 2.1-2
Drawdown Rate versus Time of Existing and Expanded Reserve Under 270-Day Criterion



An additional site, Richton, Mississippi (which would also provide for expansion in the Capline Complex), was added during the scoping process and is also assessed herein.

2.3 Alternatives Considered but Not Assessed

At the conclusion of the scoping process, the two Texas sites eliminated from further consideration were Boling and Hawkinsville. Boling was eliminated because it would not be cost effective due to its more inland location, which would require longer raw water, brine, and crude oil distribution pipelines. Construction of such long pipelines would drastically increase the development and maintenance costs for the site. The Hawkinsville salt dome was eliminated because the dome is not well characterized due to limited subsurface data. In addition, existing evidence suggests that the dome may be too small to accommodate ten 10-MMB caverns. Selection of Hawkinsville would likely require time-consuming and costly geological and geophysical investigations that could delay the program schedule.

The two Louisiana sites eliminated from further consideration are Chacahoula and Napoleonville. Both the Chacahoula and Napoleonville sites are located in cypress swamps, which would pose significant construction, environmental, and security problems and increase costs to the program. Not only is development of the Napoleonville salt dome limited by extensive commercial development but also it would be extremely costly due to the inland location, which would require construction of very long raw water and brine disposal pipelines (27 and 80 miles, respectively).

In addition to eliminating these four sites from further analysis, DOE has also considered and eliminated several crude oil distribution alternatives including two for Weeks Island or Cote Blanche and several for Big Hill. The first of the dismissed alternatives for Weeks Island/Cote Blanche involved construction of a pipeline from Weeks Island or Cote Blanche directly to Clovelly salt dome in Lafourche Parish to connect with the Louisiana Offshore Oil Port (LOOP) Terminal. This pipeline would have been approximately 100 miles long and would have crossed sensitive wetlands areas. In accordance with national policy to avoid actions in wetlands whenever alternatives exist, DOE has eliminated this pipeline route from further consideration. A second alternative for Weeks Island/Cote Blanche involved construction of a new pipeline in the existing Weeks Island to St. James pipeline right-of-way (ROW) and was also dismissed because of cost considerations.

The distribution alternatives considered and dismissed for Big Hill included the construction of a deep water port at the 60-foot contour offshore from the Big Hill, Texas site, which was determined to be too costly to be feasible, and a new pipeline from Big Hill to Trinity Bay at a point more northern than one of the assessed routes, which was determined to have significantly more environmental impacts and was not considered further.

2.4 Assessed Alternative Sites, Distribution Configurations, and Brine Disposal Approaches

Two of the five sites considered in this DEIS, one in the Seaway Complex and one in the Capline Complex would be needed, to accommodate an SPR expansion. A prototype SPR facility in the Capline Complex would include up to sixteen 10-MMB caverns on a 300-acre site. A prototype facility in the Seaway Complex would consist of up to ten 10-MMB caverns on a 200-acre site. The caverns would be created in rock salt from 2,000 to 5,000 feet below ground by solution mining, or leaching, using raw water. Leaching the storage space would generate approximately seven barrels of brine for each barrel of storage space created. This brine would require disposal via pipelines and diffusers into the Gulf of Mexico or via an array of underground injection wells into appropriate formations. The water and brine systems would be sized for leaching caverns at a flow rate of 1.0 MMBD.

Figure 2.4-1 shows the locations of the five candidate sites. SPR facilities already exist at Weeks Island and Big Hill. Expansion of Big Hill would use existing infrastructure, such as water, brine, and crude oil systems. However, since the Weeks Island facility is a converted room-and-pillar salt mine, there was no cavern creation and no raw water or brine disposal systems exist. Consequently, if Weeks Island is chosen, virtually a whole new facility would be necessary, although some existing infrastructure (e.g., administration facilities) might be used.

2.4.1 Seaway Complex Expansion Alternatives

The Seaway Complex currently consists of a 226-MMB storage facility at the Bryan Mound salt dome and a 42-inch DOE pipeline from the caverns to the ARCO Terminal in Texas City, Texas. Bryan Mound is also connected by DOE pipelines to the Phillips Jones Creek Tank Farm and the Phillips docks at Freeport. The two proposed alternative sites for the Seaway Complex expansion are:

(1) the expansion of the existing facilities at Big Hill, and
(2) the development of a new site at Stratton Ridge.

Figure 2.4-2 illustrates the existing Seaway Complex and the proposed sites.

Under the 270-day drawdown criterion, Big Hill would require no distribution enhancements and Stratton Ridge would be connected to the nearby Bryan Mound-to-Texas City DOE pipeline.

To meet the alternative 180-day drawdown criterion, which is also assessed in this DEIS, an expanded Big Hill site would require the construction of a pipeline to access the Houston refining center. For Stratton Ridge, the 180-day drawdown criterion would require no further distribution enhancements. However, achieving the 180-day drawdown criterion for the Stratton Ridge site would be subject to the reconversion of the existing Seaway commercial pipeline from natural gas to crude oil. In the 1980s, the Seaway crude oil pipeline was converted to gas transmission due to lack of demand for commercial pipeline transport of crude oil from the Gulf to the Midwest. The pipeline is not integral to the nation's gas transmission system, however, and is expected to be converted back to crude oil when the inland demand for crude oil transport increases.

2.4.1.1 Big Hill Expansion Site

Big Hill is located in Jefferson County, Texas, 17 miles southwest of Port Arthur. The existing Big Hill site's current crude oil storage capacity is 160 MMB; the proposed expansion would increase the amount stored by 90 MMB. Although the expansion capacity at Big Hill may be limited for policy reasons to 90 MMB, this DEIS assesses the impacts associated with an expansion of up to 100 MMB. Conversely, Capline Complex candidates are assessed at 160 million barrels. Currently, the Big Hill site is part of the Texoma Complex and both fill and

Figure 2.4-1
Candidate SPR Storage Sites

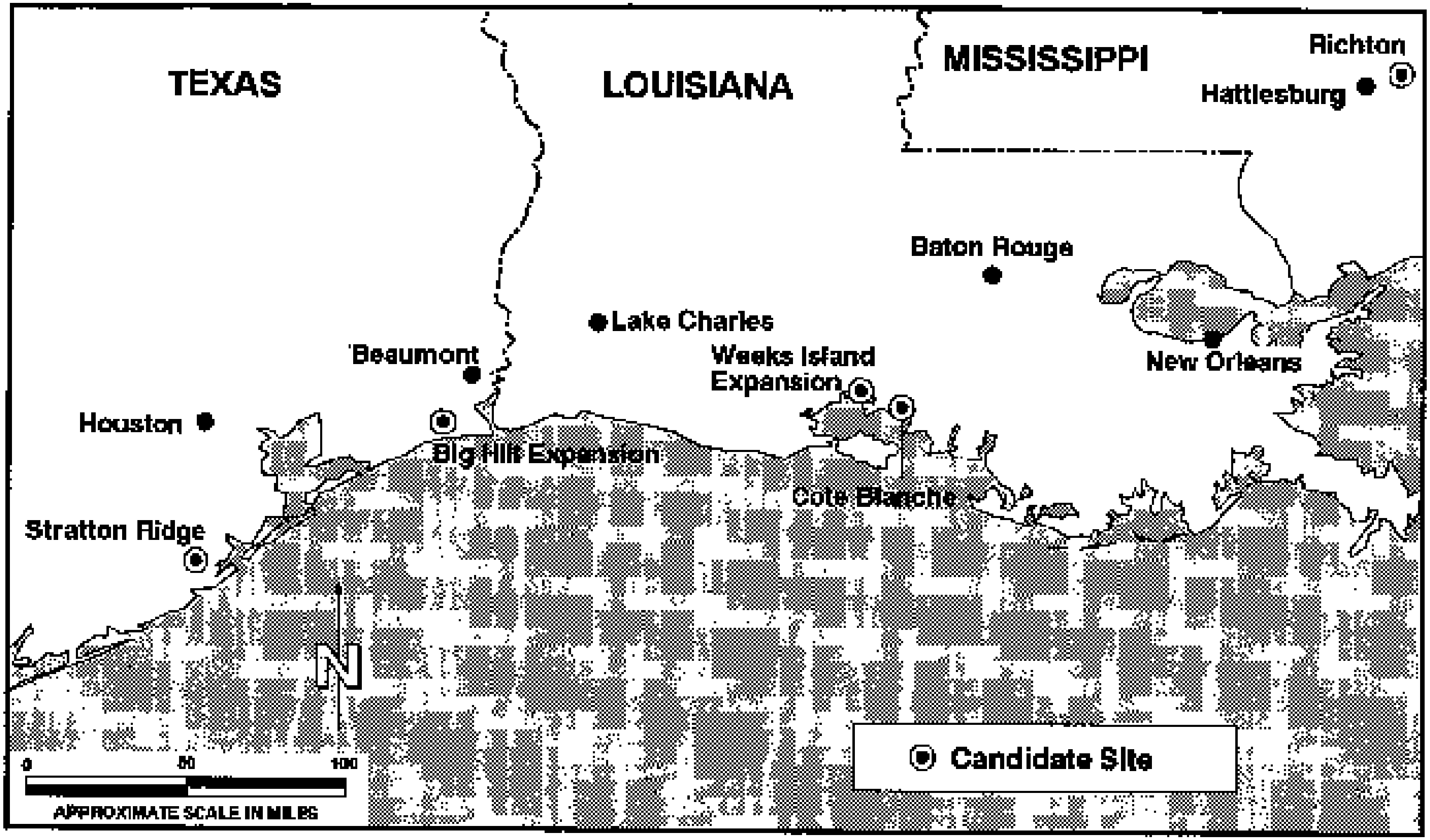
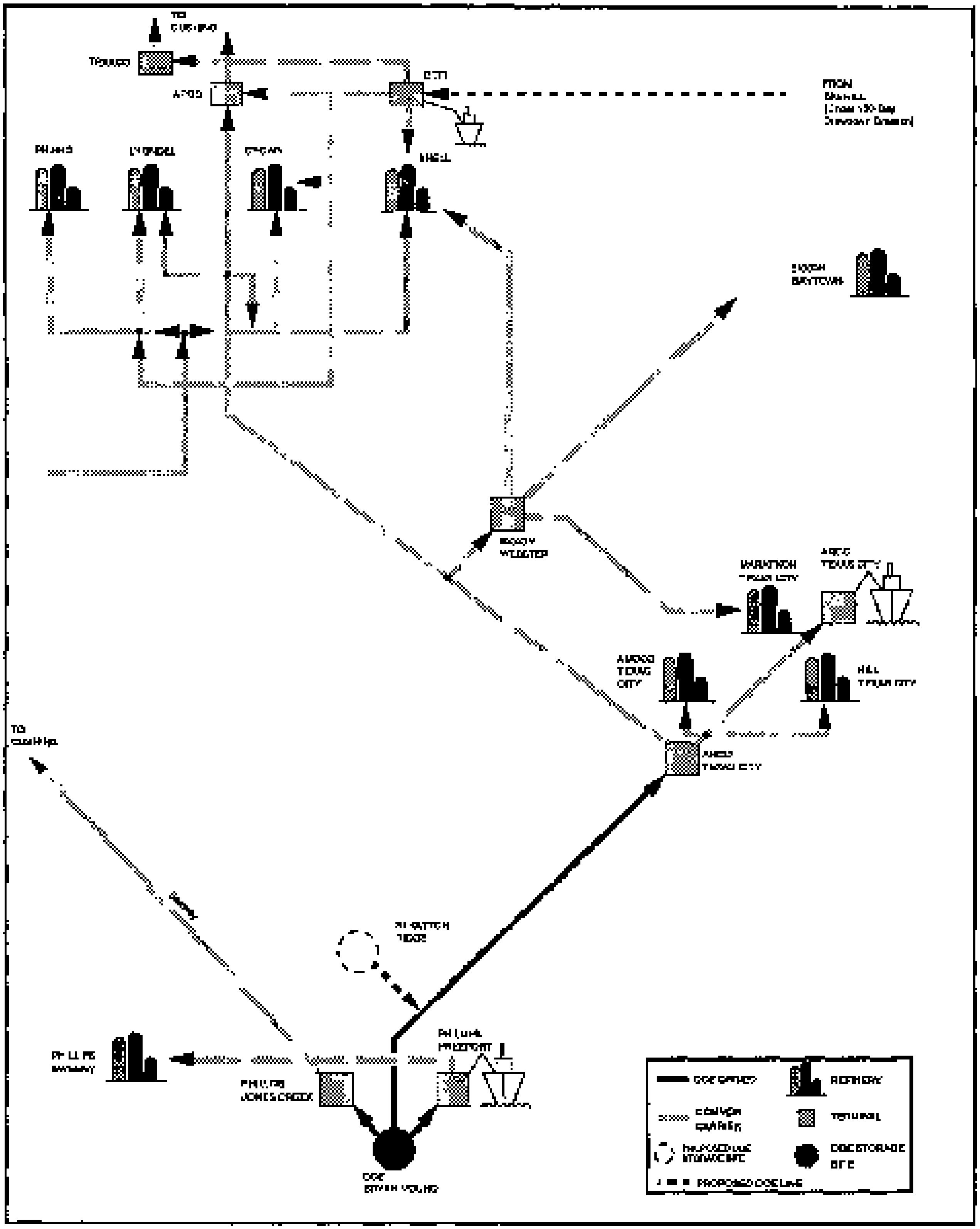


Figure 2.4-2
The Seaway Complex



distribution are accomplished via commercial terminals in Nederland, Texas. New caverns would also be filled with crude oil from these terminals. Under the 270-day drawdown scenario, no distribution enhancements are required.

Under a 180-day drawdown criterion, additional distribution capacity would be added to the Big Hill site via a new pipeline from the site to the Houston refining center. Two pipeline routes are assessed in this DEIS for the 180-day drawdown criterion: one from Big Hill across the Trinity Bay, south of the Houston Ship Channel, and under the channel to tie-in to Oil Tanking of Texas, Inc. (OTTI) (referred to as the Trinity Bay route); and one from Big Hill along the existing Highway I-10 ROW, to connect to a new DOE metering station that would tie into existing OTTI and Texaco lines and a new DOE line to ARCO (referred to as the I-10 route). Either pipeline route would essentially integrate the Texoma and Seaway Complexes from a distribution standpoint. As Figure 2.4-3 illustrates, the Texoma Complex consists of the Big Hill, Sulphur Mines, and West Hackberry salt dome caverns, and the associated pipelines to connect these sites to the Sun Terminal and the Texas 22" pipeline. (The Sulphur Mines site is being decommissioned.)

2.4.1.2 Stratton Ridge Site

Stratton Ridge is located in Brazoria County, Texas, 2.5 miles northeast of Clute. The 100-MMB Stratton Ridge site would be a new site in the Seaway Complex. DOE would construct an approximately one-mile pipeline spur from Stratton Ridge to the existing 42-inch pipeline from Bryan Mound to Texas City. Through this pipeline, the site would receive crude oil for fill via the ARCO terminal in Texas City. During a drawdown, it would ship all of its crude oil north to Texas City via the existing pipeline. Brine disposal would be by ocean discharge about 3.5 miles offshore in the Gulf of Mexico. Raw water would be obtained from a new intake structure constructed along the IntraCoastal Waterway (ICW).

2.4.2 Capline Complex Expansion Alternatives

The three Capline SPR expansion alternatives are an "expansion" of storage at the Weeks Island, Louisiana salt dome, the creation of a new site at the Cote Blanche, Louisiana salt dome, and the development of a new site at the Richton, Mississippi salt dome.

Currently, the Capline Complex consists of storage facilities in Louisiana at Weeks Island and Bayou Choctaw connected by 36-inch DOE pipelines to DOE's St. James Terminal and from there to the LOCAP and Capline Terminals, which are connected to the Capline pipeline. These storage facilities can distribute crude oil via the two docks at the St. James Terminal, via LOCAP to refineries in southern Louisiana, or via the Capline pipeline to refineries in the Midwest. Figure 2.4-4 illustrates the existing Capline Complex and the proposed sites.

2.4.2.1 Weeks Island Expansion Site

Weeks Island is located in Iberia Parish, Louisiana, 15 miles south of New Iberia. The existing Weeks Island storage facility is unique within the SPR in that crude oil is stored in one very large cavern that was formerly a room-and-pillar salt mine. Crude oil is moved in and out of the mine by electric submersible pumps; there is no raw waste or brine-handling system. Therefore, in addition to leaching, new storage capacity of up to sixteen caverns in a different part of the salt dome, expansion would require construction of several operations systems,

Figure 2.4-3
The Texoma Complex

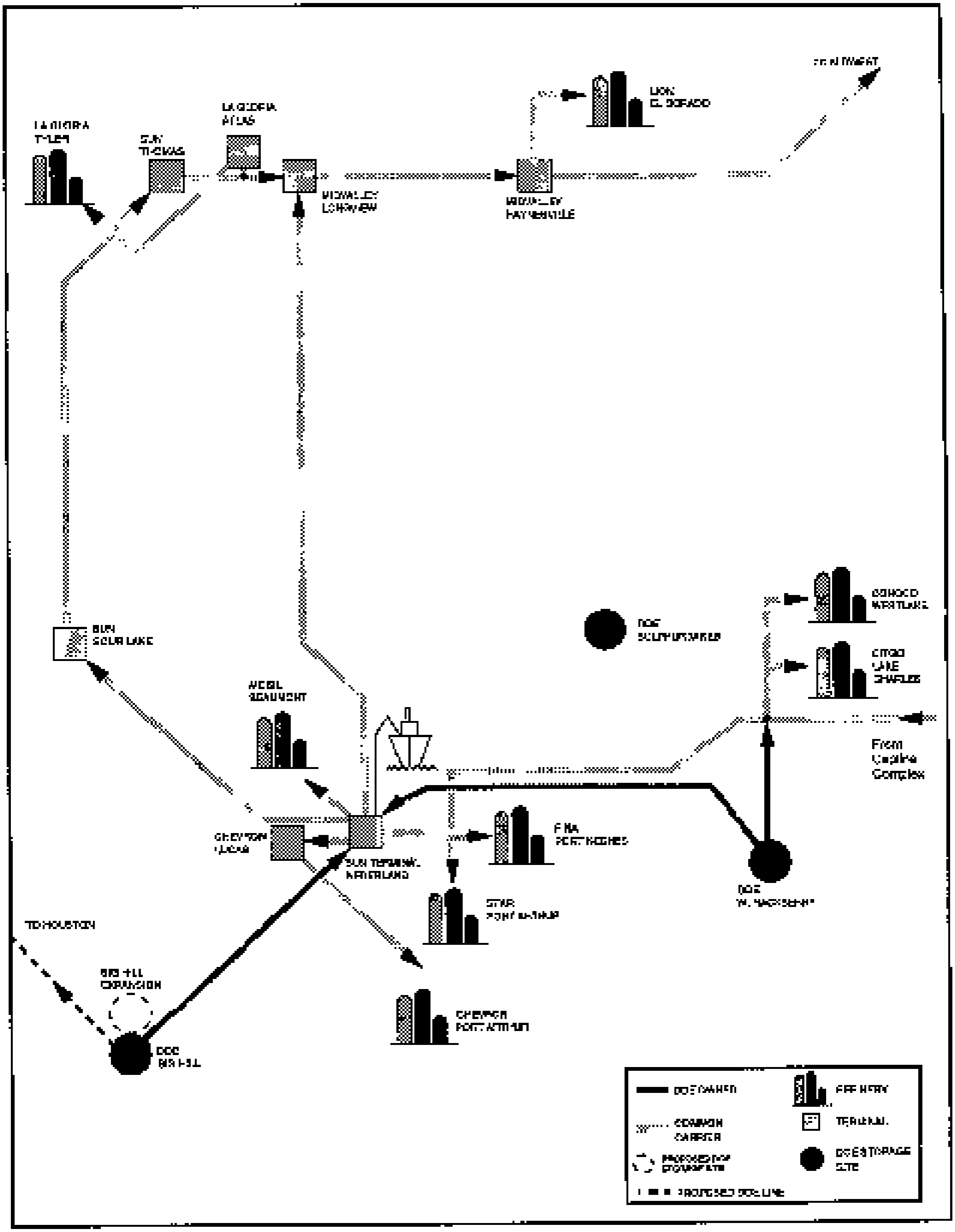
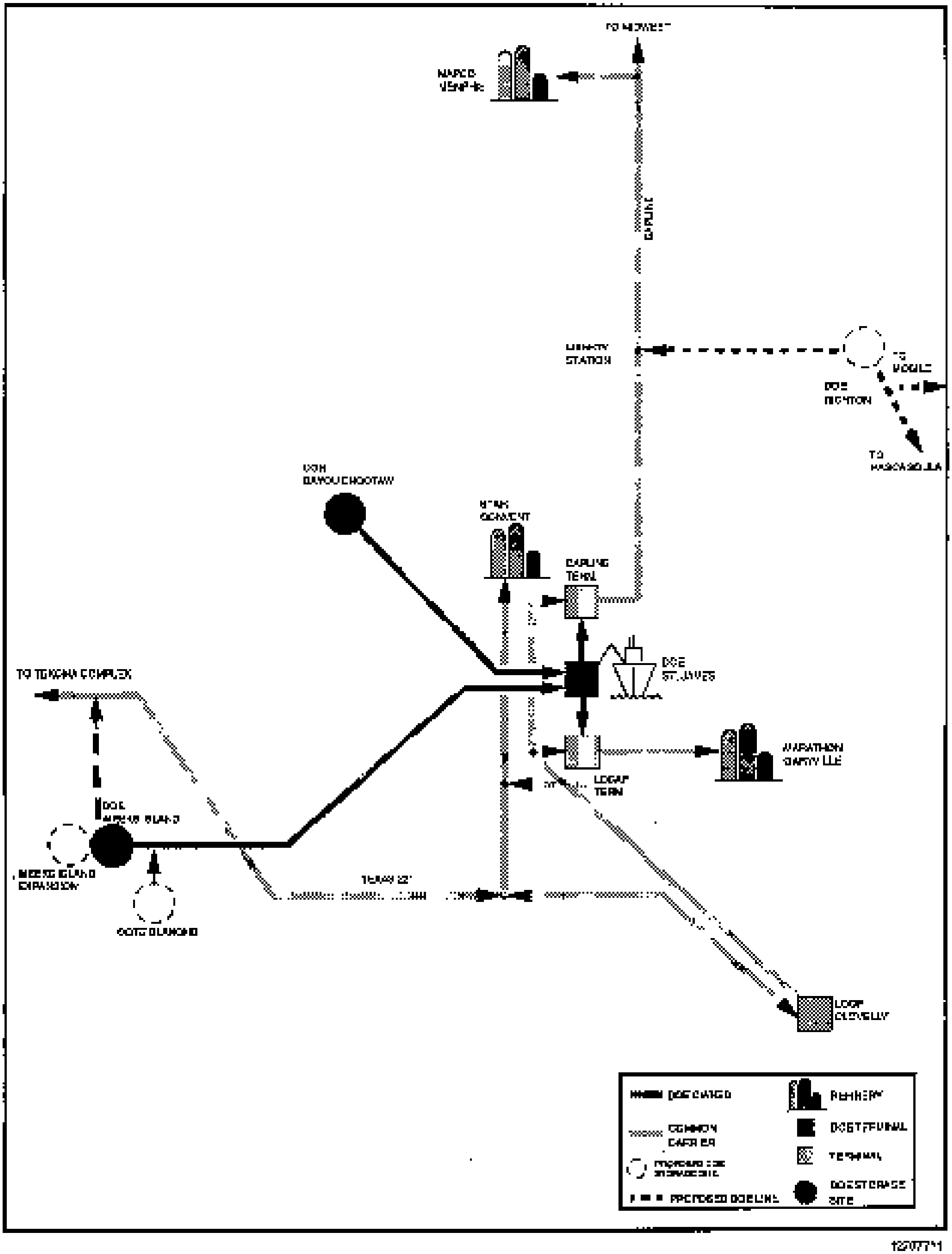


Figure 2.4-4
The Capline Complex



including a raw water solution mining/drawdown system, a brine settling and disposal system, a fire protection system, and a central control system.

Under the 270-day criterion, the Weeks Island-to-St. James pipeline would be upgraded by the installation of one pump station. To meet a 180-day criterion, the Weeks Island-to-St. James pipeline would be upgraded by the addition of a second pump station, DOE's St. James Terminal marine distribution capability would be expanded by adding up to two docks and up to two tanks, and a pipeline would be constructed to connect Weeks Island to the Texas 22" pipeline system to access the LOOP Clovelly Terminal.

DOE is considering two options for brine disposal at Weeks Island. One of these options involves disposal of brine via pipeline and diffuser into the Gulf of Mexico. The proposed brine disposal pipeline route would pass west of Marsh Island, crossing Southwest Point Peninsula through a portion of the Paul J. Rainey Wildlife Refuge (administered by the National Audobon Society) and a portion of the State Wildlife Refuge. In the other option, DOE is assessing brine disposal through underground injection.

2.4.2.2 Cote Blanche Site

Cote Blanche is located in St. Mary Parish, Louisiana, 18 miles southwest of New Iberia. Construction of a site at Cote Blanche would require structures and systems similar to those described for Weeks Island, including additional administrative and support structures. In addition, the Cote Blanche site would require a bridge over the ICW. Caverns at the Cote Blanche site would be filled via the existing 36-inch pipeline from St. James Terminal. Options at a Cote Blanche site would be similar to those described above for the Weeks Island alternative. Under the 270-day drawdown criterion, the crude oil distribution option would entail the construction of a two-mile spur to the existing pipeline to St. James Terminal, which would be upgraded by adding a booster pump station. The distribution enhancements for the 180-day criterion include the addition of a second pump station to the Weeks Island-to-St. James pipeline, expansion of the St. James Terminal, and the construction of a pipeline to the Texas 22" pipeline system.

2.4.2.3 Richton Site

The Richton salt dome is located in northeastern Perry County, Mississippi, approximately 18 miles east of Hattiesburg and approximately three miles from the town of Richton. It is an alternative to the candidate sites at Weeks Island and Cote Blanche. Under the Richton alternative, DOE would construct up to 16 storage caverns totaling 160 MMB capacity on approximately 300 acres with associated operations and maintenance facilities similar to those described for other Capline Complex sites. Raw water would be obtained through a 10-mile pipeline to a new RWI structure on the Leaf River. DOE would also construct a terminal at Pascagoula with pipeline connections to the Chevron Refinery and connection to new public docks to be constructed by the State on Greenwood Island.

The brine disposal system would use both underground injection and ocean discharge, featuring two dual-purpose oil/brine pipelines. One would be a 10.6-mile connection to a Hess 10" oil pipeline with a 2.8-mile extension to 15 brine disposal wells, and the other an 82-mile pipeline to the Port of Pascagoula with a 15-mile brine-only extension to a brine diffuser 14 miles offshore in the Gulf of Mexico to a depth of 47 feet.

In addition to the dual-purpose pipeline to Pascagoula, other oil distribution options to meet the 270-day drawdown criterion include a 70-mile pipeline to Mobile with one pump station; and a 118-mile pipeline to the Capline Pipeline at Liberty with three 0.4 MMB tanks. Under the 180-day drawdown criterion, DOE would either provide connections from the new Pascagoula terminal to new public docks on Greenwood Island (enhancing the Mobile pipeline option), add one pump station, and one dock and one 0.4-MMB tank at St. James Terminal (for the Liberty pipeline option); or add pipeline connections to an additional public dock and a reversed Cal-Ky pipeline (for the Pascagoula option). Oil fill of the site would occur through the Liberty pipeline or the Mobile pipeline (if constructed) or through the dual-purpose pipeline (if the Pascagoula only alternative is selected).

2.5 Construction and Operation of Typical SPR Facilities

This section discusses the activities and operations at a typical SPR storage site, SPR pipelines, and the St. James Terminal.

To develop an SPR facility, DOE must first prepare the salt dome for oil storage. Several caverns, which serve as storage space for oil, are created in a salt dome by pumping water into the dome and dissolving the salt in a process called "leaching" or "solution mining." Each cavern generally is located between 2,000 feet and 5,000 feet below the surface. Caverns are created by leaching with raw water, producing brine that is disposed of via either pipeline and diffuser system to the Gulf of Mexico or underground injection to appropriate aquifers. A typical cavern is designed to hold about ten million barrels of crude oil.

When the oil is needed for use, it can be removed from the cavern by displacement with water or saturated brine. The water intake and brine system used for this process, called drawdown, is similar to that used for the leaching process. After oil is displaced from the caverns, it is distributed via pipeline to coastal terminals, pipeline systems, and refineries.

Each of the proposed sites would occupy 200 to 300 acres. Major surface buildings and structures would include the water leaching/drawdown system, a brine settling and disposal system, a crude oil injection/distribution system, a fixed fire protection system, an electrical substation, a control center, administration and security buildings, and a storage warehouse. Construction and operation of these systems and facilities are discussed below.

2.5.1 Construction Activities

SPR site and pipeline construction activities pose the greatest potential for significant adverse environmental impacts. Construction necessary for the expansion of the SPR to one billion barrels would include on-site construction of storage facilities and off-site construction of pipelines, raw water systems, and brine disposal systems. In addition, construction of up to two new docks and additional tanks at the St. James Terminal and a DOE-owned bulk storage terminal at Pascagoula might be required.

2.5.1.1 Site Construction

In general, construction activities necessary to develop an SPR site include site preparation, development of raw water intake systems, cavern creation, development of brine disposal systems, and construction of support structures and equipment. The actual activities undertaken would depend on the sites selected and the existing facilities, if any, at the site. The following sections describe required activities in the development of an SPR site.

Clearing and Grubbing

Construction of an SPR facility would begin with the clearing and grubbing of the site. Clearing would consist of felling, trimming, and cutting trees into sections as well as removing surface vegetation, rubbish, and existing structures. Materials removed would generally be disposed of at an off-site approved facility. In most cases, on-site burning or disposal would not be permitted. Grubbing would include the removal of roots, stumps, brush, and general debris. As part of this work, topsoil would also be removed. Generally, clean topsoil would be stockpiled on the site for use in restoration of sloped areas, which would be seeded to control erosion. Waste materials would be disposed of off the site.

At a typical site, approximately half of the acreage (about 130 acres for a 300-acre site) would require clearing and grubbing for initial site construction activities.[g] These operations would generally require two crews (an onshore construction crew is about 52 people), and depending on the density of trees and brush, would be completed in approximately 33 working days, including removal and disposal.[11] Approximately 90 percent of the total land area would ultimately be cleared during site development.

Grading and Stabilization

Grading and general embankment, stabilization, and compaction operations would begin as soon as clearing and grubbing of the site are completed. As adequate site areas are cleared, rough grading (i.e., moving dirt from high portions of the site to lower areas) would begin. Estimated daily production would be 3,000 cubic yards for two 300-HP dozers (short haul) and 2,500 cubic yards for two 14-cubic yard scrapers (long haul). Rough grading would require one to two weeks,[12] and as areas of the site are cut to subgrade levels, the soil would be stabilized with lime. Lime stabilization would consist of mixing 62 pounds of hydrated lime per square yard of surface area into the upper twelve inches of soil and compacting the mixture. Two crews could stabilize approximately one acre per day, resulting in a total of 130 working days for this operation. Placing and compacting embankment material could be done at a rate of 2,000 cubic yards per day and would require approximately 60 working days.[13]

Raw Water System

To support leaching and drawdown activities, a Raw Water Intake (RWI) system would be required.[h] The main component of this system is the RWI structure that will be located on a water source with sufficient flow to meet site cavern leaching and drawdown requirements. A typical RWI structure would be a steel and concrete platform sufficiently elevated to withstand

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[g] For purposes of calculating potential sediment loading resulting from land clearing for construction operations in Appendix O, DOE is using the 50 percent of total site acreage value required for initial site construction activities. The remaining site acreage is ultimately cleared for reasons of security, site drainage, grass cutting, access, etc., but is not necessary for construction, nor is it done on any particular schedule.

[h] If Big Hill is selected as a site for the expansion, the existing raw water system would be adequate without modification.

the 100 year flood. It would have four 2,500-HP vertical, centrifugal pumps, each with a capacity of 0.46 MMBD, which remove water from the water source, and pump it through a pipeline to the site. The RWI would have a concrete sump on an intake channel equipped with bar racks and traveling screens to filter out debris and collect aquatic life and return it to the water. The effective cross section at the screens would be sufficient to ensure a maximum intake velocity of 0.5 ft/sec. The intake channel would be riprapped according to COE permit requirements to prevent shore erosion. The entire structure would be surrounded by a fence and security lights, and a security building would be built near the entrance to the structure area.

In addition to the RWI pumps, other types of pumps would be constructed as part of the RWI system. Two seal/firewater vertical, centrifugal 100-HP pumps would maintain pressure in the RWI structure service water, fire-protection water, and raw-water system when the intake pumps are not operating and would provide fire-protection water at the RWI structure. Also, 2,000-HP raw water injection pumps would pump water to the caverns for leaching or drawdown operations once the water reaches the site.[18]

Cavern Layout

The cavern layout at the existing Big Hill site would be used as the prototype for a new SPR site. Cavern spacing would be based on specific criteria detailed in the Level III Design Criteria for the SPR that ensure cavern integrity and stability and also enable a space-efficient arrangement. These criteria detail minimum cavern center-to-center spacing, cavern pillar thickness, distances from the pillar thickness to the edge of the dome and to the property line, distance between the top of the cavern roof to the top of the salt, and the ratio of pillar thickness to final cavern diameter. A safety factor is also specified to allow for borehole deviation when drilling, and uncertainties regarding proximity to the edge of the dome.

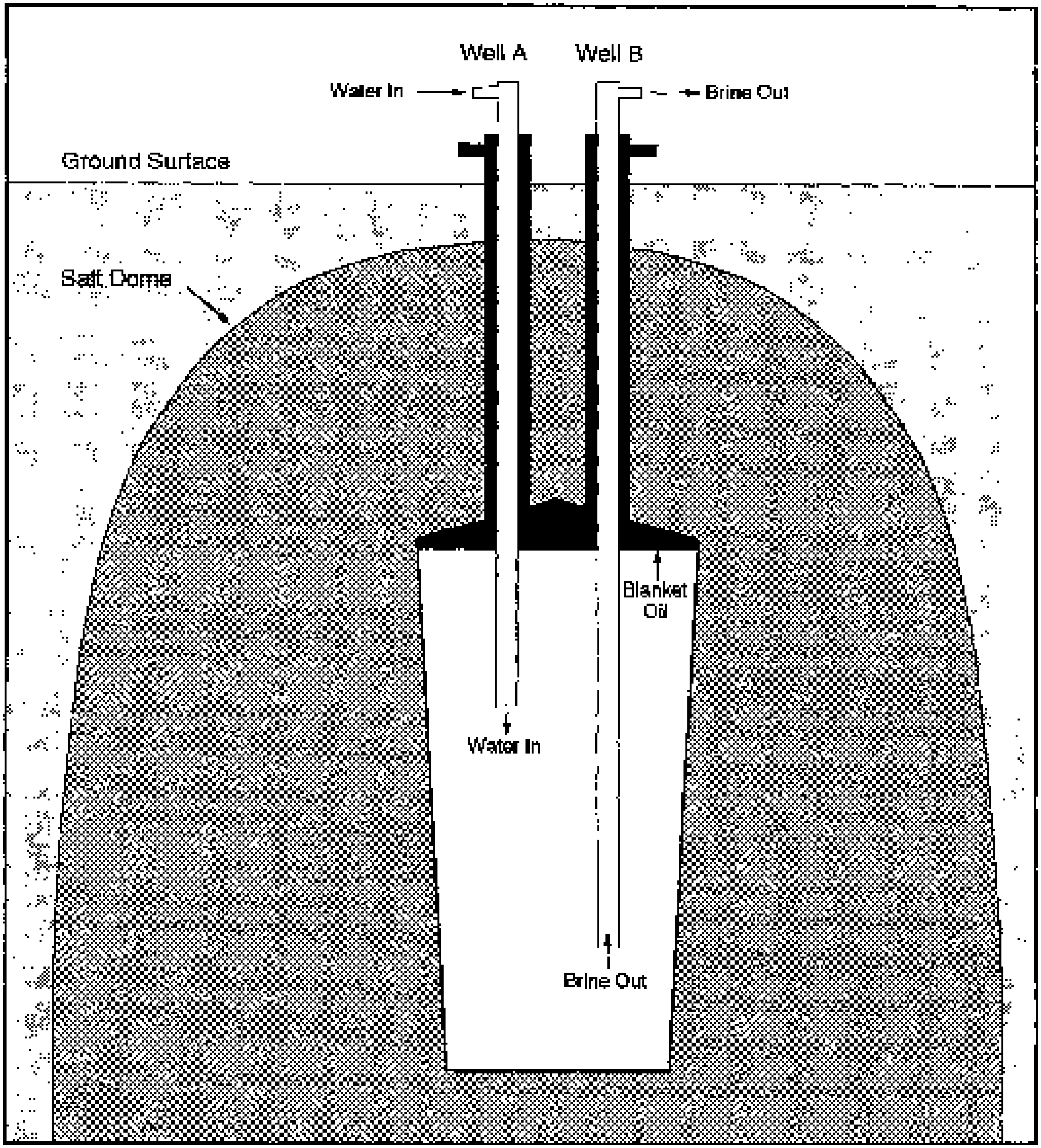
The wellhead area at each cavern would be diked with impervious material to contain and control spills as a result of a manifold failure or blowout, and at least two drains would be located on opposite sides of the dike. The containment area would have facilities to remove accumulated rain water, and the drain or spillway between the containment and remote basins would be covered to prevent vegetation, and capable of removing the maximum spill rate plus firefighting water.

Cavern Creation and Fill System

Cavern development would begin after completion of geological studies, assessment of salt properties and quality, and grading of the expansion area. The basic technique that would be used in cavern development is the dissolution of salt by injecting large quantities of raw water into the dome and displacing the resulting brine produced to the surface.

To create a cavern, DOE first would drill a pair of wells (see Wells A and B in Figure 2.5-1) into the salt dome. Mud generated during the well boring (i.e., drill cuttings) would not be considered hazardous and would be deposited on site. To begin leaching a cavern, concentric tubing strings would be suspended down the borehole from one of the wellheads at the surface. Water pumped down one tubing string would dissolve the salt from the borehole wall, and the resulting brine displaced out through the other tubing string. Shortly after initiating leaching, the cavern grows in size and water is pumped in through one well (e.g., Well A), and out through the second (e.g., Well B).

Figure 2.5-1
Cavern Creation in Salt Domes



The injected water would dissolve the salt to form brine (i.e., water with a salt concentration greater than 35,000 mg/l), which after the initial growth of the cavern would be removed through Well B. Approximately seven barrels of brine are produced for each barrel of cavern storage space created, which results in seven barrels of brine being produced at the surface. Disposal of the brine would be either by injection through deep wells into salt water aquifers below potable groundwater supplies or by direct discharge into the marine environment in accordance with the terms of applicable permits.

Cavern development would be carefully controlled to produce the desired size and shape. This would be done by regulating water flow, varying the position of the tubing strings, and injecting a quantity of oil which floats on top of the water and blankets the salt roof, protecting it from upward leaching. The cavern development process would be monitored by computer and sonar instruments. After the initial cavity is created, a sonar caliper survey would be run to verify if the cavern is developing as planned. The chemical composition of water differs from that of crude oil. Water is a polar substance and will break the ionic bonds between the sodium and chloride, dissolving the salt dome; crude oil is non-polar and will not break the bonds. A blanket of oil would then be injected into the well to prevent the dissolution of salt at the roof of the cavern and direct cavity growth downward. During leaching, DOE would employ a computer modeling system to predict the size and shape of a cavern as it is being developed. The water injection level would then be adjusted to create the desired size and shape. Sonar would be used two more times to measure each cavern. The results would then be used to adjust the computer model. Upon completion, each cavern would be roughly cylindrical in shape, tapering slightly inward from top to bottom, and will be approximately 2,200 feet high and 260 feet wide at its widest point.

DOE would test the structural integrity of caverns before long-term oil storage would be permitted. This would be accomplished through a two-phase test that is designed to detect both large and small cavern leakage. A cavern would be approved for oil storage only after the test demonstrates that total leakage will be less than 100 barrels of oil per year. The first phase of the test would involve two hydrostatic tests and would be designed to check the response of the entire cavern to gross leakage. The second phase of the test would be a nitrogen well leak test, which would be performed on both wells entering the cavern. The test would last at least five days and be designed to detect small leaks in the last cemented casing, casing seat, casing hanger, and well head. For this phase, nitrogen would be injected into the cavern, and the nitrogen/oil interface monitored.[15]

Upon completion of integrity testing, a cavern would be filled with oil through one well as the remaining brine is displaced from the second. Oil would be delivered to the site from coastal terminals via pipelines. Oil arriving at the SPR site would be metered at a transfer metering skid. From this skid, oil would flow to the oil injection/transfer pumps for injection into the caverns, where it would be metered again. Oil in the caverns would be stored under pressure until drawdown. During drawdown, oil would be displaced to the surface and pumped through the site's transfer metering station and distribution pipeline to the receiving terminal.

Brine Disposal System

As discussed above, the cavern leaching process would produce brine and DOE would dispose of it either through underground injection or through a pipeline diffuser system into the Gulf of Mexico. In one case, DOE would construct a 0.25-MMB clarifier pond, where anhydrites would be separated from the brine by gravity settling. From this pond, the brine would flow under an oil skimmer boom and over an overflow weir into a second 0.10-MMB pond. Oil collected by the skimmer boom is temporarily stored in a waste oil tank; after an evaluation of waste oil quality, it is returned to inventory (if high quality), sold on the commercial market (if moderate quality), or sent off-site to a non-hazardous waste facility (if poor quality).[16] Finally, the brine would pass into a brine pump pond, from which it would be pumped into the brine disposal pipeline. Each pond would be equipped with a high-density polyethylene liner. Vertical, centrifugal brine disposal pumps would pump brine at a rate of approximately 1.0 MMBD to the disposal point.

When brine is disposed of in the Gulf of Mexico, it would be discharged underwater vertically from the pipeline through a diffuser which has three-inch nozzles mounted vertically and spaced 60 feet apart. A 48-inch diffuser header extends over 4,000 feet beyond the pipeline. Each nozzle is equipped with a flexible rubber hose that extends above the Gulf floor and a diffuser guard, which are designed to prevent interference with shrimping and other fishing activities.

As an alternative to brine discharge in the Gulf of Mexico at Weeks Island and Cote Blanche, DOE is assessing construction of an underground injection system. This system would include a brine treatment system, a connecting a brine discharge pipeline, and a series of injection wells. Injection wells would be spaced 1,000 feet apart, with each well designed to dispose of up to 50,000 barrels of brine per day. In the case of Richton, underground injection wells would be used in conjunction with ocean discharge for brine disposal during leaching, if needed, and as the brine disposal method during standby, drawdown, and refill.

Support Structure and Equipment

Several types of structures and equipment would be constructed at the site to support operations. DOE would construct buildings such as administrative facilities, laboratories, security buildings, and warehouses. Site buildings would typically occupy a 35,000 square foot area. To facilitate construction as well as site operations, DOE would construct roads at the site. Site roads generally would have two ten-foot lanes with six-foot shoulders. Total roadway length for a site would average 27,000 feet. DOE would also construct a number of miscellaneous surface facilities such as pump pads, piping manifolds, maintenance yards, laydown yards, and parking lots. Total surface facility area would occupy approximately 160 acres.[17] If Cote Blanche is selected as the site for the SPR expansion, DOE would also build a 500-foot-long, 35-foot-wide bridge across the ICW to the site.

Also, DOE would construct an electrical substation, a pre-packaged 1,500-gallon-per-day sewage treatment facility, a lightning-protection system, and a fire-safety system. The fire-protection system would receive its water supply either from the RWI structure or from an 800,000 gallon tank, of which 720,000 gallons would be dedicated for fire emergencies. The water would be distributed through underground water piping in the event of fire. DOE would also construct a foam (aqueous film forming foam) spray system for use in fire control at the oil injection pump pads and oil loading center. The fire protection system would also include an automatic sprinkler system inside buildings and an on-site fire truck.

Electrical power would be required for basic operational activities, monthly equipment testing, and annual testing of the drawdown capabilities. The raw water intake, brine disposal, and oil fill and distribution systems would be powered by electric pumps. During cavern development, pumps would usually run 24 hours each day, although peak usage would be coordinated with the local utility to coincide with the time of least demand in order to minimize interference with service to other customers.

The number of pumps used at any one time and their energy requirements would vary depending on the number of caverns currently being developed, type of activity, and conditions of each individual pipe casing. Cavern development would be the most energy intensive activity. Energy use during the cavern development stage would average approximately twelve million kilowatt hours per month for a 15-cavern site, and approximately eight million kilowatt hours per month for a ten-cavern site. Oil fill energy requirements would be about six million kilowatt hours per month. During standby periods, energy requirements would be about one million kilowatt hours per month for a 15-cavern site. For a ten-cavern site, oil fill energy requirements would be about four million kilowatt hours per month. During standby periods, energy requirements would be about 0.5 million kilowatt hours per month. During periods of drawdown, energy requirements would be more than for oil fill, and less than for cavern development.[18]

2.5.1.2 Pipeline Construction

For a solution-mined SPR site, brine disposal and crude oil pipelines are required. In preparation for pipeline construction, DOE would clear the ROW, similar to readying the site for construction. DOE would give all possible consideration to the preservation of trees within the ROW. DOE would also grade the ROW to facilitate laying of the pipeline, and construct temporary facilities such as roads and bridges for use during construction.

Five basic modes of pipeline construction would be used. The method chosen for a particular pipeline would depend on terrain, pipe size, and schedules for construction. The five modes are:

- **Conventional Land Lay.** This method is generally used for pipe installation at higher elevations where water is not a consideration and where the ground can support heavy equipment. The pipe is installed in ditches excavated by backhoes and ditching machines. The pipeline is assembled and lowered into the ditch by sideboom tractors and other equipment. The ditch is then backfilled, returning the terrain to its original contour.

- **Conventional Push Ditch.** This method is used in swampy areas where water depths are reasonably predictable. Timber mats provide support to heavy equipment that is used to create a ditch of sufficient depth to allow pipeline installation. The pipeline is assembled at the push site (on high ground, a barge, or a temporary platform) and pushed into the ditch. Floats are used to push the pipe into position. When these floats are removed, the concrete-coated pipe sinks to the bottom of the ditch. Returning the ROW to its original contour depends on the success of the backfilling and the ditch slope.

- **Flotation Canal.** For this method, which requires a minimum of six feet of water, a canal that can accommodate barges and floating equipment is created. The pipe is installed through a sequential assembly operation on a barge deck. The canal is not backfilled.

- **Modified Push Ditch.** This method is most applicable to areas with predictable water levels, such as coastal marshes. Shallow draft barges are used to excavate a canal. A larger push barge is then used to assemble the pipe and float it into the canal. Flotation buoys are removed, allowing the pipe to sink to the bottom of the canal, and the canal is backfilled.[19]

- **Directional Drilling.** This method is used for major road and water crossings. The main advantage of the directional drilling method is that it avoids traffic disruption during construction because the pipeline is laid beneath the crossing. In this method, a pilot hole is drilled on one side of the crossing using a slanted drill. After the pilot hole is completed, it is reamed to create sufficient freedom for the crude oil pipeline.

Pipeline construction would require temporary and permanent easements. Easements would vary with the type of terrain the pipeline crosses. Table 2.5-1 lists the estimated easement requirements. Pipeline-specific acreages are tabulated in Chapter 3 using these easements.

2.5.1.3 St. James Terminal Construction

Although not required under the 270-day drawdown criterion, DOE is assessing the impacts of constructing up to two additional docks at its St. James Terminal. Under the 180-day criterion, two docks would be required to enhance distribution capacity for Weeks Island or Cote Blanche; one dock would be required for Richton. Each dock would be constructed of concrete and steel. Docking facilities would consist of a 60-foot by 100-foot loading platform designed to contain a 670-barrel spill, two 16 inch loading arms, a 15-foot by 15-foot control room constructed of pre-engineered metal building, and four breasting and six mooring dolphins. A 14-foot-wide approach ramp would be constructed to allow access to the docking platform.

A single dock would have an area of 1,400 feet long by 1,100 feet wide by 40-feet deep. The addition of a second dock would require approximately twice the riverfront property and dredge area (2,600 feet long by 1,100 feet wide by 40 feet deep). Total dredged volume for two docks would be approximately 1.85 million cubic yards.[20] To support the operation of the two additional docks, two 400,000-barrel tanks would also be constructed at the terminal.

2.5.2 Operation and Maintenance

Operation at an SPR site would include major activities such as cavern creation and fill and drawdown as well as daily routine activities such as recordkeeping and maintenance activities. This section discusses operation and maintenance for the sites and pipeline systems, as well as those for the St. James Terminal.

2.5.2.1 Site Operation/Maintenance

As discussed above, the main activities at an SPR site would include cavern leaching, cavern fill, and oil drawdown. Daily routine operations at an SPR site would include inspecting equipment and preparing log sheets, documenting data for equipment performance evaluation, reporting safety hazards, making environmental checks, performing lab work, and requesting maintenance. A site would also be sprayed periodically with herbicides (e.g., around fenceline) and pesticides (e.g., on fire ants and mosquitos), as necessary. Section 6.5 identifies these and

Table 2.5-1
Pipeline Construction

Land Type	Permanent Easement	Construction Easement	Total Easement
Dry Land	50 feet	50 feet	100 feet
Marsh Land	50 feet	100 feet	150 feet
Water	50 feet	100 feet	150 feet

Source: USDOE, 1991. *Right-of-Way Study for Big Hill, Stratton Ridge, Weeks Island, and Cote Blanche Pipelines* (Task 16), Strategic Petroleum Reserve Program, PB-KBB, Inc., Houston, Texas, July 1991.

other chemicals commonly used at an SPR site. An SPR facility would employ approximately between 75 and 120 people on-site, depending on storage capacity. Security personnel would be on-site 24 hours per day.

Cavern structural integrity would be monitored on a daily basis by measuring pressure trends. Completed caverns would be tested for structural stability every five years using the tests described above, and quarterly by logging the oil/brine interface.

The central control room at an SPR site would be used to monitor remotely many on-site activities and operations. Valves and other operating mechanisms along the oil line can be adjusted from the control room, from which the control room operator can also detect such things as leaks in the brine line and deviations in cavern pressure and temperature. During oil movement, flow and pressure can be monitored. Measurements generally would be taken and recorded hourly.[21]

The control room would be staffed by at least one shift leader 24 hours per day, seven days per week. The shift leader could send people out to monitor situations at distant locations.[22]

Maintenance activities at an SPR site typically would include cleaning, repairing, and replacing equipment and equipment parts such as pond liners, filters and strainers, and lights. Maintenance would also be required on site structures such as dikes and wells.

2.5.2.2 Pipeline Operation/Maintenance

Pipeline ROWs would be inspected regularly to observe or detect surface conditions on and adjacent to the ROW, indications of leaks, geophysical activity, oil theft, sabotage, construction by others, and other factors affecting the safety and operation of the pipeline. Weekly aerial patrols would monitor all general conditions affecting the ROW. Land and navigable water patrols would investigate problems observed from the air.

Defoliants (listed in section 6.5) would be used to destroy vegetation that hinders pipeline operation and maintenance. Remaining vegetation would be removed by clearing and grubbing.

Erosive conditions would be prevented and controlled by maintaining or constructing terraces, plugs, and bulkheads.

Other pipeline maintenance would include painting, coating, and pigging[c] the pipeline, as well as installing internal corrosion monitoring devices. Pigging monitors the interior condition of the pipeline and ensures that efficient flow conditions are maintained. The raw water intake pipeline would be cleaned by running scraper/brush pigs at least semi-monthly. Caliper pigging[d] would be performed annually.[23]

2.5.2.3 St. James Terminal Operation/Maintenance

Each new dock constructed at the St. James Terminal would be designed for loading or unloading one tanker with a maximum loaded displacement of 100,000 dead weight tonnage (DWT) and a maximum draft of approximately 40 feet under all weather conditions. Crude oil from a tanker would be transferred using the ship's pumps and will be stored in the terminal storage tanks. Crude oil would be transferred to a tanker through a 36-inch pipeline and the two 16-inch loading arms at a maximum rate of 40,000 barrels per hour per dock.[24]

2.5.3 Permits and Monitoring Requirements

The following sections provide an overview of permits and associated monitoring requirements that may be required for the development of the proposed SPR expansion sites.

2.5.3.1 Permits

DOE would obtain and comply with all required permits. Tables 2.5-2 and 2.5-3 list permits that may be applicable.

2.5.3.2 Monitoring

To obtain information necessary for limiting environmental impacts, DOE would monitor air, surface water, and groundwater at the SPR sites. DOE also would perform monitoring activities to ensure the proper operation of the SPR facilities.

Environmental Monitoring

Air emissions would be monitored primarily through measurements and calculations from operating data. Where necessary, air emissions would be monitored for permit compliance using an organic vapor analyzer. Air emission monitoring may also include testing valves and pump seals for fugitive emissions.

DOE would establish monitoring stations at surface water bodies to assess site-associated surface water quality and to provide early detection of any surface water quality degradation that

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[c] In pigging operations, an inspection and cleaning device, called a "pig," is sent through a pipeline to check the condition of the pipeline and to clean the pipe.

[d] Using a mechanical device, called a pig, to determine the diameter of a pipeline.

Table 2.5-2
Site and Terminal Construction/Operation Permits

Federal	U.S. Army Corps of Engineers - Permit for construction in wetlands and navigable waterways (includes dredge and fill in wetlands) U.S. Environmental Protection Agency - Permit for any industrial discharge into navigable waters, including the territorial sea (National Pollutant Discharge Elimination System (NPDES) permit) In Mississippi, NPDES program is administered by Mississippi Department of Environmental Quality
State	Louisiana Department of Environmental Quality - Permit for discharges to water Louisiana Department of Environmental Quality - Air emissions permit Louisiana Department of Natural Resources - Permit to use salt dome cavities for liquid hydrocarbon storage Louisiana Department of Transportation and Development - Water purchase agreement. Heavy equipment load transport permit, and access road construction permit Louisiana Department of Natural Resources - Letter of financial responsibility to plug and abandon injection wells Louisiana Department of Natural Resources - Permit for Operation of Class II underground injection wells Texas Department of Highway and Public Transportation - Access road construction permit, and heavy equipment load transport permit Texas Water Commission - Permit for discharges to water (corresponds to U.S. Environmental Protection Agency NPDES permit) Texas Water Commission - Permit for use of State waters Texas Air Control Board - Air emissions permit Railroad Commission of Texas - Permit to operate and maintain anhydrite and brine/oil pits Railroad Commission of Texas - Permit to create, operate, and maintain an underground hydrocarbon storage facility Mississippi Department of Environmental Quality - Permit to withdraw water Mississippi Department of Environmental Quality - Permit to discharge brine (if in State waters) Mississippi State Oil and Gas Board - Permit for underground injection - Class II wells Mississippi Department of Environmental Quality - Air emissions permit Mississippi State Highway Department - Permits for access and construction, and transport of heavy equipment loads

Table 2.5-3
Pipeline Construction/Operation Permits

Federal	U.S. Army Corps of Engineers - Permit for pipeline construction in and across wetlands and under navigable waterways (includes dredge and fill in wetlands) U.S. Environmental Protection Agency - Permit for any industrial discharge into navigable waters, including the territorial sea (NPDES permit)
State	Louisiana State Department of Highways - "Notice of Proposed Installation of Utility Line on Controlled Access Highway," "Notice of Proposed Installation of Utility Line on Noncontrolled Access Highway," and permit for construction of temporary access road Louisiana State Land Office - Easement for crossing State lands (stream beds and submerged lands in tidal areas and under the Gulf of Mexico) State of Louisiana Department of Public Works - Permit to operate pipelines in Louisiana Texas Department of Highways and Public Transportation - "Notice of Proposed Installation of Utility Line on Controlled Access Highway," "Notice of Proposed Installation of Utility Line on Noncontrolled Access Highway," and permit for construction of temporary access road Texas General Land Office - Easement for crossing State lands (stream beds and submerged lands in tidal areas and under the Gulf of Mexico) Railroad Commission of Texas - Permit to operate pipelines in Texas Mississippi Department of Wildlife, Fisheries, and Parks - Surface easements for pipelines through State lands and pipeline through coastal zone Mississippi State Higway Department and State Road Division - Easements for pipeline crossings of primary and secondary roads, respectively; permit for construction of temporary access road Secretary of State (Mississippi) - Leasing submerged water bottoms for pipelines Alabama Department of Environmental Management - Permits, as necessary, for pipeline construction
Local	Parish Police Jury, Engineering Department (Louisiana) - Easement when crossing parish property or parish roads with a pipeline Parish Drainage District (Louisiana) - Letter of notification to cross drainage district ditches with a pipeline County Commissioners Court, Engineering (Texas) - Easement when crossing county property or county roads with a pipeline County Drainage District (Texas) - Letter of notification to cross drainage district ditches with a pipeline County School Boards (Mississippi) - Permission to cross section 16 lands

may result from SPR operations. DOE would monitor parameters such as pH, salinity, temperature, total organic carbon, oil and grease, and dissolved oxygen. Point source discharges to surface waters would also be monitored to assess compliance with water discharge permit requirements (NPDES permits). SPR point source discharges would consist of brine discharge, stormwater runoff from tank, well, and pump pads, and effluent from package sewage treatment plants. Parameters monitored would vary by site and discharge, but may include flow, oil and grease, pH, dissolved oxygen, chlorine, total dissolved solids, total suspended solids, fecal coliforms, and five-day biochemical oxygen demand.

DOE would monitor groundwater salinity at new SPR sites. Groundwater wells generally would be located around the brine pond system. Groundwater sampling would also be used to confirm findings of resistivity/conductance and soil hydrocarbon vapor testing for brine and crude oil contamination of soil.

Operational Monitoring

DOE would monitor caverns and subsidence at the site as well as the equipment used there. Cavern monitoring activities would include brine/oil interface surveys and cavern integrity monitoring. Surveys to determine rates of surface subsidence would be conducted semi-annually. These surveys would be aided by aerial photography and satellite monitoring. In addition, DOE would monitor temperatures and vibration of running equipment such as motors and pumps.

2.6 Decommissioning and Closure[c]

An SPR facility may be decommissioned and disposed of if it can no longer support the program mission economically and remain in compliance with DOE environmental, safety, and health requirements. The SPR site at Sulphur Mines is currently being decommissioned because of high operating costs per barrel of oil stored, costly improvements needed to meet fire protection and security standards, and limited drawdown capabilities.[25]

Decommissioning activities at an SPR facility and associated potential environmental impacts would depend on the future use of the facility. If the site were destined for continued use as an oil storage facility, activities might consist of little more than a change in ownership. Oil in storage could be included in the sale or withdrawn and moved to another SPR site. If, however, DOE closes the facility entirely, extensive closure activities could be necessary. Under this scenario, crude oil would be removed from the caverns by displacement with water, which eventually would form brine in the caverns. Cavern wells would be plugged with concrete to prevent brine leakage through the casing.[26] All above ground facilities, such as buildings and pumps would be demolished or removed from the site. Brine ponds would be closed and crude oil pipelines would be emptied, cleaned, and capped. Underground pipelines likely would be left in place.[27] Pipeline water crossings would be abandoned, but pipelines crossing waterways would be modified to minimize the chance that they could become future hazards to navigation.

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[c] The potential environmental impacts associated with decommissioning and closure are not addressed in this EIS. For more information on potential impacts, see Environmental Assessment: Strategic Petroleum Reserve Sulphur Mines Decommissioning and Big Hill Expansion; Calcasieu Parish, Louisiana, and Jefferson County, Texas, U.S. Department of Energy, January 1990, DOE/EA-0401.

Such actions might include filling the pipelines with cement or filling them with a substance to encourage oxidation and decomposition.[28] Finally, the site would be revegetated.

Because the ranges of possible decommissioning activities and associated environmental impacts is so broad, no further discussion is included in this DEIS. At the time of any decommissioning, further environmental assessments, as required under NEPA, would be performed.

ENDNOTES

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   Federal Energy Administration, *Strategic Petroleum Reserve, Final Environmental Impact Statement, Volume 2*, Federal Energy Administration, Office of Strategic Petroleum Reserve, Washington, DC, National Technical Information Service, December 1976, Document Number PB-261 800.

2. U.S. Department of Energy, *Strategic Petroleum Reserve, Expansion of Reserve, Final Supplement Environmental Impact Statement*, Office of Strategic Petroleum Reserve, Washington, DC, 1979, Document Number DOE/EIS-0034.

3. Federal Energy Administration, *Strategic Petroleum Reserve, West Hackberry Salt Dome, Final Environmental Impact Statement*, Federal Energy Administration, Office of Strategic Petroleum Reserve, Washington, DC, 1977, Document Numbers: FEA/S-76/503, NTIS No. PB262508.

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8. U.S. Department of Energy, *Report to Congress on Candidate Sites for Expansion of the Strategic Petroleum Reserve*, Office of Strategic Petroleum Reserve, March 1991, Document Number DOE/FE-0221P.

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10. U.S. Department of Energy, *Report to Congress on Candidate Sites for Expansion of the Strategic Petroleum Reserve*, Office of Strategic Petroleum Reserve, March 1991, Document Number DOE/FE-0221P.

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13. *Ibid.*

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28. *Ibid.*

3.0 ALTERNATIVES

This chapter provides an overview of each proposed site and its associated distribution and brine disposal configurations. Information presented includes general descriptions of the candidate sites and their surrounding environment, construction requirements for site development or expansion, and, where applicable, options for the oil distribution and brine disposal systems. The chapter also briefly discusses the construction requirements for expanding the St. James Terminal. More detailed site-specific and regional descriptions are presented in later chapters of this document, and generic site development considerations, including the cavern development process, are discussed in section 2.4.

3.1 Big Hill Expansion (Seaway Complex Site)

Under the Big Hill expansion alternative, DOE would construct additional caverns with the capacity to store 90 MMB of oil, raising the total oil storage capacity of the existing SPR site from 160 to 250 MMB. The expansion would be accomplished by developing nine storage caverns in an area adjacent to and north of the existing oil storage caverns. Oil fill would be through terminals in Nederland, Texas. To meet the oil drawdown requirements under the 270-day drawdown criterion, expansion of the Big Hill site would require no distribution enhancements. However, under a 180-day criterion, the expansion would include construction of a crude oil distribution pipeline to East Houston where connections would be made to commercial refineries for inland distribution and to terminals for marine distribution. The existing pipeline has a capacity and drawdown rate of about 0.93 MMBD. The proposed pipeline required for the 180-day drawdown would have a capacity of about 0.9 MMBD and would increase the drawdown rate for Big Hill to approximately 1.4 MMBD.

3.1.1 Description of Existing Facility

The existing Big Hill SPR site encompasses approximately 250 acres of land acquired from numerous private landowners in 1982 and 1983. Developed as part of the Phase III expansion of the SPR, Big Hill is the newest of six existing SPR facilities and is one of three facilities in the Texoma Complex.[a] Leaching of the SPR storage caverns at Big Hill began in 1987 and was completed in September 1991.

The Big Hill facility is located in Jefferson County, Texas, approximately 17 miles southwest of Port Arthur and 70 miles east of Houston. The surrounding area is predominantly rural with agricultural production the primary land use; rice is the most common crop in the area. Oil and gas production is the other major economic activity in Jefferson County. Population density is sparse within a 15-mile radius of the Big Hill facility. The two closest towns are Winnie and Stowell with a combined population of about 5,000.[1]

The present site is developed in an upland area with elevation exceeding 35 feet above mean sea level (msl) at the highest point, the highest elevation in the region. Prior to development as an SPR facility, the site was used primarily for pasture land, although

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[a] The Texoma Complex, along with the other complexes in the SPR distribution system, is described in section 2.1. One of the facilities in the Texoma Complex, Sulphur Mines, is being decommissioned and stored crude oil has been transferred to Big Hill.

petroleum-related operations had altered land use at the salt dome. The present site contains no wetlands and the only water bodies in the vicinity of the site are two freshwater ponds about ten to 20 acres in size located on the eastern and northern edges of the salt dome, respectively. Less than one mile south of the salt dome, however, is the northern boundary of fresh to intermediate marsh. Further south of the site there are extensive wetlands. The McFadden National Wildlife Refuge, an important waterfowl habitat, occupies about 55,000 acres in an area approximately eight miles southeast of Big Hill and north of the Gulf Coast.

The existing Big Hill facility, illustrated in Figure 3.1-1, consists of 14 oil storage caverns, a brine disposal system, a raw water intake system, and a crude oil distribution system. The site also has various support facilities including a heliport, diesel oil storage, various laydown yards, a maintenance yard, and control, service, and administration buildings.

The 14 oil storage caverns are located in the center portion of the salt dome and are arranged in three rows (two rows of five caverns and one row of four caverns) extending west to east. Each of the caverns is located at a depth of 2,200 to 4,200 feet, has a maximum width of about 200 feet, and a storage capacity of approximately 11.5 MMB.

The brine disposal system consists of a pond complex and an underground pipeline. During leaching, brine is transported from the caverns to a sacrificial anhydrite pond[b] where insolubles are settled out. The brine then flows into a second pond partitioned into two sections by a floating weir that traps any residual oil floating on the surface of the brine. The oil-free brine is then treated with ammonium bisulfite which scavenges oxygen, therefore reducing corrosion of the 36-inch, 15-mile brine pipeline that carries the brine to the Gulf.

The brine pipeline's terminus is at coordinates 29°34'N and 94°12'W, which corresponds to a location about four miles offshore in the Gulf of Mexico and a depth of 30 feet. Diffuser ports are located along the final 4,000 feet of the pipeline that is positioned perpendicular to the coastline to take advantage of the ocean current for maximum diffusion.

Crude oil fill and distribution is made via a 36-inch, 24-mile pipeline to commercial terminal facilities in Nederland, Texas. The drawdown capacity of this pipeline is 0.93 MMBD. This connection provides access to Sun Terminal tank farms and docks, an additional commercial terminal, and commercial pipeline connections to a number of local refineries.

The RWI structure is located at an abandoned barge slip at mile 305 of the ICW and at coordinates 29°41'N and 94°11'W, approximately half way between East Galveston Bay and the Port Arthur Canal (see Figure 3.1-2).[2] Section 5.1.3.2 of this DEIS describes the ICW in this area in more detail. The site includes a parking area and the intake structure. The structure is a concrete box, approximately three stories tall, housing intake equipment and raw water pumps. Intake equipment includes bar racks, five traveling screens, and screen wash pumps.[3] The bar racks and traveling screens keep solid waste, debris, and aquatic biota from entering the pipeline.

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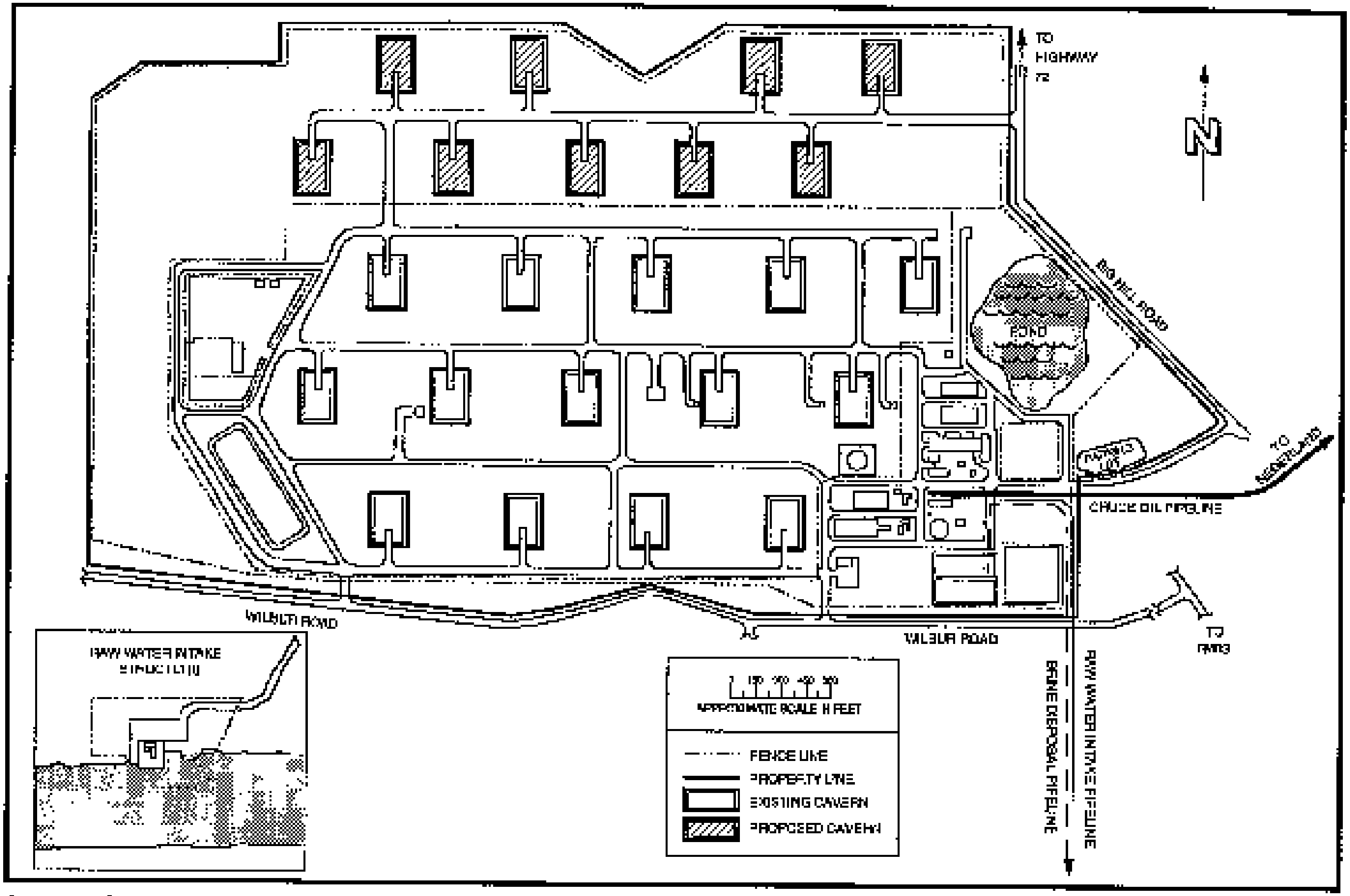
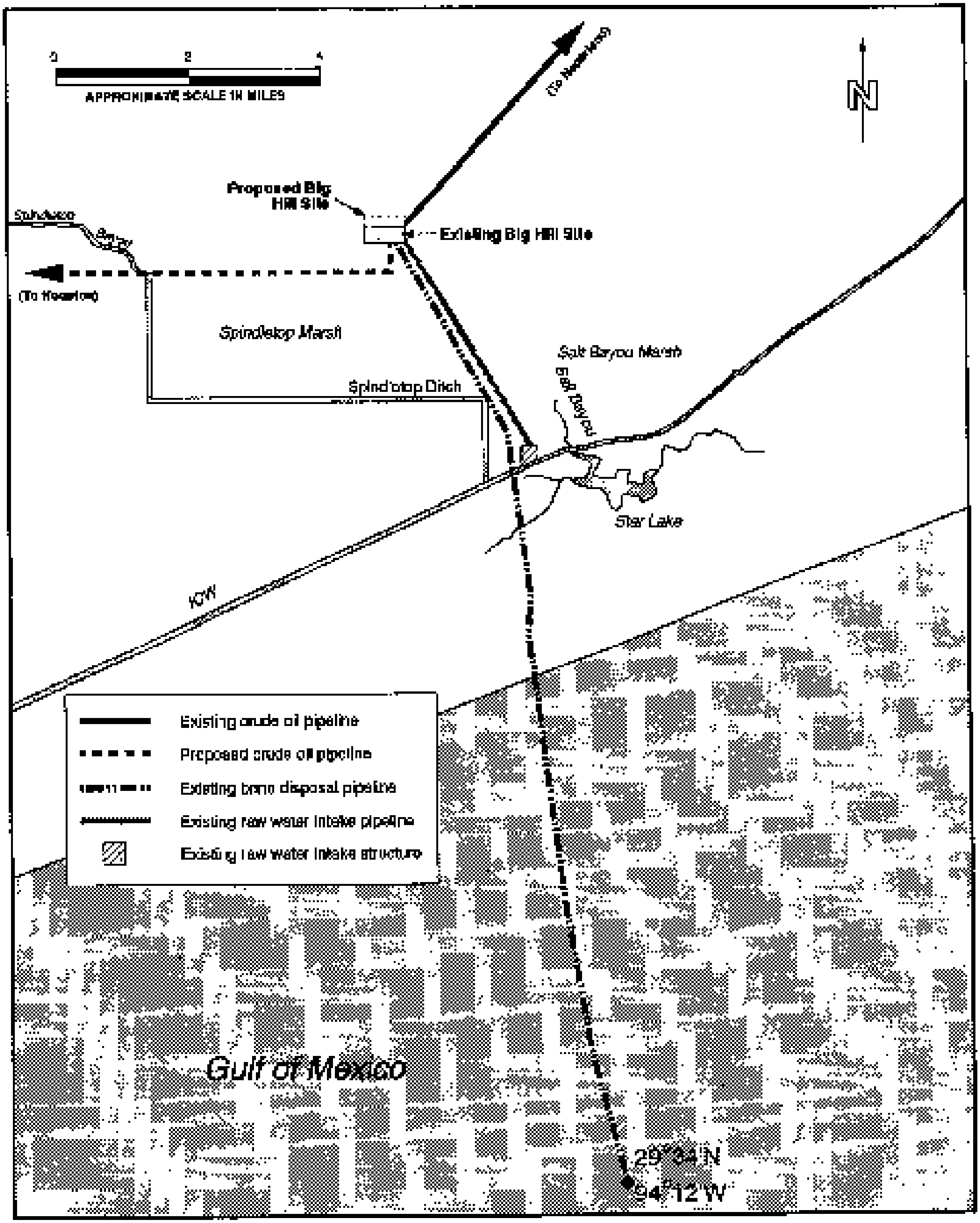
[b] Anhydrites are never removed from such a pond; after a significant quantity of anhydrites have accumulated, the pond is sealed or permanently closed. Samples of anhydrites have tested negative for all RCRA waste characteristics and brine anhydrites are not listed as a waste. Therefore, no Federal waste disposal requirements apply. The states of Texas and Louisiana concur with this conclusion and also agree that no state hazardous waste requirements apply to anhydrite ponds at existing SPR sites.

Figure 3.1-1
Existing and Proposed Cavern Layout for Big Hill



Source: U.S. Department of Energy. Strategic Petroleum Reserve; Site Development Plan.

Figure 3.1-2
Existing Raw Water Intake and Brine Disposal Systems for Big Hill



Source: Walk, Haydel, & Associates, Inc., *Big Hill Oil Storage Complex*, Jefferson County, Texas – Big Hill to the Gulf of Mexico Raw Water and Brine Disposal Pipelines, Baton Rouge, Louisiana.

There are currently four raw water pumps that supply water for leaching, drawdown, and fire protection. Three pumps are used for leaching and one serves as a backup.[4]

3.1.2 Expansion Site Configuration and Construction

Nine additional oil storage caverns would be developed in a 150-acre area directly north of the current facility at coordinates 29°45'N and 94°14'W. Geophysical studies would need to be conducted to define the dome boundaries precisely. A preliminary geological assessment conducted for DOE indicated that a minor salt overhang occurs on the western edge of the dome, and a major overhang exists on the southern flank, but neither overhang is expected to affect cavern development in the proposed expansion area.[5]

The area where the expansion would take place is currently owned by Sabine Pass Terminal, although Amoco Oil Company retains mineral rights. Neither of these companies currently has operations of any type on the site. Unocal, however, has developed two 0.5-MMB liquid petroleum gas storage caverns just north of the proposed storage area. These caverns are not believed to pose any problems for SPR expansion. There are no other operators on the Big Hill salt dome.

A possible layout of caverns is illustrated in Figure 3.1-1. Future geotechnical investigations would determine the optimum site layout and the precise location of the caverns. For example, if the investigation determined that the proposed layout would result in caverns being located too near the edge of the dome, one or two caverns could be relocated within existing facility boundaries.

Ecologically, the proposed expansion area is a disturbed/regrowth area with a heavy herb/shrub layer. Legumes are found in open areas and along the fence line of the existing site. Wet areas exist throughout the proposed site. The tallow tree is the dominant tree in the area, but box elder and sweet gum trees are also prevalent. Young sapling trees, ten to twelve feet in height, are characteristic of the area, although there is a scattering of large 150-year-old live oak trees. Diverse fauna reside on the proposed site, including coyote, rabbits, raccoon, rodents, snakes, turtles, lizards, armadillo, deer, and upland game birds and passerines. Cattle roam freely over the proposed site. The ecology of the site is assessed in detail in section 5.1.5.

Because Big Hill is currently an SPR facility, any site expansion would be able to take advantage of the existing infrastructure including the RWI and the brine disposal systems, without modification. Construction necessary to expand the facility, therefore, would be limited primarily to preparation of the site, leaching of the new storage caverns, and, under a 180-day drawdown criterion, construction of a new crude oil distribution pipeline. For a discussion of the estimated labor force for both the construction and operation phases, see section 7.1.9.

There are approximately 415 contiguous acres potentially suited for the development of nine 10-MMB storage caverns within the -600 to -1,500-meter depth range of the Big Hill salt dome. The area to the north of the existing caverns is considered most suitable for cavern development.

The areas to the south and west of the current site are least favorable for development because of the presence of two overhangs. On the southern portion of the dome, there is a large overhang that would limit storage on the south flank of the dome. The other overhang, on the western portion of the dome, could limit the space available for cavern construction to the northwest of the existing site. These overhangs, which are often present near the edges of salt domes, limit the construction of solution caverns because the salt in these overhangs tends to be more fractured or of poorer quality than in the main salt mass.

3.1.3 Brine Disposal System

Leaching of additional caverns at Big Hill would require brine disposal into the Gulf of Mexico. DOE believes that the existing brine pipeline would be sufficient for the additional leaching necessary to expand the Big Hill facility. Building upon experience gained at previously developed SPR facilities, DOE instituted brine pipeline corrosion mitigation measures at the startup of the ongoing leaching phase at the Big Hill facility. Ammonium bisulfite has been used as an oxygen scavenger to minimize corrosion and deterioration of the brine pipeline. The structural status of the brine pipeline is monitored using integrity testing. The most recent integrity testing, conducted in September 1991, indicated that the use of the oxygen scavenger had halved the corrosion rate as compared to previous DOE experience (i.e., at Bryan Mound and West Hackberry) where oxygen scavenging was not used. Test results show that in selected discrete locations up to 37 percent of the original wall thickness has corroded, and that 63 percent remains.[6]

Leaching new caverns would generate volumes of anhydrites as well as brine. Because the existing anhydrite pond would no longer be usable after the current leaching phase is completed, a new sacrificial pond would be needed. The existing pond will be drained and then capped. It may be possible to locate the replacement pond directly adjacent to the existing pond. Because the new pond would be connected to the existing underground pipeline network, construction would be limited primarily to the pond itself, and would have little or no effect on vegetation since the area already has been cleared.

3.1.4 Raw Water Intake System

Raw water used for the development and operation of Big Hill is transported by pipeline from the ICW (see Figure 3.1-2). The RWI pipeline is 48 inches in diameter and approximately five miles long. The RWI pipeline, as well as utility lines and the brine disposal pipeline, are buried at a minimum of three feet[7] beneath one mile of prairie pasture and four miles of wetlands.[8] The pipeline route has a permanent ROW that is 50 feet wide and occupies a total of 48 acres.[9] Since completion of the pipeline, ROW land has been kept clear of trees but has otherwise reverted to crop and pasture land.

The existing RWI system at Big Hill is considered adequate for the expansion and no modifications are proposed.

3.1.5 Crude Oil Distribution System

The existing crude oil distribution system consists of a 24-mile, 36-inch pipeline that connects Big Hill to commercial terminals in Nederland, Texas (in the Port Arthur/Beaumont area). The pipeline has a drawdown rate of 0.93 MMBD. Under the 270-day drawdown criterion, no oil distribution enhancements are required for the Big Hill expansion. DOE, however, is also assessing a 180-day drawdown criterion. To meet this requirement, DOE would construct a new crude oil distribution pipeline connecting Big Hill to East Houston (see Figure

3.1-3). Two routes are being assessed for the new pipeline to meet the 180-day criterion, one crossing Trinity Bay and one generally following I-10.

The selection of the pipeline routes to East Houston was based on numerous criteria, including total length, related land-use patterns, avoidance wherever possible of ecologically sensitive areas, major and minor crossings, and use of existing rights-of-way. The ROW required for the pipeline crossing Trinity Bay would include 39.7 miles of dry land, approximately 12 miles of open water, and 6.5 miles of wet land. The ROW required for the I-10 route would involve 49 miles of dry land, approximately 1 mile of open water, and 13 miles of wet land.

Construction of the crude oil distribution pipeline would require temporary and permanent easements. Generic easements requirements are given in Table 2.4-1. Based on the above assumptions, construction of the crude oil pipelines would require the acreages indicated in Table 3.1-1.

Also, construction of either pipeline would involve crossing various transportation routes including twelve major roads, seven major waterways that support boat traffic, and six railroads. As described in more detail in section 5.1.3.3, the Trinity Bay route would cross 19 water bodies in total and the I-10 route would cross 31 water bodies.

Table 3.1-1
Acreage Requirements for Proposed Big Hill Crude Oil Pipelines

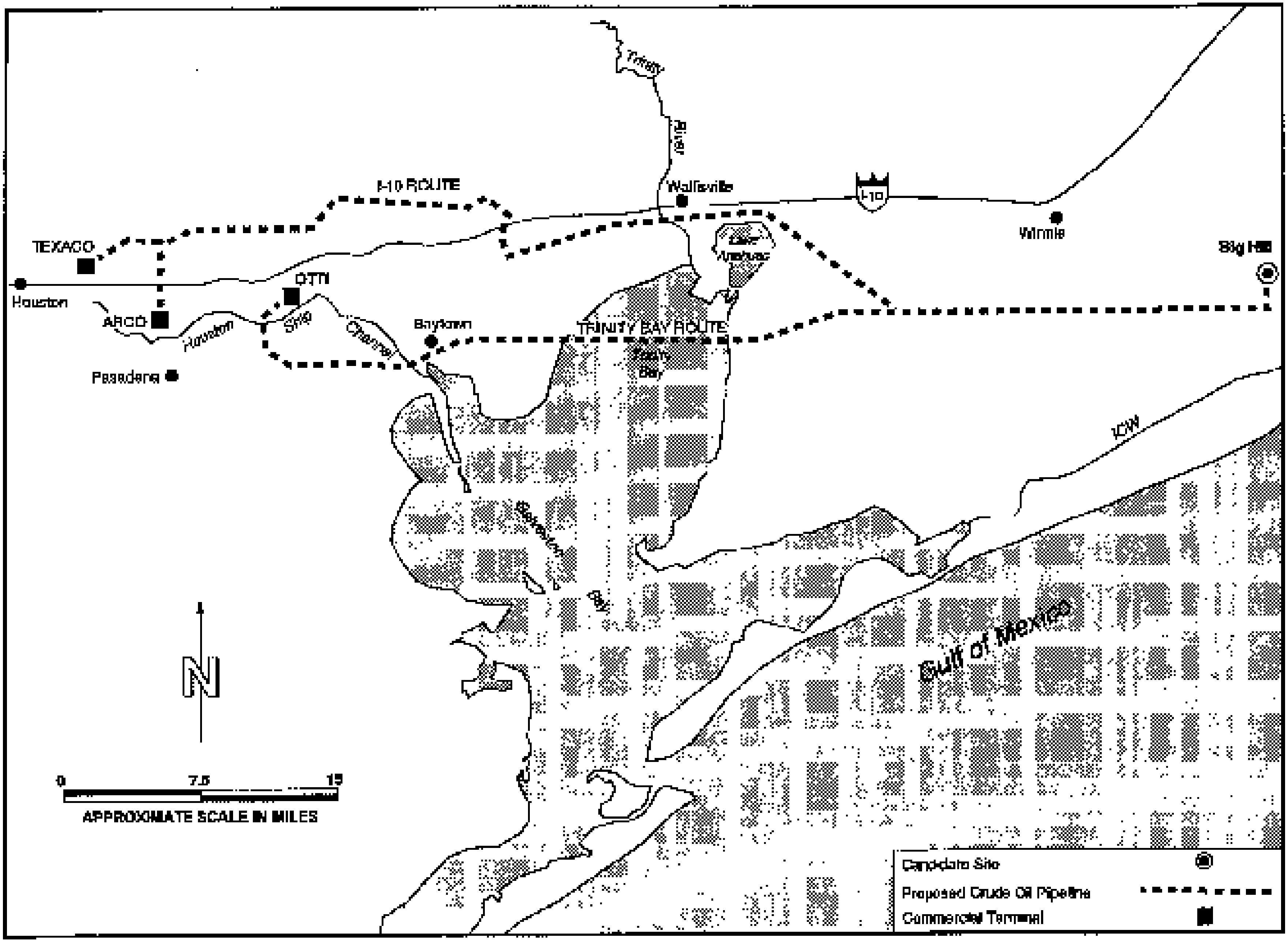
Easement Types	Acres	
	Trinity Bay Route	**I-10 Route**
Construction Easements	482	451
Temporary Construction Easements	97	196
Permanent Easements	357	373
Total Easements	936	1,020

Source: USDOE, 1991. Row Study for Big Hill, Stratton Ridge, Weeks Island, and Cote Blanche Pipelines (Task 16), Strategic Petroleum Reserve Program, PB-KBB, Inc., Houston, Texas, July 1991 and ICF Incorporated calculations using overlays of PB-KBB's proposed I-10 Route on National Wetland Inventory (NWI) maps, January 1992.

3.2 Stratton Ridge (Seaway Complex Site)

The Stratton Ridge salt dome is the alternative site for SPR expansion of the Seaway Complex in Texas. Under this alternative, DOE would construct a new facility with a potential storage capacity of 100 MMB. Site development would include leaching ten storage caverns, each with a capacity of ten MMB, and construction of an RWI structure, a brine disposal system, and a crude oil distribution system. The facility configuration would be modelled on the existing Big Hill site. The Stratton Ridge site is well located for efficient oil distribution and would only require construction of an approximately one-mile pipeline spur to the existing Bryan Mound-

Figure 3.1-3
Proposed Crude Oil Pipelines for Big Hill



Texas City pipeline, which passes to the south of the proposed site. The pipeline would have a capacity of about 0.6 MMBD. Oil fill would be from either the ARCO Terminal in Texas City or the Phillips Terminal in Freeport. Because more significant environmental impacts would be associated with the fill from the ARCO Terminal, fill from that terminal has been assessed in this DEIS.

3.2.1 Site Configuration and Construction

The salt dome is relatively large with approximate dimensions of three miles (north-south) by four miles (east-west). The proposed site would be located on approximately 200 acres on the south-central portion of the dome at coordinates 29°03'N and 95°22'W on property currently owned by Cockrell Oil Company. The northwest boundary of the proposed site abuts a Missouri Pacific railroad track and the southern boundary is defined by Oyster Creek.

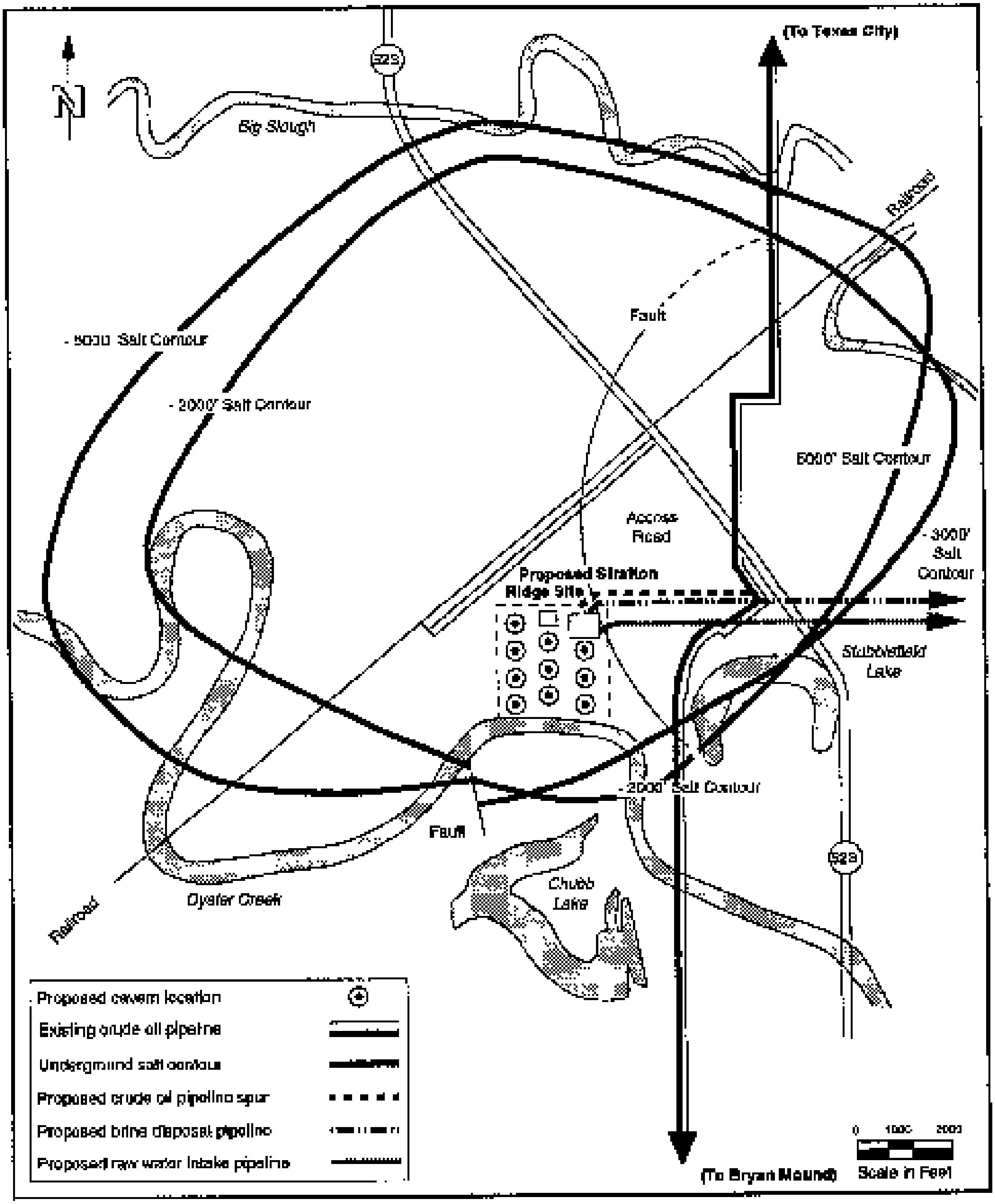
The proposed Stratton Ridge site is in Brazoria County, Texas, three miles east of Clute and Lake Jackson and six miles north of Freeport. Although there is some cattle ranching around Stratton Ridge, the economy of the area centers on the petrochemical industry. Because of the industrial nature of the area, population densities around Stratton Ridge are the highest of any of the proposed expansion sites. Clute and Lake Jackson, the closest population centers, have a combined population of more than 30,000. Freeport, the next closest incorporated town within ten miles of the site, has a population of over 11,000.[10]

Stratton Ridge is considered an upland area even with its relatively low elevation of ten to 15 feet above msl. The local topography is characterized primarily by the surrounding water bodies, including Stubblefield Lake, Club Lake, and Big Slough, which are within one mile of the site. Several wetland areas, old-growth forests, and cattle grazing fields are adjacent to the site. A large wetland exists along the southwest edge of the site, a small wetland area lies adjacent to the Missouri Pacific roadbed, and a forested wetland can be found along a small stream that passes near the site. Site construction would be done so as to minimize impacts to wetlands.

Currently, on the Stratton Ridge salt dome, 57 brine and storage caverns, with an approximate total volume of about 150 MMB, are operated by Dow, Amoco, Conoco, and Occidental. Although the salt dome is quite large (there are 325 contiguous acres available for cavern construction), the operation of a large number of caverns by multiple users could pose some construction and operational problems. Additionally, the existence of an active slump fault to the east of the site and a history of corrosion and casing failures at existing, privately-owned caverns could be of potential concern. Through proper siting, construction, and communication with the dome's co-users, these potential impacts could be minimized. If the Stratton Ridge site is selected, the precise layout of the caverns would be determined by results of geophysical studies, although this assumes that the site configuration would be similar to that at the Big Hill facility. Figure 3.2-1 illustrates a schematic cavern layout for the Stratton Ridge salt dome.

Because Stratton Ridge would be a new SPR site, extensive on-site construction would be required. In addition to the storage caverns, facilities that would be constructed at the site include a raw water leaching/drawdown system, a brine settling and disposal system, a crude oil injection/distribution system, and operation, maintenance, and security buildings. New access roads and on-site roads may be required. Additionally, an RWI structure, brine diffusers, and the associated pipelines would be constructed off-site. For a description of the estimated number of workers, see section 7.2.9.

Figure 3.2-1
Proposed Cavern Layout for Stratton Ridge



Source: U.S. Department of Energy, Report to Congress on Candidate Sites for Expansion of the Strategic Petroleum Reserve, March 1991, DOE/F-0221P.E

3.2.2 Brine Disposal System

The design and construction of the brine disposal system would be based on the existing Big Hill system (see Figure 3.2-2). Brine would be pumped from the caverns to a pond system consisting of a sacrificial anhydrite pond where insoluble components of the brine would settle out and a second pond where any residual oil would be skimmed off the top of the brine. The oil-free brine would then flow into a 16-mile, 36-inch pipeline that would carry the brine to a depth of 36 feet into the Gulf of Mexico. As with the Big Hill system, diffuser ports would be located on the final 4,000 feet of this pipeline. The pipeline would lie perpendicular to the coast to take advantage of ocean currents for maximizing diffusion, and its terminus would be located at coordinates 28°56'N and 95°13'W.

3.2.3 Raw Water Intake System

The RWI structure would be located eight miles southwest of the site on the ICW at coordinates 28°59'N and 95°16'W and would consist of an elevated platform containing raw water pumps and screening devices to keep debris and organisms out of the raw water pipeline. The 36-inch raw water pipeline would be used to transport raw water from the ICW to the site for cavern leaching and oil drawdown (see Figure 3.2-2). The pipeline would have a throughput capacity sufficient to leach caverns at a rate of one MMBD and would provide water volumes adequate for drawdown.

The raw water pipeline would begin at the site, travel east until it crosses Highway 523, where it would turn southeast to cross Essex Bayou and end at the ICW. The raw water pipeline would be constructed in the same ROW as the brine pipeline except that the latter would cross the ICW and continue southeast to the Gulf of Mexico. The ROW route required for this pipeline would include four miles of dry land and approximately three miles of wet land. The pipeline would cross a total of two water bodies with a combined width of approximately 30 feet. The ROW width for the dry land segment containing both pipelines would be 170 feet, consisting of a 70-foot permanent easement and a 100-foot construction easement, and the ROW for the wetland segment would be 120 feet, consisting of a 70-foot permanent easement and a 50-foot construction easement. The ROW segment containing only the brine pipeline consists of less than one mile of wet land and approximately nine miles of offshore area. The easement for this section of the ROW would be 150 feet for the wetland segment and a 50-foot construction easement. The estimated acreage requirements for developing the ROW for the brine pipeline and RWI pipeline are identified in Table 3.2 1.

3.2.4 Crude Oil Distribution System

Crude oil pipeline construction would be minimal at the Stratton Ridge site and would consist of building a one-mile pipeline spur from the site to the existing Bryan Mound-Texas City pipeline (see Figure 3.2-2). This configuration would allow Stratton Ridge to provide the Houston/Texas City refining center with 0.6 MMBD in the event of a national energy emergency and would also allow for oil fill and crude oil transfers between the Stratton Ridge and Bryan Mound sites.

Figure 3.2-2
Proposed Brine Disposal, Raw Water Intake, and Crude Oil Systems for Stratton Ridge

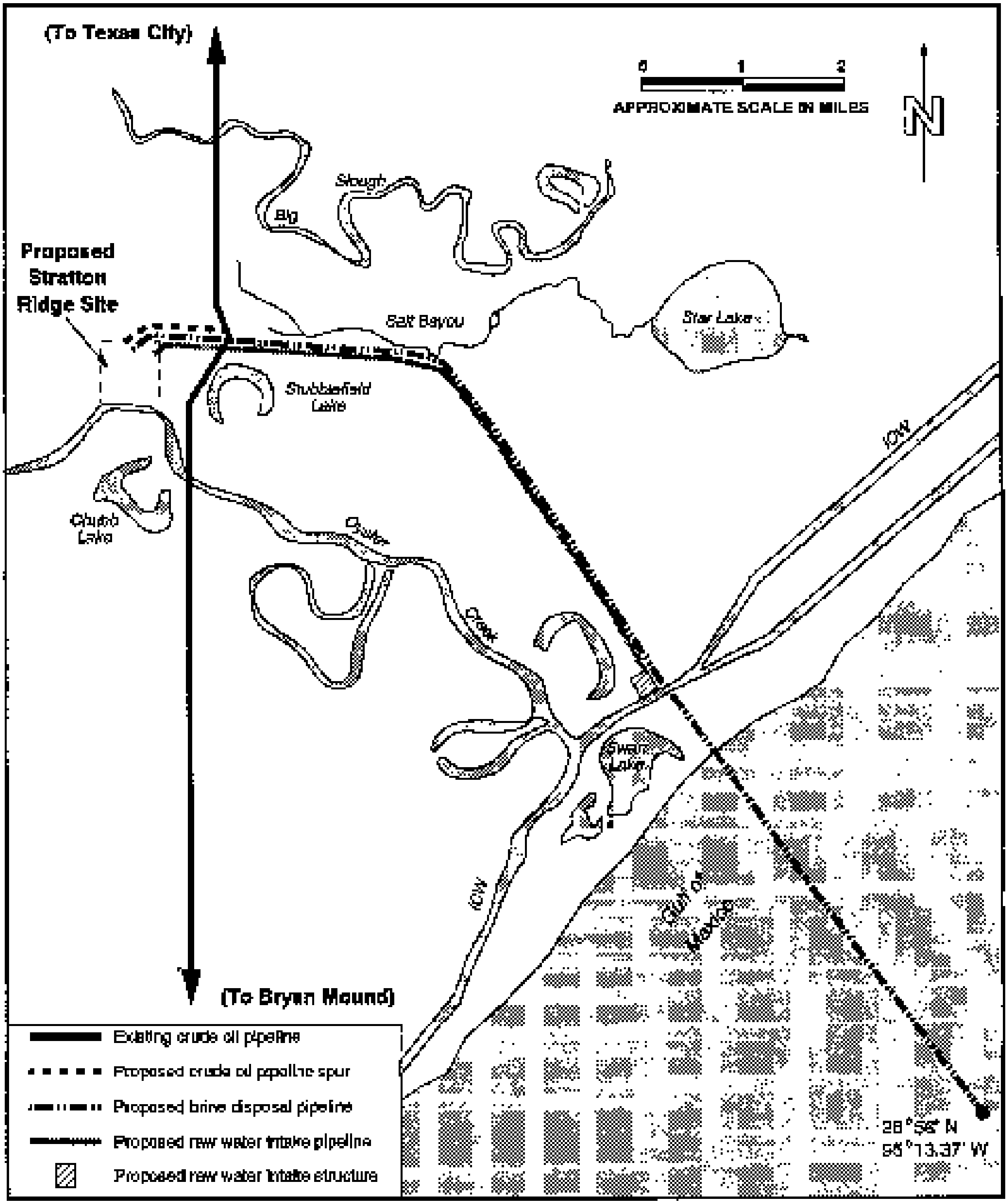


Table 3.2-1
Stratton Ridge Brine Disposal and Raw Water Intake Pipeline Easements

Easement Types	Acres
Construction easement (raw water/brine)	82
Temporary construction easement (raw water/brine)	13
Permanent easement (raw water/brine)	57
Construction easement (brine)	8
Temporary construction easements (brine)	3
Permanent easement (brine)	4
Total easements	159

Source: USDOE, 1991. *ROW Study for Big Hill, Stratton Ridge, Weeks Island, and Cote Blanche Pipelines* (Task 16), Strategic Petroleum Reserve Program, PB-KBB, Inc., Houston, Texas, July 1991.

3.3 Weeks Island Expansion (Capline Complex Site)

Under the Weeks Island expansion alternative, DOE would create up to 16 storage caverns, with a total storage capacity of 160 MMB, on the eastern portion of the salt dome. Together with the existing storage capacity, the Weeks Island SPR facility would store up to 233 MMB of crude oil. The distribution alternative for the Capline Complex is upgrading the existing pipeline to the St. James Terminal by adding one booster pump to the existing pipeline. This would provide a combined drawdown rate from the existing and expanded Weeks Island facilities of 0.86 MMBD under the 270-day drawdown criterion. Under the 180-day drawdown criterion, the pipeline upgrade would be augmented with another pump station and by constructing a seven-mile spur to the existing Texas 22" pipeline to Clovelly, as well as expanding St. James Terminal with up to two new docks and two new tanks. Assuming a 180-day drawdown criterion, the combined drawdown rate would be about 1.29 MMBD. Oil fill would be from the St. James Terminal through the existing DOE pipeline.

3.3.1 Description of Existing Facility

The existing Weeks Island SPR facility was developed on the southwest slope of the island and occupies about 1.8 surface acres and 402 subsurface acres of the Weeks Island salt dome. DOE acquired this storage site from the Morton Salt Company in 1977 and converted the existing salt mines to oil storage. Oil is moved into and out of the room-and-pillar salt mine using submersible pumps, and, therefore, the existing facility does not have raw water intake or brine disposal systems. Development and fill of the existing facility was completed in 1982. At Weeks Island, crude oil is stored in the pre-existing room-and-pillar mine. Sections of the salt dome are still occupied and mined by the Morton Salt Company, which currently operates a mechanically mined room-and-pillar salt mine to a depth of about 1,300 feet. The Weeks Island salt mines have been actively worked since 1898.

The Weeks Island SPR facility is located in Iberia Parish, Louisiana, on the eastern edge of Weeks Bay, about nine miles south of Lydia (1990 pop. 1,136), approximately 14 miles south of New Iberia, and 95 miles west of New Orleans. Weeks Island itself is virtually uninhabited and the surrounding area is sparsely populated. Iberia Parish has a total population of 68,297 (1990), and New Iberia, with a population of 31,828, is the Parish's only major urban center and supplies the majority of the labor force for the facility. The major economic activities in the Parish are mineral production (oil, gas, and salt), manufacturing (sugar refining and petrochemicals), construction, shipping, agriculture (sugar cane fields), and fishing. Land use in Iberia Parish and in the surrounding parishes includes forests (41 percent), crop and pasture (28 percent), marshlands (approximately 15 percent), and urban/residential (three percent). Avery Island bird sanctuary is ten miles northwest of Weeks Island. Marsh Island, a national wildlife refuge in the Gulf of Mexico, is 17 miles south of the facility. Off the southern shore of Marsh Island is an eight-acre nesting area called Shell Keys National Wildlife Refuge.

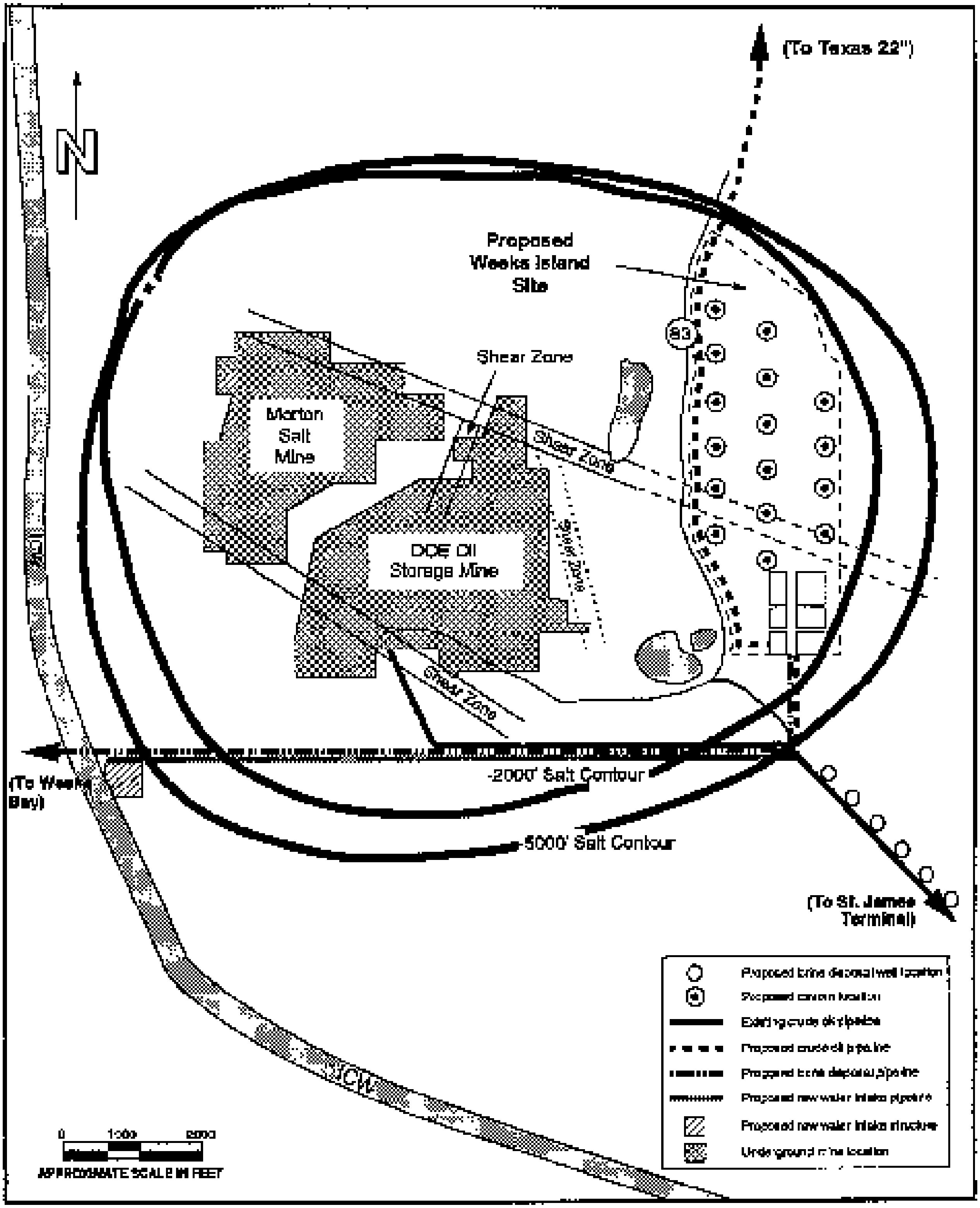
The Weeks Island salt dome, one of the Five Island salt domes in a northwest-southeast direction in southern Louisiana, is roughly circular with a diameter of approximately two miles. The dome is flattened on the top and has slight overhangs on the north and east. As seen in Figure 3.3-1, a shear zone runs through the storage area between the Morton Salt Company mines and the DOE facility. This shear zone could influence the positioning of individual caverns on the dome because the caverns must be constructed some distance from the shear zone. The exact placement of the caverns would be determined by more detailed geophysical studies.

The land surface over the salt dome forms an "island" caused by domal upthrusting, rising to 171 feet above msl, the highest point in elevation in south Louisiana. The island is mostly covered with second growth deciduous forest, except for a few hundred acres on the eastern portion of the island that are used for sugar cane farming. Other operations on the dome include table salt production at Morton Salt Company's two leached caverns, located on the northeast corner of the dome, and oil and gas production at Shell Oil Company's facility on the north overhang. Additional oil and gas fields are located at the northern and southern edges of the island.

Coastal wetlands in the surrounding area include a combination of saline and brackish marshes, bayous, man-made canals (including the ICW), and bays contiguous with the Gulf of Mexico. The island also contains several ponds of which the largest, Plantation Lake, covers about 20 acres and has a depth of about ten feet.

The Weeks Island SPR facility is a component of the Capline Complex and is connected to the St. James Terminal by a 36-inch, 67-mile crude oil pipeline. The Weeks Island SPR facility currently consists of the main site, the fill site, the laydown yard, the fire protection site, the service shaft, and the production shaft. Key features at the facility include eleven submersible electric pumps, three mainline pumps, an oil sump, a flow metering facility, and a collection pond. Additional site support facilities include a heliport, a maintenance yard, and control, administration, and service buildings. The storage capacity of the site is about 73 MMB.

Figure 3.3-1
Existing and Proposed Cavern Layout for Weeks Island



Source: U.S. Department of Energy, Report to Congress on Candidate Sites for Expansion of the Strategic Petroleum Reserve, March 1991, DOE/F-0221P.E

3.3.2 Expansion Site Configuration and Construction

The 270-acre area of Weeks Island proposed for SPR expansion is directly east of the current facility at 29°48'N and 91°48'W and is approximately 50 feet above msl. The proposed cavern layout and expansion area are illustrated in Figure 3.3-1. Morton International, Inc. has surface rights in the proposed SPR expansion area, although Benjamin Minerals owns mineral rights to the salt. The salt in the expansion area, however, is not being considered for future salt mining by Morton or Benjamin Minerals. Up to 16 oil storage caverns, each with a ten MMB storage capacity, would be developed in the salt dome by leaching with raw water. Preliminary geologic characterization of the site[11] identified a major overhang on the north side of the dome and a minor top caprock on the periphery. Further studies would be needed to determine the extent of several shear zones and to better define the overhang if caverns were to be placed on the north side of the dome. Additional geotechnical investigations could be required for consideration of cavern emplacement below the present oil storage mines.

The proposed expansion area would be located above marsh, except the outside cavern row, where wetlands alteration may be required. Several small, shallow ponds occur on the east side of the salt dome, the area being considered for expansion. Approximately half of the proposed expansion site is hardwood forest where water oak, sweetgum, hickory, magnolia, and pecan are the dominant trees. Partridge pea, cypress vine, and shining sumac are common herbaceous plants in the fields and along the forest/field edges. Virginia chainferns and royal ferns are common species in the alluvial swamp area. The eastern area of the proposed site, however, contains sparse understory and herb layer, possibly due to flooding from field irrigation. Mink, alligator, raccoon, nutria, river otter, gulls, terns, egrets, and herons are common species found in the marsh area. The diverse lowland fauna residing in the area includes various predatory and game birds, white-tailed deer, bobcat, black bears, bats, and swamp rabbits. Further ecological characteristics of the site are discussed in section 5.3.5.

The proposed Weeks Island expansion would require substantial facility development. Along with the construction of up to sixteen 10-MMB storage caverns, additional on-site facilities required would include a raw water leaching/drawdown system, a brine settling and disposal system, a crude oil injection/distribution system, and operations and maintenance and security buildings. In addition, construction of off-site facilities would consist of a raw water intake structure on about five acres of land along the ICW located approximately two miles west of the site, and interconnecting pipelines for raw water, brine disposal, and crude oil receipt and distribution. For a discussion of the estimated number of workers for the construction and operational phases of site development, see section 7.3.9.

There are approximately 560 contiguous acres, which extend to the 5,000-foot depth of the Weeks Island salt dome, potentially suitable for sixteen 10-MMB caverns within the -2,000-foot salt contour. The east side of the salt dome would be the most suitable for cavern development in the 2,000-foot to 4,000-foot depth range, although the south side of the dome may also be suitable. The south side of the dome alone has insufficient space for all of the caverns, however, a few caverns could be placed as extensions from the east side. (Cavern development is described in detail in section 2.4.1.1.) The area on the north side of the salt dome is least favorable for cavern development because of the overhang, the proximity to Morton's current mine, and the proximity to Shell Oil's carbon dioxide compression plant.

3.3.3 Brine Disposal System

DOE is considering two brine disposal systems. The first would be the construction of a 48-inch, 41-mile brine disposal pipeline and diffuser system extending to the 25-foot water depth contour in the Gulf of Mexico. The diffuser, which would be designed to disperse the brine into ocean currents, would lie perpendicular to the coast at coordinates 29°25'N and 92°16'W. The proposed brine pipeline route would extend west from the facility, crossing Highway 83 and the Southern Pacific Railroad, paralleling the RWI pipeline into the ICW. The brine pipeline would continue west, skirting Blue Point and several other land masses in Weeks Bay, proceeding west into Vermilion Bay, turning southwest to cross Southwest Point Peninsula east of Portage Lake, and extending roughly 15 miles offshore into the Gulf of Mexico (see Figure 3.3-2).

The proposed brine disposal pipeline would share a common ROW with the RWI pipeline from the site to the ICW, a distance of two miles, of which 1.3 miles are dry land and 0.7 mile is wet land. The ROW width for the wetland segment containing both pipelines would be 170 feet, consisting of a 70-foot permanent easement and a 100-foot construction easement. The ROW width in dry land would be 120 feet. These pipelines would cross Highway 83 and the Southern Pacific Railroad. The brine-only pipeline portion of the ROW extends slightly more than two miles until it reaches the shoreline. The ROW width in wetlands would be 150 feet with a 100-foot construction and 50-foot permanent easement. In uplands, the ROW width would be 100 feet. Including Weeks Bay, Vermilion Bay, and the Gulf of Mexico, the brine pipeline would cross approximately 33 miles of open water. The proposed acreage requirements[6] for the brine and RWI pipelines are identified in Table 3.3-1.

Because of the nearshore features and gentle slope of the continental shelf in this area, the brine discharge pipeline route around Marsh Island would have to be more than 40 miles long to reach a candidate diffuser location in the Gulf that is at least 25 feet deep. As a potentially cost-competitive alternative to this lengthy pipeline, DOE is considering deep underground injection close to the site as a brine disposal alternative (see Figure 3.3-3). The injection well system would consist of a brine treatment system, a brine discharge pipeline, and up to 25 injection wells. The treatment system would include on-site alum treatment, a 360,000 square foot (0.51-MMB capacity) brine pond for the settling of suspended solids, three cyclone separators to provide additional filtration, and individual polishing filters on each injection well. The pipeline for well injection would follow the same ROW as the existing crude oil pipeline from Weeks Island to the St. James Terminal. The pipeline would have an outside diameter of 42 inches, would be lined with cement, and would extend a maximum length of approximately five miles. The 25 injection wells would be spaced 1,000 feet apart along this pipeline length, with each well positioned on a 180-foot by 180-foot well pad. The wells would be drilled to a total depth of more than 1,200 feet, if the Illinoian formation is used as the injection zone, or more than 2,200 feet, if the Nebraskan formation is used as the injection zone (section 5.3.2 describes these underground formations in detail). The wells would be outfitted with standard equipment for Class II injection wells, including surface casing set with cement to a depth of 800 feet, intermediate casing, an intermediate casing/borehole annulus cemented completely to the land surface, injection tubing, and a packer.

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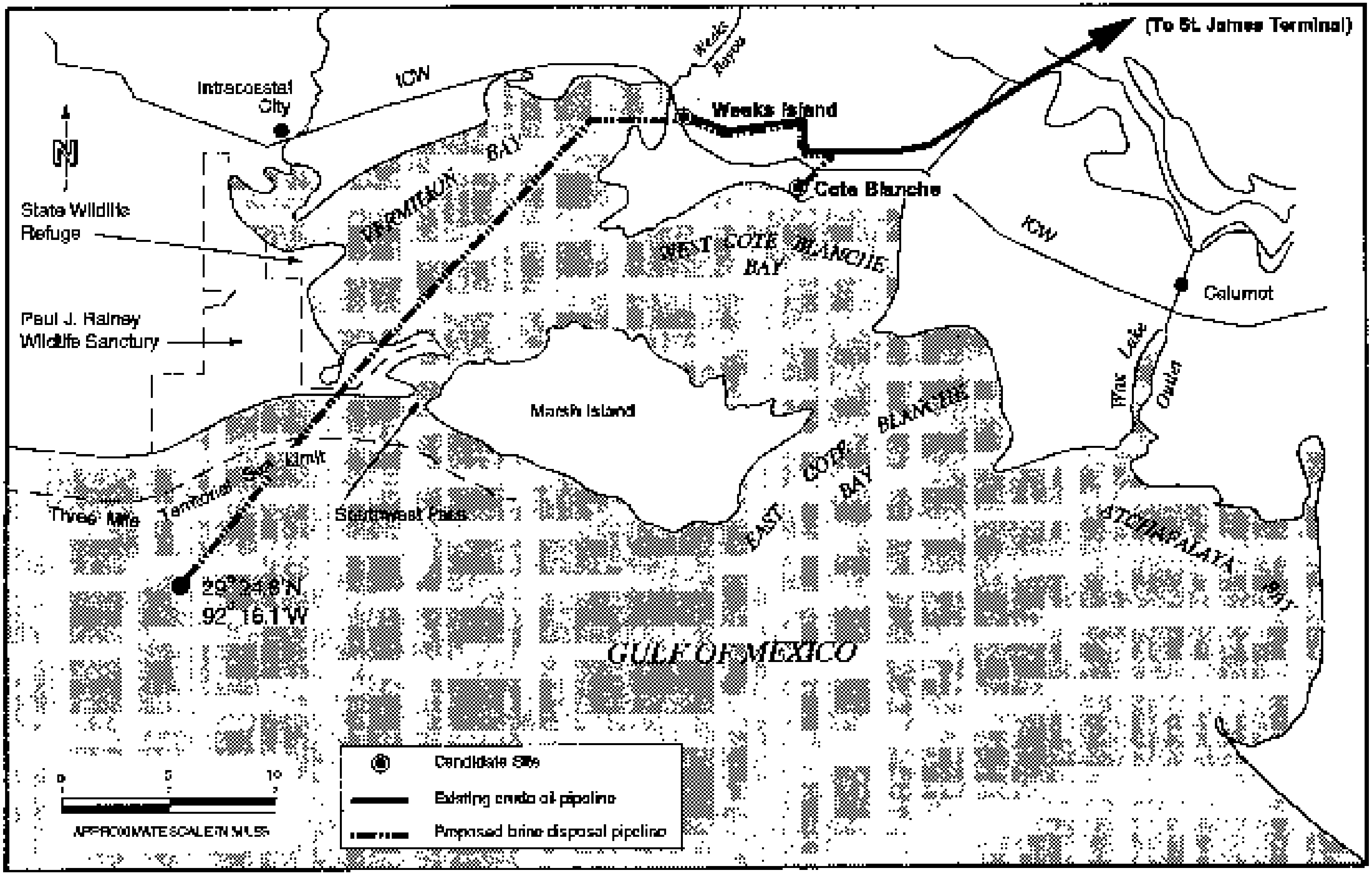
[6] The easement required for miles of brine line in offshore waters is not included in the total acreage requirements.

Figure 3.3-2
Proposed Brine Disposal System (Diffuser) for Weeks Island/Cote Blanche



Source: PB-KBB Inc., Brine Pipeline Maps of Weeks Island on National Oceanic and Atmospheric Administration nautical charts.

Table 3.3-1
Weeks Island Brine Disposal and Raw Water Intake Pipeline Easements

Easement Types	Acres
Construction easement (raw water/brine)	24
Temporary construction easement (raw water/brine)	4
Permanent easement (raw water/brine)	17
Construction easement (brine)	27
Temporary construction easement	8
Permanent easement (brine)	14
Total easements	104

Source: ICF Incorporated calculations using overlays of PB-KBB proposed brine and raw water pipeline route on NWI maps, January 1992.

3.3.4 Raw Water Intake System

A 48-inch, two-mile long pipeline would transport raw water from the ICW west of Weeks Island to the facility. The RWI structure would be located at 29°48'N and 91°49'W (see Figure 3.3-1). The raw water and brine systems would be sized for leaching caverns at an average rate of one MMBD. The mileage and acreage required for this pipeline are detailed in the preceding section.

3.3.5 Crude Oil Distribution System

The existing crude oil drawdown/distribution system consists of a 36-inch, 67-mile crude oil pipeline that connects Weeks Island to DOE's terminal at St. James. Under either drawdown criterion, a 30-inch, one-mile spur would be constructed to the existing pipeline, which currently has a drawdown rate of 0.59 MMBD. Under the 270-day criterion, DOE would also upgrade the existing Weeks Island to St. James Terminal pipeline by adding one booster pump to increase the distribution capability. Under a 180-day drawdown criterion, a second pump station would be added to upgrade the existing pipeline, a seven-mile, 24-inch pipeline would be constructed to the Texas 22" pipeline to connect to Clovelly, and the St. James Terminal would be expanded by constructing up to two new docks and two new tanks. The 270-day drawdown criterion would increase the total drawdown rate from Weeks Island to approximately 0.9 MMBD. The crude oil pipeline alternatives under both drawdown criteria are depicted in Figure 3.3-4. The proposed spur would be primarily through wetlands and would not affect any transportation routes or surface water bodies. The western pump station would be located in St. Mary Parish, approximately 2.5 miles southeast of Baldwin. The eastern pump station would be located in Assumption Parish, approximately 1.2 miles south of Pierre Port.

Figure 3.3-3
Proposed Brine Disposal (Underground Injection) and Raw Water Intake Systems for Weeks Island

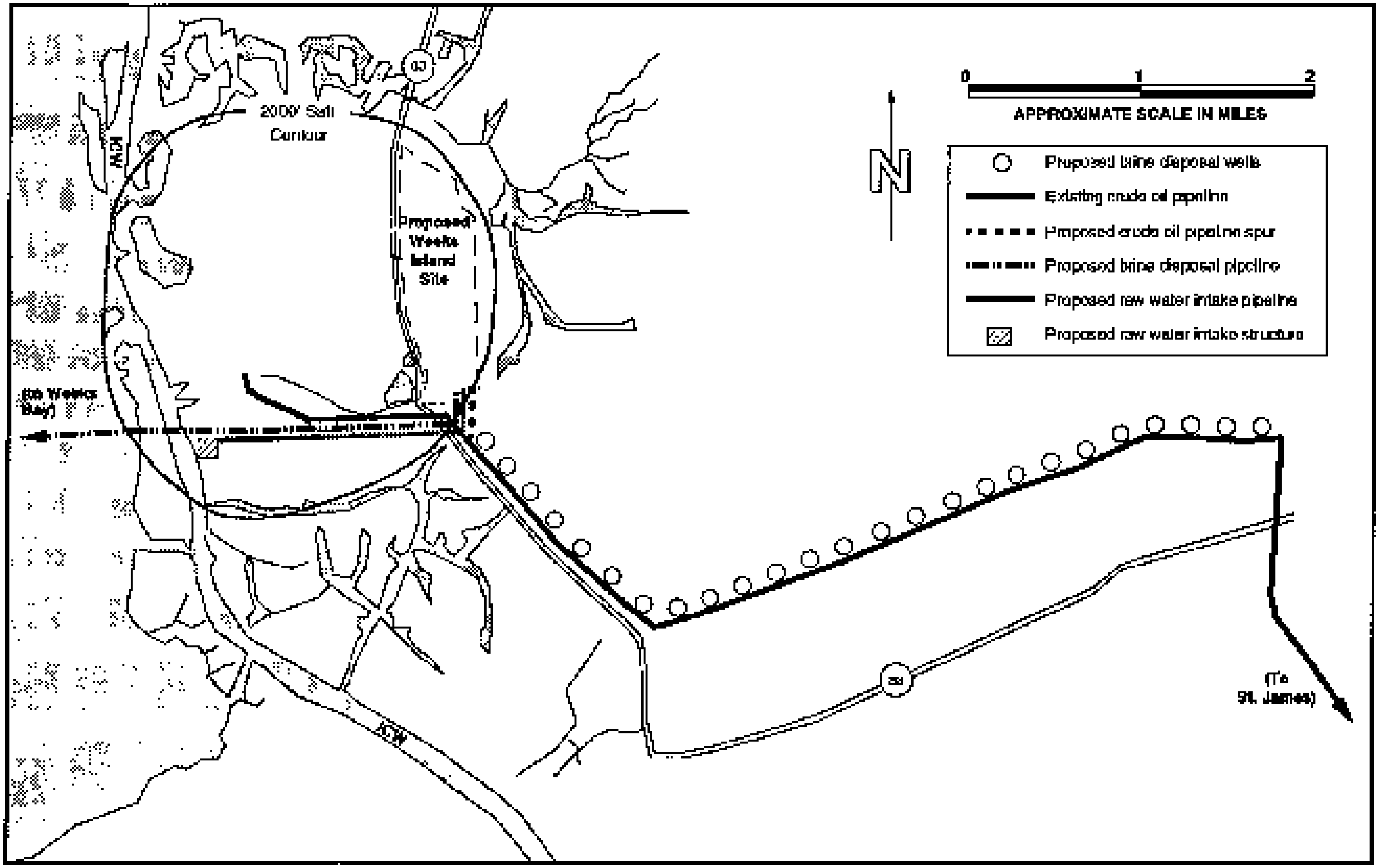
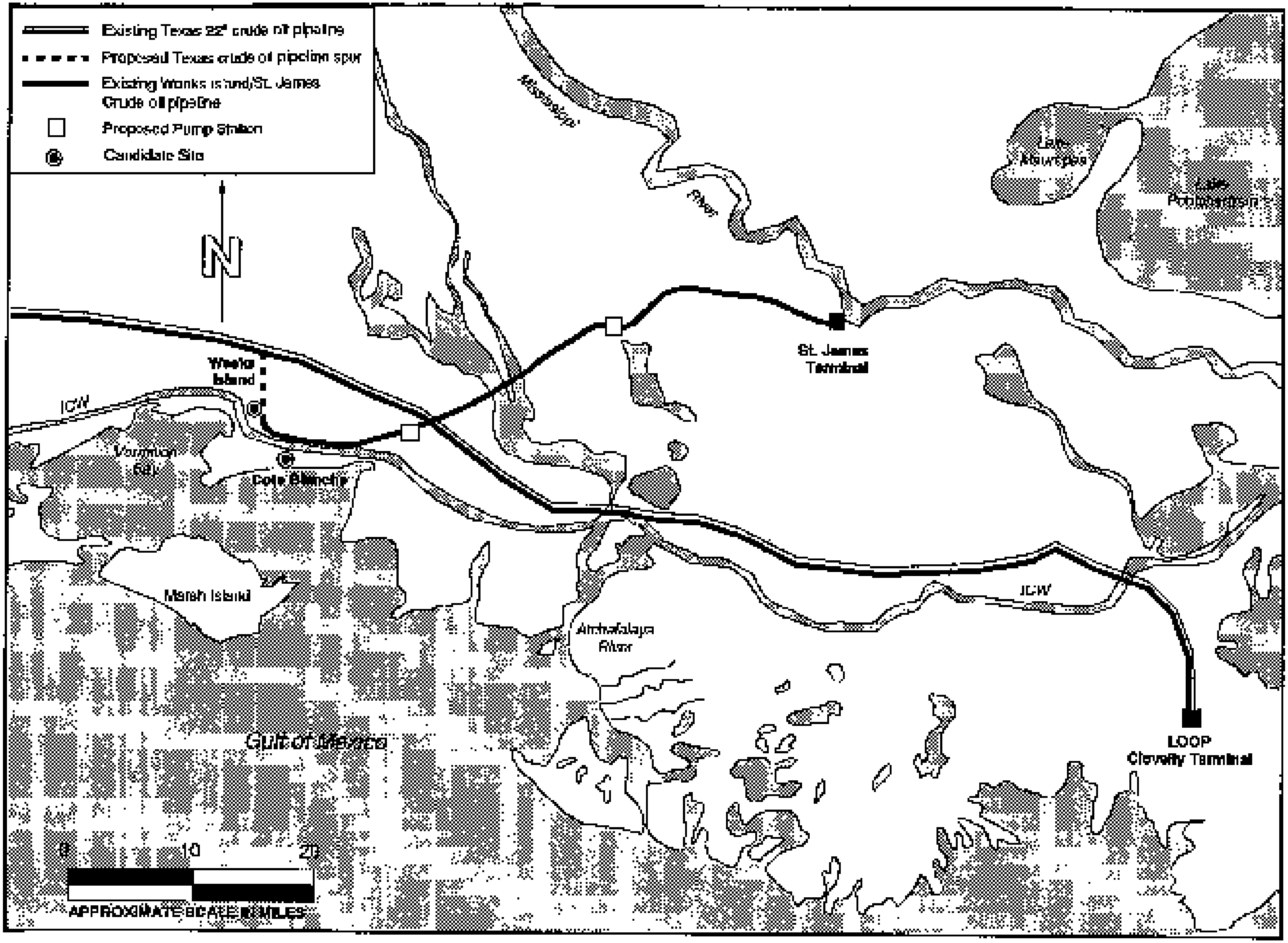


Figure 3.3-4
Proposed Crude Oil System for Weeks Island/Cote Blanche



DOE proposes a construction ROW width of 100 feet in dry land and 150 feet in wet land. Permanent easements in dry land and wet land would be 50 feet. Construction easements would be 50 feet for dry land and 100 feet for wet land. Easement acreage requirements for the proposed pipeline under the 180-day drawdown criterion are listed in Table 3.3-2.

Table 3.3-2
Crude Oil Pipeline Easements at Weeks Island

Easement Types	Acres	
	Quarter-Mile Pipeline Connection Spur	Pipeline Spur to Texas 22"
Construction easement	2	73
Temporary construction easement	4	14
Permanent easement	2	42
Total easements	8	129

Source: ICF Incorporated calculations using overlays of PB-KBB's proposed pipeline routes on NWI maps, January 1992.

3.4 Cote Blanche (Capline Complex Site)

The Cote Blanche salt dome is one of the three DOE candidate sites for SPR development in the Capline Complex. Under this alternative, DOE would create up to 16 storage caverns, with a total storage capacity of up to 160 MMB, on the east-northeast portion of the salt dome. Distribution options for the Cote Blanche site are similar to those described for Weeks Island:

- 270-day criterion -- construction of a two-mile spur to the existing pipeline to St. James Terminal, which would be upgraded by adding one booster pump; and
- 180-day criterion -- pipeline upgrade with two pump stations plus the expansion of the St. James Terminal as discussed in Section 3.6 and construction of a spur from Weeks Island to the Texas 22" pipeline.

The first option would have a combined drawdown rate from the existing Weeks Island and Cote Blanche expansion sites of 0.86 MMBD. The other option would have a combined drawdown rate of approximately 1.29 MMBD. Oil fill would be from the St. James Terminal through the DOE pipeline.

3.4.1 Site Configuration and Construction

The Cote Blanche salt dome rises from the north shore of West Cote Blanche Bay to about 75 feet above msl at coordinates 29°45'N and 91°43'W. The proposed site would be located on approximately 300 acres, east of the existing salt mine. The salt dome is surrounded on three sides by coastal wetlands and forms an "island" that is separated from the mainland by the ICW. Coastal wetlands surrounding the proposed Cote Blanche site include a combination of saline and brackish marshes, bayous, man-made canals (including the ICW), and bays contiguous with the Gulf of Mexico. The southern half of the dome is beneath the bay and is, therefore, considered unsuitable for SPR development. Currently, access to the Cote Blanche "island" is by cabled ferry across the ICW.

A conventional room-and-pillar salt mine, located within the large overhang to the north-northwest of the dome, is currently operated by the Carey Salt Company, a subsidiary of North American Salt Company. The mine was developed by the Carey Salt Company in association with Monsanto Chemical Company in the early 1960s and salt production began in 1965. Domtar Chemicals purchased the mine in 1973 and operated it through 1990, when it was sold to the North American Salt Company. Mining to date has been approximately at the -1,350-foot level, considerably deeper than the development of the original mines at Weeks Island. The mine supplies about one to 1.5 metric tons of rock salt annually; approximately ten percent of the rock salt produced in the United States each year. A number of oil wells, owned by Shell Oil Company, were drilled through the salt dome before the salt mine was developed. Substantial hydrocarbon production has occurred on the north and south flanks of the dome, including approximately 200 to 300 MMB of oil and approximately 300 million cubic feet of natural gas.

Mine ownership is believed to include surface and mineral rights to 160 acres, which would include the areas occupied by the mine buildings and ancillary surface facilities, and mineral rights for most, if not all, of the remainder of the onshore section of the dome. These rights are also believed to extend 3,000 feet below the surface; however, these claims are not confirmed. In addition, the Taylor Cafferty estate and its 200-plus heirs claim ownership of the entire island.[12] Although the estate's ownership of the island is not known to be in dispute, the allocation of shares among the 200-plus heirs could potentially lead to legal actions which might delay site development.

The salt dome is located in St. Mary Parish, Louisiana, on the northern edge of West Cote Blanche Bay, about eleven miles southwest of Franklin (1990 population 9,004), approximately 18 miles southeast of New Iberia (1990 population 31,828), and about twelve miles south-southeast of Lydia (1990 population 1,136). The proposed SPR facility would be approximately seven miles southwest of the existing SPR facility at Weeks Island. Avery Island bird sanctuary is about 17 miles northwest of Cote Blanche. In addition, Marsh Island, a Federal wildlife refuge in the Gulf of Mexico, is approximately ten miles southwest of the facility.

The Cote Blanche site would be located in an upland area (relative to the surrounding low-lying marshes and swamps) and would require little mitigation to develop, although nearby wetlands may be altered somewhat when on-site flood protection is developed. The proposed expansion area is sufficiently elevated so that flooding is of little concern, even during the most severe hurricanes, except perhaps in marsh areas on the southeast side of the dome. Inundation of these areas, however, would not affect cavern development.

Development of the proposed SPR facility at Cote Blanche would require substantial on-site and off-site facility construction. In addition to the construction of up to sixteen 10-MMB storage caverns, DOE would construct other on-site facilities including a raw water leaching/drawdown system, a brine settling and disposal system, a crude oil fill and drawdown/distribution system, operations, maintenance, and security buildings, and access roads.

Figure 3.4-1 illustrates a schematic layout for the Cote Blanche salt dome. The eastern portion of the salt dome may contain a shear zone, although the exact location of such a zone has not been determined (see section 5.4.1 for further discussion of subsurface geology at Cote Blanche). Off-site facilities would consist of an RWI structure on the ICW located about one mile north of the proposed site and interconnecting pipelines for raw water, brine disposal, and crude oil receipt and distribution. The raw water and brine systems would be sized for leaching caverns at an average rate of one MMBD and the crude oil system designed for drawdown rate of approximately 0.7 MMBD. For a description of labor force requirements, see section 7.4.9.

Access to the island is presently via cabled ferry; alternative access would require a bridge or tunnel to support fire, security, and site personnel. The likely cost-effective approach would be a two-lane, steel, built-up plate girder bridge with H-20 loading capabilities. H-20 loading capabilities are designed for industrial use. The width of the bridge roadway would be 24 feet and of the overall bridge would be 35 feet. The bridge would also be a cable swing-type structure to allow for ICW boat traffic. On site road construction could be required. There would be no off-site road construction required because the bridge would be constructed at the existing ferry roadway. A pivot/push barge would be used for heavy equipment.

The permanent easement for the bridge would be about 700 feet by 135 feet and would require 217 acres. The construction easement for the bridge would be approximately 900 feet by 435 feet and would require the usage of about nine acres.

3.4.2 Brine Disposal System

The brine disposal options being considered for Cote Blanche are the same as those considered for Weeks Island (see section 3.3.3). The first option is discharge to the Gulf of Mexico, via a pipeline that passes to the west of Marsh Island. The pipeline would extend more than 40 miles from the site to a diffuser located in at least 25 feet of water in the Gulf of Mexico, either at 29°25'N and 92°16'W or 29°7'N and 91°50'W (see Figure 3.3-2).

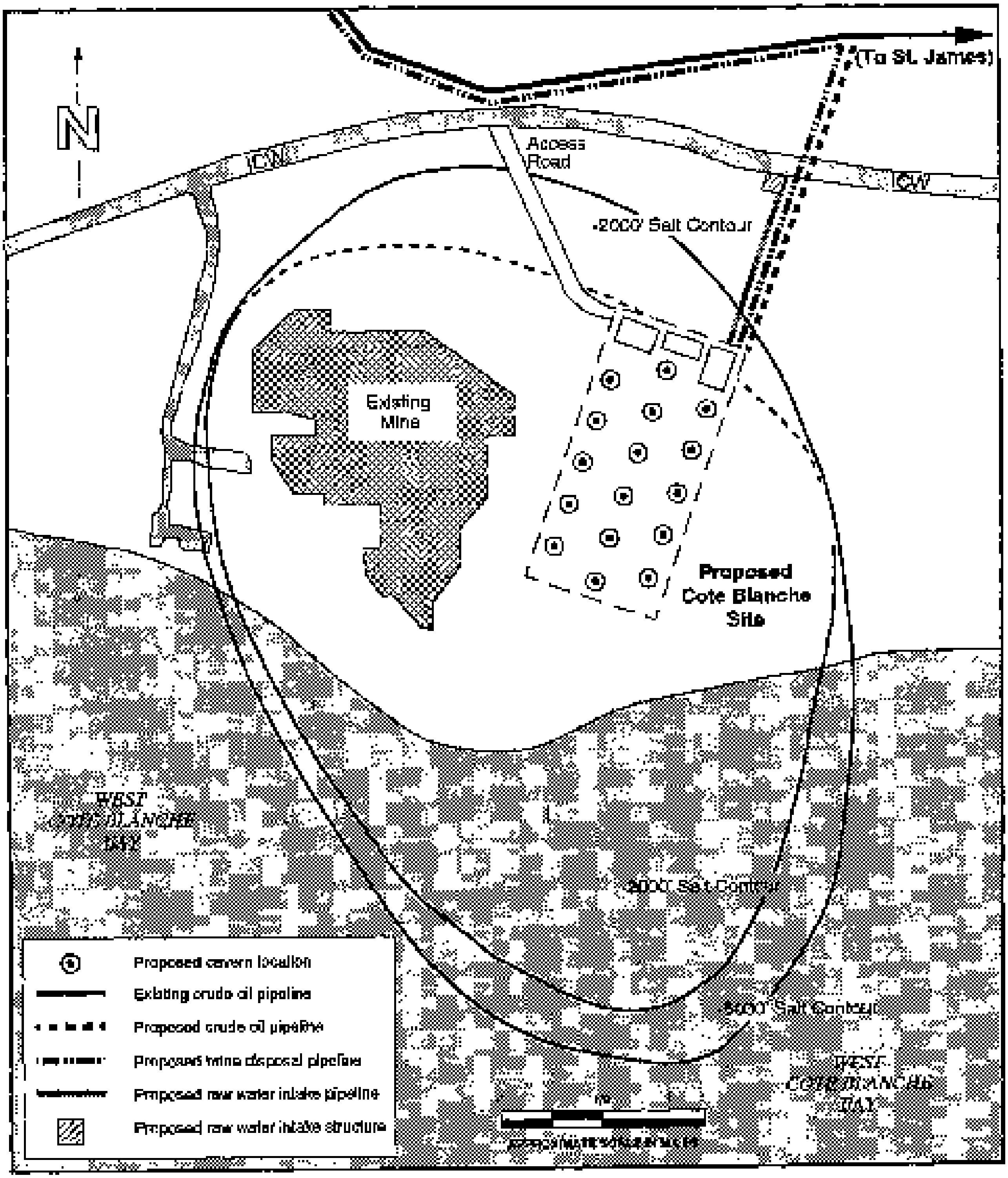
The proposed acreage requirements for the brine pipeline are listed in Table 3.4-1. The easements required for the extent of pipeline in open waters are not included in the total acreage requirements.

An alternative means of brine disposal would be injection into deep saline aquifers. Deep well injection could be cost competitive, due to the length of pipeline necessary to reach the 25-foot water depth in the Gulf. Up to 25 properly designed deep disposal injection wells located in the sands and gravels along the ROW for the St. James pipeline could be capable of sustaining flows in excess of 50,000 barrels per day per well. Further discussion of the proposed injection system can be found in section 3.3.3.

3.4.3 Raw Water Intake System

Raw water would be drawn from the ICW through a 48-inch pipeline that would traverse approximately one mile with a 150-foot ROW (see Figure 3.4-2). The pipeline would exit the proposed site from the northeast and continue in that direction until reaching the ICW. At that point, a set of intake pumps and auxiliary structures would be constructed. The RWI structure would be located at coordinates 29°46'N and 91°42'W. Clearing the ROW of trees and

Figure 3.4-1
Proposed Cavern Layout for Cote Blanche



Source: U.S. Department of Energy, Report to Congress on Candidate Sites for Expansion of the Strategic Petroleum Reserve, March 1991, DOE/F-0221P.E

Table 3.4-1
Cote Blanche Brine Disposal Pipeline Easements

Easement Types	Acres
Construction easement	111
Temporary construction easement	24
Permanent easement	69
Total easements	204

Source: USDOE, 1991. *ROW Study for Big Hill, Stratton Ridge, Weeks Island, and Cote Blanche Pipelines* (Task 16), Strategic Petroleum Reserve Program, PB-KBB, Inc., Houston, Texas, July 1991 and ICF Incorporated calculations using overlays of PB-KBB's proposed brine route on NWI maps, January 1992.

vegetation, installing the pipeline and maintaining its ROW, and constructing the RWI structure would impact approximately ten acres of wetlands.

The proposed raw water pipeline to the ICW would consist of approximately 0.1 mile of dry land and approximately 0.5 mile of wet land. The pipeline would not cross any water bodies before ending at the ICW. This ROW would remain constant for the entire alignment of the pipeline because of the dry land portion is negligible. There are no identifiable crossings that the raw water pipeline would encounter. The proposed acreage requirements for the raw water pipeline are listed in Table 3.4-2.

3.4.4 Crude Oil Distribution System

An SPR facility at the Cote Blanche salt dome would be connected by pipeline to the existing DOE St. James Terminal on the Mississippi River for oil fill and distribution. DOE would construct a two-mile, 30-inch crude oil pipeline spur (see Figure 3.4-2), with a drawdown rate of 0.7 MMBD, from the existing Weeks Island-to-St. James pipeline to the Cote Blanche crude oil storage site. This pipeline spur and its ROW would cross the ICW and approximately 40 acres of wetlands. The proposed acreage requirements for the crude oil pipeline are provided in Table 3.4-3. No other transportation crossings would be required.

The two distribution options are the same as those described for Weeks Island in section 3.3.5. It should be noted that if Cote Blanche is selected as the expansion, any spur to the Texas 22" pipeline to meet the 180-day drawdown criterion would originate at the existing Weeks Island facility, and would be used primarily to drawdown oil from that facility to Clovelly. Under this scenario, the capacity of the Weeks Island-to-St. James pipeline could be primarily dedicated to the drawdown of crude oil from Cote Blanche.

Figure 3.4-2
Proposed Brine Disposal, Crude Oil, and Raw Water Intake Systems for Cote Blanche

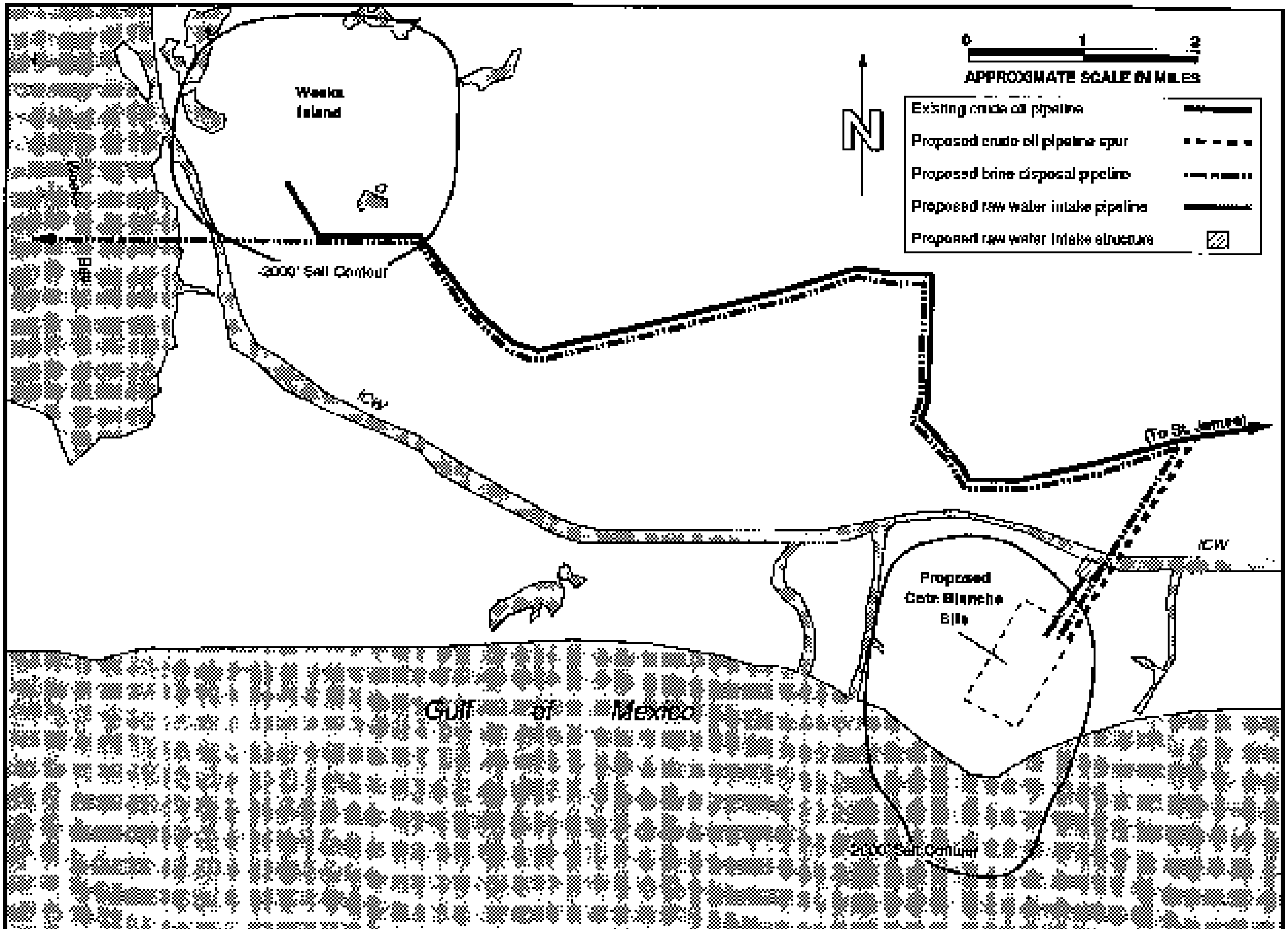


Table 3.4-2
Raw Water Pipeline Easements at Cote Blanche

Easement Types	Acres
Construction easement	8
Temporary construction easement	0
Permanent easement	4
Total easements	12

Source: USDOE, 1991. *ROW Study for Big Hill, Stratton Ridge, Weeks Island, and Cote Blanche Pipelines* (Task 16), Strategic Petroleum Reserve Program, PB-KBB, Inc., Houston, Texas, July 1991.

3.5 Richton (Capline Complex Site)

The Richton salt dome is located in Perry County, Mississippi, 18 miles east of Hattiesburg. Construction of a 160-MMB storage facility at Richton would require the onsite development of 16 subsurface caverns and surface facilities, structures, and operating systems for handling water, brine, and oil comparable to those described for the Louisiana candidate sites. The RWI structure would be located on the Leaf River about 10 miles south of the site.

A bulk storage crude oil terminal would be constructed at Pascagoula, Mississippi, in the northeast corner of the old Jackson County airport with about nine miles of pipelines to connect with: (1) the Chevron/Pascagoula Refinery and Chevron Dock 7; (2) up to three docks of the Port of Pascagoula on Bayou Casotte; and (3) possibly the terminus of the Cal-Ky Pipeline on the Chevron property. The new oil terminal would have five 0.4-MMB tanks and other support facilities (e.g., control building, office and warehouse space, pump stations, launcher/retriever, an oil/water separator, and a retention basin).

The brine disposal system would utilize both underground injection and ocean discharge and, in order to maximize cost-effectiveness, would feature two dual-purpose pipelines for both crude oil and brine service that would be unique among SPR facilities. The underground injection system would consist of 15 brine disposal wells laid out at 1000-foot intervals along an existing ROW for a United Gas 16-inch pipeline between 10.6 miles and 13.5 miles northwest of the site. The brine disposal field would extend into Jones County. A 10.6-mile 24-inch dual-purpose pipeline would connect the site to the brine injection wells and also to the Hess 10-inch Lumberton-Eucutta crude oil pipeline. The connection to Hess would be made for a one-time oil shipment of 4-MMB for use as blanket oil for cavern leaching.

For the ocean discharge system, a multiport brine diffuser would be located within a COE dredge disposal site in 47 feet of water about 5 miles south of Horn Island. An 82-mile 42-inch dual-purpose pipeline would connect Richton to the Pascagoula terminal and port facilities. A 15-mile 42-inch brine-only pipeline segment would extend from the Pascagoula terminus of the dual-purpose line to the diffuser offshore.

Table 3.4-3
Crude Oil Pipeline Easements at Cote Blanche

Easement Types	Acres
Construction easement	24
Temporary construction easement	2
Permanent easement	12
Total easements	38

Source: USDOE, 1991. *Flow Study for Big Hill, Stratton Ridge, Weeks Island, and Cote Blanche Pipelines* (Task 16), Strategic Petroleum Reserve Program, PB-KBB, Inc. Houston, Texas, July 1991.

During cavern leaching, brine would be disposed initially only offshore. When sufficient cavern space had been create to store it, the 4 MMB of blanket oil would be shipped from the Hess pipeline, the 24-inch dual-purpose line would be cleaned and converted to brine service, and the brine injection wells would be made available for supplemental or backup brine injection during leaching as required. Upon completion of leaching, the dual-purpose Richton-Pascagoula line would be cleaned and converted to oil service and all future brine disposal requirements (i.e., for fill and refill) would be met by the underground injection system.

In addition to crude oil distribution through Pascagoula, DOE is considering alternative distribution configurations for Richton. Each is assessed for a base case of 0.6 MMBD capability under the 270-day drawdown criterion and an enhanced case of 0.9 MMBD under the 180-day drawdown criterion.

The first of these alternatives would involve construction of a 118-mile 36-inch crude oil pipeline to connect Richton with the Capline pipeline at Liberty, Mississippi. The proposed pipeline would have a distribution capacity of 0.72 MMBD. This would accomplish the strategic objective of maximizing pipeline distribution capability to the upper midwest which is the most efficient and environmentally sound method.

Crude oil for fill would be unloaded at the St. James Terminal and Richton would be filled through the Capline. Three new 0.4-MMB tanks would be required at the Liberty connection for surge capacity and to allow pigging of the line. Under the 270-day drawdown criterion, only the Chevron refinery and dock would be required at Pascagoula; there would be no connection to public docks. A booster pump station would be constructed at mile 42 (from Richton) at the intersection with a Hess 14-inch line.

To meet the 180-day criterion, a pump station would be added to the Richton-Liberty pipeline west of the Pearl River floodplain. The increased capability to the Capline pipeline would displace an equal drawdown volume from Bayou Choctaw and/or Weeks Island. Therefore, an additional dock and tank at DOE's St. James terminal would be required to accommodate the displaced flows from these two sites.

A second alternative distribution configuration would substitute a pipeline connection to the Port of Mobile, Alabama for the Liberty pipeline. This would involve constructing a 70-mile 24-inch pipeline to the Hess Ten-Mile Terminal in Mobile County, Alabama. The line would have a capacity of 0.72 MMBD and would utilize the same pump station constructed for the Richton-Pascagoula pipeline. There would be no physical enhancements required at Pascagoula under the 270-day drawdown criterion. However, for the 180-day criterion, DOE would connect to two new public docks that would be built by the State of Mississippi across the Bayou Casotte Channel on Greenwood Island. Crude oil for fill would be unloaded at commercial terminals in Mobile. Modifications and upgrades, such as valves, pumps, manifolding, and controls would likely be needed and could be carried out under a joint agreement with commercial facilities. This alternative would be essentially a waterborne distribution configuration which would be lower cost than the Liberty connection to Capline and would mitigate the congestion and vulnerability concerns of a Pascagoula-only distribution option.

In a third alternative, DOE would provide connections from the new DOE bulk terminal to two new public docks constructed by the State on Greenwood Island through a meter bank via a one-mile, 42-inch pipeline directionally-drilled under Bayou Casotte Channel. To meet a 180-day drawdown criterion, DOE would enhance the physical distribution configuration by adding crude oil pipeline connections to the Port of Pascagoula Public Terminal dock G and to a reversed Cal-Ky pipeline to allow direct refining connection at Empire to four refineries: BP/Alliance, Mobil/Chalmette, Shell/Norco, and Exxon/Baton Rouge. The pipeline spur to Pascagoula public dock G would be a 30-inch, one-mile line from the 42-inch line from the DOE terminal. The pipeline to the Cal-Ky would be a 12-inch, three-mile line from the DOE terminal paralleling the dual-purpose pipeline ROW.

3.5.1 Site Configuration and Construction

The Richton salt dome is located in northeastern Perry County, Mississippi, approximately 18 miles east of Hattiesburg (1980 pop. 40,829) and approximately three miles from the town of Richton (1980 pop. 1,205), which is located at the southeast edge of the dome. The salt dome is located at coordinates 31°17'N and 88°59'W in a region called the Southern Pine Hills. The terrain in this region ranges from gently rolling hills to flat "bottom" land associated with tributaries to the Pearl and Pascagoula Rivers. Mississippi State Highway 42 from Hattiesburg to Richton traverses the salt dome from west to east. The proposed SPR facility would be located on approximately 300 acres of land, just north of State Highway 42 in Township Four north, Range Ten west, in the northern part of Section 34, extending further north into Section 27.[13]

The surface elevation on the salt dome at the proposed location for the caverns averages about 250 feet above msl, with elevations elsewhere on the dome ranging from 150 feet along creek bottoms to 300 feet above msl. The salt dome is within the Pascagoula River drainage basin about ten miles north of the Leaf River, a major tributary of the Pascagoula River, and about 26 miles northwest of the Pascagoula River. Only small and intermittent streams cross the dome with slightly larger streams nearby. A small creek, Harper's Branch, runs from the northern center of the proposed site location to the southwest portion of the dome. Several small ponds also overlie the dome.

In addition, the Richton salt dome is located in the southeast portion of the Mississippi salt dome basin. The central area of the salt dome has the largest surface area of any shallow salt dome within the Mississippi salt dome basin, covering approximately seven square miles; the areal extend of the salt at the -2,000-foot contour is approximately 5,500 contiguous acres.[14] The dome is elongated in shape, approximately five miles long on the northwest-southeast axis by approximately three miles wide at the -2,000-foot contour. Seismic profiles reveal a somewhat mushroom-shaped (bulbous) dome that forms large overhangs on both sides of the steep salt wall. The west overhang has been proven to be very large by a Shell Oil Company exploration well and the east overhang is unknown below the -2,000-foot contour.[15] Caprock in the area of the proposed site ranges from 300-foot to 500-foot depth below msl. Depth to salt in the area of the proposed site is approximately 650 feet below msl; however, salt has been found as shallow as 508 feet below msl, just east of the proposed site.

Faults are present in the vicinity of the Richton salt dome, originating from crustal tectonics and diapiric rise of the salt. One major fault, the Phillips fault zone, occurs approximately 20 miles to the north of the dome. Another fault (the F-7 fault) intersects the Richton salt ridge at depth at the northwestern end, and extends obliquely away from the dome for approximately ten miles. Evidence for two other possible faults was observed atop the dome, but they may not extend into the salt mass.[16] There is no evidence, however, to indicate that any of these faults are seismically active.

At present there is no hydrocarbon production in the dome area, and the potential for future production is low. Although sulfur and oil have been found flanking the dome, they are not present in commercial quantities. There are, however, several small oil and gas fields present within ten miles of the dome. Unlike coastal salt domes, very little oil and gas is trapped against Mississippi salt domes, even though the Mississippi Salt Basin is an oil-rich province.

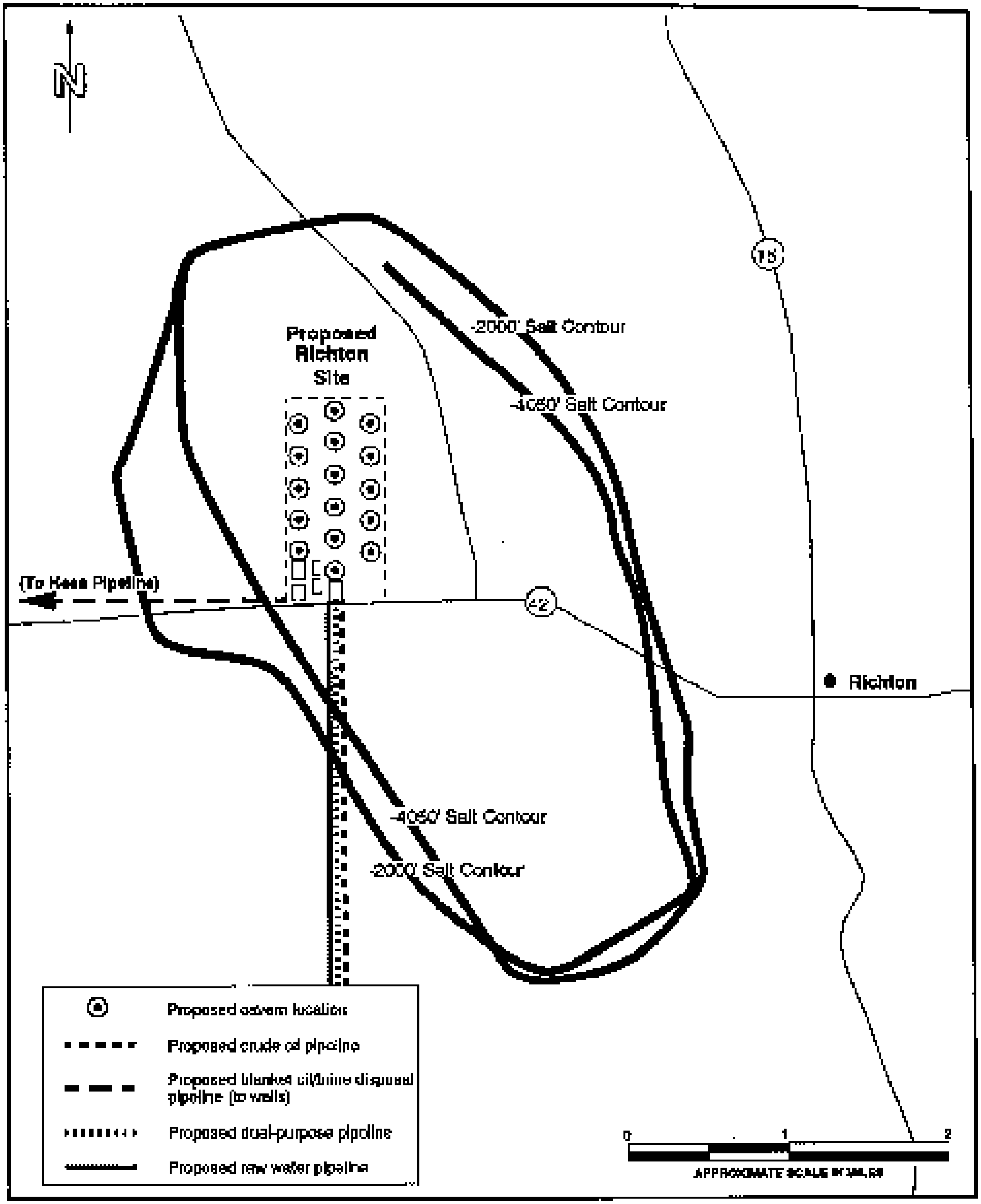
A significant portion of the proposed SPR site is privately owned by Elmer Hilman and the remainder of the site is owned by the Ridgeway Corporation. The proposed site area is primarily used for forestry and agriculture. In 1986, there were three farm dwellings located within the dome area; however, less than one percent of the land on the dome is zoned residential.

Development of the proposed SPR facility at Richton would require substantial on site and off-site facility development. For a description of the estimated work force required for the construction and operation phases of site development, see section 7.5.9. In addition to the construction of up to sixteen 10-MMB storage caverns, other on-site facilities constructed would include a raw water leaching/drawdown system, a brine settling and disposal system, a crude oil fill and drawdown/distribution system, operations, maintenance, and security buildings, and both on-site and access roads. The location of the proposed Richton crude oil storage site is presented in Figure 3.5-1.

3.5.2 Brine Disposal System

Brine disposal at the Richton salt dome would require construction of a 96-mile, 42-inch pipeline with diffuser extending into the Gulf of Mexico, a lined brine pond, an oil/brine separator, and pumps. The first 82 miles of the brine pipeline would be a dual-purpose pipeline, designed for conversion to crude oil use after the completion of cavern development. The pipeline would exit the site from the south and share a ROW with the raw water pipeline for approximately six miles to the Plantation Pipeline ROW. The dual-purpose pipeline would then follow the Plantation ROW for about 76 miles to Pascagoula, Mississippi. A brine-only pipeline would then be constructed southeastward to a point approximately 14 miles offshore with a depth

Figure 3.5-1
Proposed Cavern Layout for Richton



Source: Sandia National Laboratories, Richton Salt Dome, Preliminary Geological Site Characterization for SPR Expansion Candidate Sites (draft), November 1991.

of approximately 50 feet in the Gulf of Mexico. The diffuser, which would be designed to disperse the brine into ocean currents, would lie perpendicular to the coast at coordinates 30°10.40'N and 88°37.53'W (see Figure 3.5-2). Construction of the pipeline would involve crossing various transportation routes including seven major roads, 24 major waterways, three railroads, and the property of one regional power plant. Figure 3.5-2 shows the proposed brine disposal pipeline. The dual-purpose portion of the pipeline would require a pump station, to be located near the midpoint.

The ROW for the dual-purpose pipeline would consist of about 50 miles of dry land, about 32 miles of wet land (including approximately three miles of open water in creeks and rivers), and about 14 miles of offshore area. The ROW width over the first six mile segment would be 190 feet in wetland, consisting of a 70-foot permanent easement and a 120-foot construction easement, and 120 feet in dryland, consisting of a 50-foot construction easement and 70-foot permanent easement. This additional width is necessary to accommodate up to three pipelines. For the remaining portion of the pipeline, the ROW width would be 150-feet for wetland and 100 feet for dryland. The proposed acreage requirements for the dual-purpose pipeline are identified in Table 3.5-1.

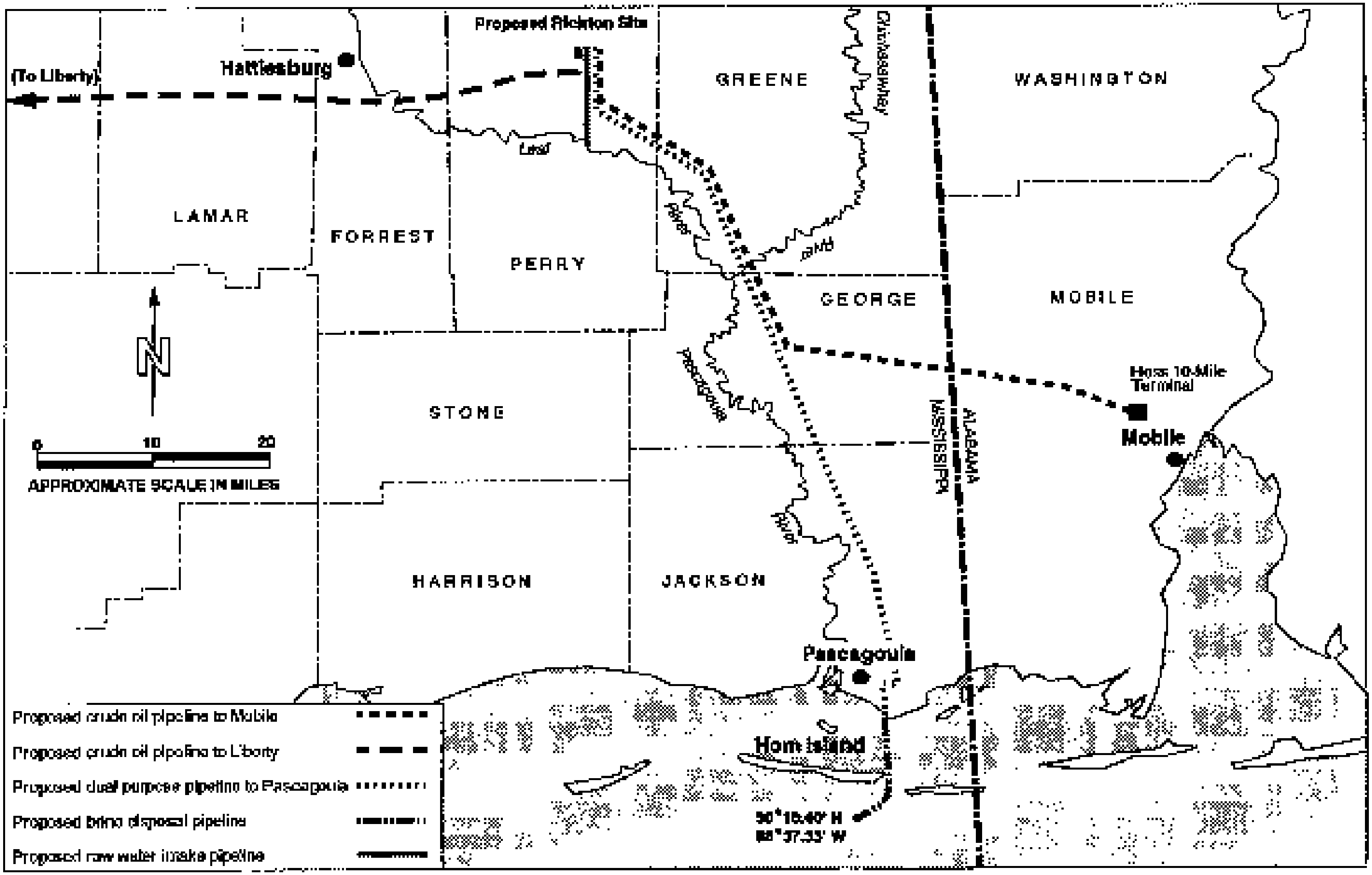
Table 3.5-1
Richton Dual-Purpose Pipeline Easements

Easement Types	Acres
Construction easement (raw water/dual/crude oil)	38
Temporary construction easement (raw water/dual/crude oil)	10
Permanent easement (raw water/dual/crude oil)	51
Construction easement (dual)	655
Permanent easement (dual)	461
Total easements	1,215

Source: Estimates based on USGS and NWI map analysis. No information on temporary construction easements at this time.

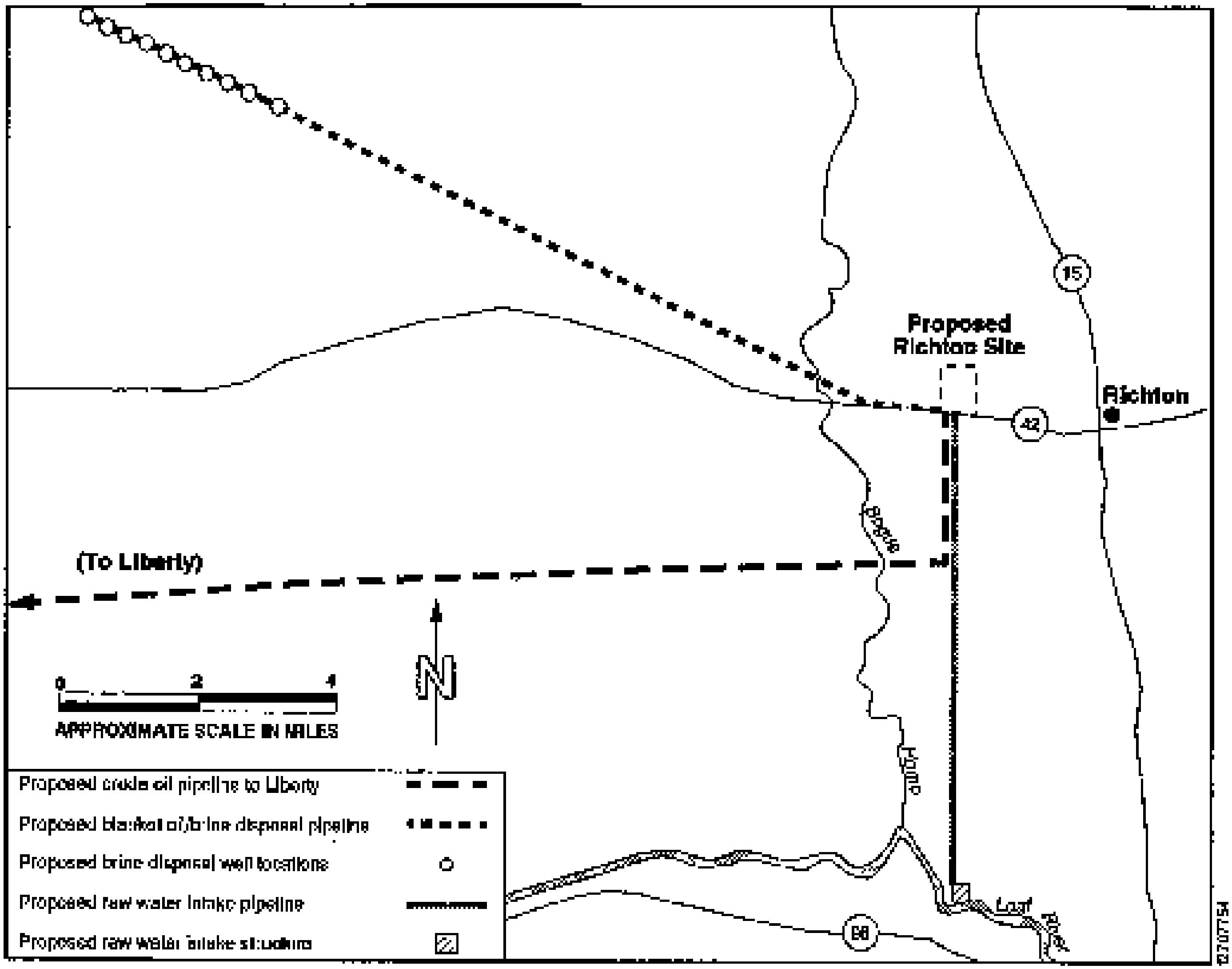
Additional brine disposal would be through underground injection into deep saline aquifers. The blanket oil pipeline from Richton, which would extend approximately three miles beyond the Hess 10-inch pipeline, would be converted to brine service. Just beyond the Hess 10-inch intersection, 15 brine disposal wells would be installed along the ROW as shown in Figure 3.5-3. The closest injection well would be approximately 10.6 miles from the Richton site with the remaining wells spaced on 1,000-foot centers along the pipeline in a west-northwest direction.

Figure 3.5-2
Proposed Crude Oil and Brine Disposal Systems for Richton



Source: 1) PB-KBB Inc., *Richton Dome Pipeline System*, Sheets 1-7, Houston, Texas; 2) Conversation with U.S. Department of Energy

Figure 3.5-3
Proposed Raw Water Intake and
Underground Injection Systems for Richton



Source: PB-KBB Inc., *Richton Dome Pipeline System*, Sheets 1-7, Houston, Texas.

3.5.3 *Raw Water Intake System*

Raw water would be drawn from the Leaf River through a 48-inch pipeline that would traverse approximately ten miles of dry land. The pipeline would run due south from the proposed site, across the Plantation Pipeline ROW to a point on the Leaf River. At that point (coordinates 31°13'N and 89°00'W), a set of intake pumps and auxiliary structures would be constructed. The raw water pipeline would be colocated for about six miles of the ROW with the brine disposal pipeline and the crude oil fill pipeline. Figure 3.5-3 shows the RWI pipeline. The final four miles of the RWI pipeline ROW would traverse a dry land and would not contain other pipelines.

There are six unnamed roads crossed by the raw water pipeline to the Leaf River. The proposed acreage requirements for the raw water intake pipeline are identified in Table 3.5-2.

Table 3.5-2
Richton Raw Water Intake Pipeline Easements

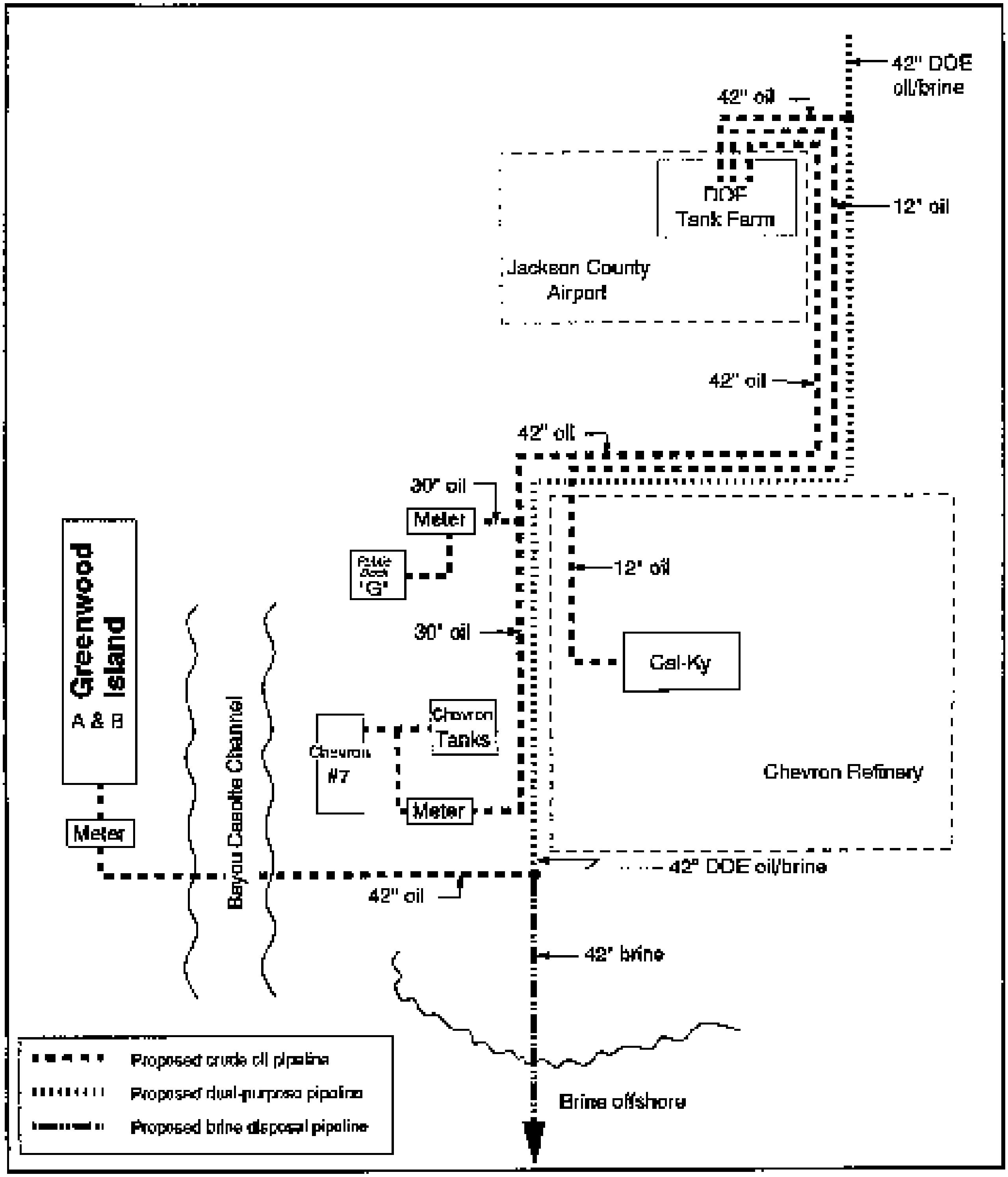
Easement Types	Acres
Construction easement (raw water/brine/crude oil)	38
Temporary construction easement (raw water/brine/crude oil)	10
Permanent easement (raw water/brine/crude oil)	51
Construction easement (raw water)	24
Temporary construction easement (raw water)	12
Permanent easement (raw water)	24
Total easements	159

Source: PB-KBB, 1992. Written correspondence from PB-KBB to ICF Incorporated. January 26.

3.5.4 Crude Oil Distribution System

The SPR facility at the Richton salt dome would be connected to Pascagoula via the converted dual-purpose pipeline and via pipeline to either the existing DOE St. James Terminal on the Mississippi River or to commercial terminals in Mobile, Alabama for oil fill and drawdown/distribution. A new DOE 2-MMB bulk storage terminal would be constructed on the northeast quadrant of the old Jackson County Airport site. The proposed terminal location and various pipeline connections are shown in Figure 3.5-4. The DOE terminal would be constructed on 60 acres in the northeast quadrant of the old Jackson County airport and crude oil pipeline connections would run from the terminal 4 to 4.5 miles to the Chevron refinery and dock seven paralleling the dual-purpose pipeline, and from the dual-purpose pipeline a one-mile directionally-drilled spur under Bayou Casotte Channel to the new Greenwood Island docks. To meet a 180-day drawdown criterion, additional pipeline connections would be constructed to Port of Pascagoula Public Terminal dock G (one-mile spur from the 42-inch line from the DOE terminal)

Figure 3.5-4
Proposed Terminal and Pipeline Configuration in Pascagoula



Source: U.S. Department of Energy
Note: Not drawn to scale

and a 3-mile spur from the terminal paralleling the dual-purpose pipeline to a reversed Cal-Ky pipeline. These connections are shown on Figure 3.5-4.

In the first option, the proposed site would serve primarily the existing SPR Capline Complex to the midwest. Oil would travel via a 118-mile, 36-inch pipeline to a tie-in point with the Capline pipeline near Liberty, Mississippi for distribution to the midwest, and to the Chevron Refinery in Pascagoula, Mississippi via the 82-mile, 42-inch dual-purpose pipeline and the bulk storage terminal, with a pump station at mile 42 at the intersection with the Hess 10-inch, for distribution through the Chevron Terminal (see discussion in section 3.5.2 and Figure 3.5-2). Three 0.4-MMB oil storage tanks would be constructed at Liberty. To meet a 180-day drawdown criterion, the physical configuration would be enhanced by adding a mobile interim pump station west of the Pearl River floodplain and by expanding the St. James Terminal by adding one dock and one tank to increase the amount of oil entering the Capline by 200 MBD. No other changes are required; however, the Chevron refinery would be assumed to sustain a higher average rate of 50 MBD.

The crude oil pipeline from Richton to Liberty Station would run due south and share a ROW with the raw water and brine disposal pipelines up to the Plantation Pipeline ROW. The pipeline would then proceed in a west-southwest direction to a point across the Leaf River and U.S. Highway 98 near Palmer's Crossing, Mississippi. The crude oil pipeline would turn in a southwesterly direction, following an existing pipeline ROW to a point west of Tyler, Mississippi. At this point, the pipeline would turn due west to a point south of Mixon, Mississippi, then west-northwest until it tied into the Capline pipeline near Liberty. Figure 3.5-5 shows the route of the proposed pipeline.

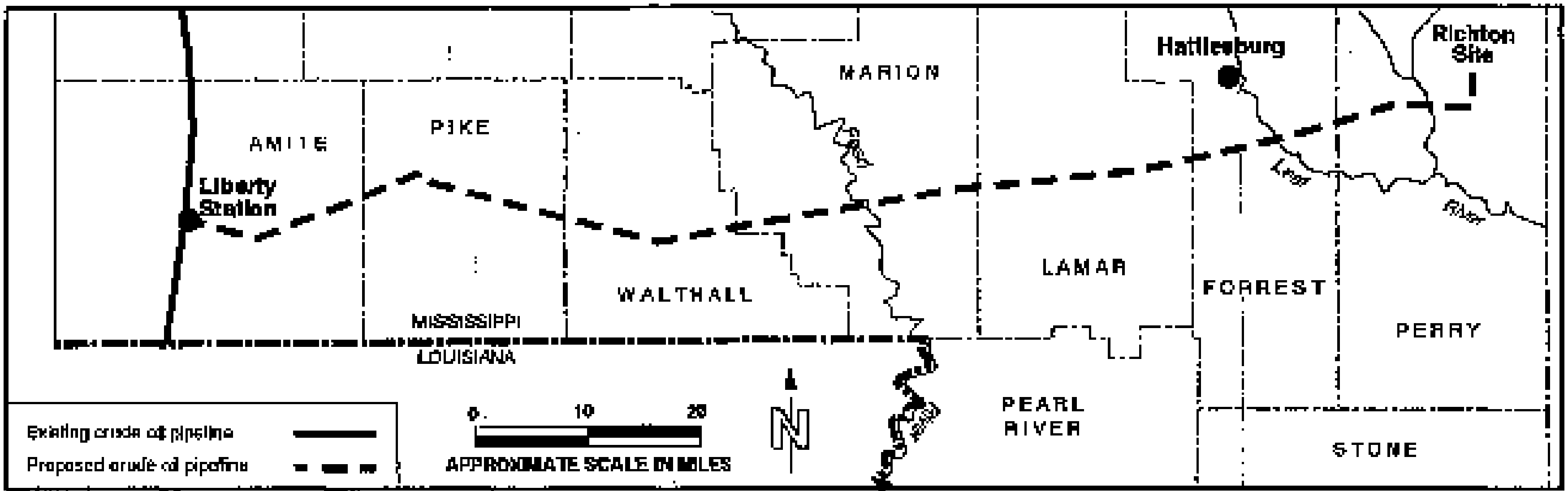
The Liberty pipeline would traverse approximately 108 miles of dry land, about 9.8 miles of wet land, and about 0.2 miles of offshore area (Leaf and Pearl Rivers). The pipeline would cross about 115 major crossings including 13 major roads, 37 creeks and rivers, including the Leaf, Pearl, and Amite Rivers, and two major railroads, the Illinois Central and the Alabama Southern Railroads, before terminating at Liberty Station on the Capline pipeline. Near this connection, DOE would construct three 0.4 MMB crude oil storage tanks.

DOE proposes a construction ROW width of 100 feet in dry land and 150 feet in wet land. Permanent easements in dry and wet land would be 50 feet. Construction easements would be 50 feet for dry land and 100 feet for wet land. Proposed acreage requirements for the Liberty pipeline are provided in Table 3.5-3. Proposed acreage requirements for the dual-purpose pipeline are provided in Table 3.5-1, and the pipeline route would be as described in section 3.5.2.

Special care would be taken to mitigate impacts upon sensitive environments traversed by or in close proximity to the pipeline, including the De Soto National Forest, the Chickasawhay Wildlife Management Area, and the Black Creek and Leaf Wilderness Areas. In addition, water control structures would be used to segregate fresh and brackish waters along the dual-purpose pipeline route, so that freshwater marshes or swamps could not be contaminated by brackish or saline water.

In the second option, oil would be distributed through a 70-mile, 24-inch pipeline connected to the Hess Ten-Mile Terminal, which would provide access to commercial docks, local refineries, and the Capline pipeline in the vicinity of Mobile, AL. In addition, oil would be distributed, as in the first option, through the dual-purpose pipeline and the bulk storage terminal

Figure 3.5-5
Proposed Crude Oil Pipeline to Liberty



Source: U.S. Department of Energy

Table 3.5-3
Crude Oil Pipeline Easements

Easement Types	Liberty Pipeline	Mobile Pipeline	Pascagoula Terminal Connections	Blanket Oil Pipeline
Construction easement (raw water/brine/crude oil)	0	38	0	0
Temporary construction easement (raw water/brine/crude oil)	0	10	0	0
Permanent easement (raw water/brine/crude oil)	0	50	0	0
Construction easement (crude oil)	775	443	24	66
Permanent easement (crude oil)	715	476	25	64
Total easements	1,490	1,017	99	130

Source: Estimates based on USGS and NWI map analysis. No information is available on temporary construction easements for the oil pipeline segments at this time.

to the Chevron Refinery; however, the Chevron Refinery would sustain an average consumption of 50 MBD rather than the 20 MBD under a 270-day drawdown criterion in option one. The distribution to local docks and refineries in Mobile would likely require upgrades and modifications. A connection would be made via 30-inch pipeline to new docks at Greenwood Island from the 42-inch pipeline from the DOE terminal running parallel to the dual-purpose pipeline.

In this option, the crude oil pipeline from Richton to Hess Ten Mile Terminal, Alabama would run due south and share a ROW with the raw water and brine disposal pipelines up to the intersection with the dual-purpose pipeline (see Figure 3.5-2). From there, the pipeline would continue southeast along a ROW shared with the dual-purpose pipeline for 36 miles to a point about two and a half miles south of the intersection with Route 26. The pipeline would then proceed in an east-southeast direction to the Hess Ten-Mile Terminal, where the pipeline would be connected, providing access to commercial terminals in Mobile, local refineries, and the Capline pipeline.[7] Figure 3.5-2 shows the route of the proposed pipeline.

In the third option DOE would distribute all oil via waterborne methods through a Chevron Refinery and dock 7 tie-in as well as a connection to the proposed Greenwood Island docks, all via the DOE-owned and operated bulk-storage terminal near the Port of Pascagoula. To meet a 180-day drawdown criterion, DOE would add pipeline connections to public dock G in the Port of Pascagoula and to a reversed Cal-Ky pipeline to Empire, LA.

3.6 Saint James Terminal (Capline Complex Distribution Enhancement)

No expansion of St. James Terminal is required to meet the 270-day drawdown criterion from any of the proposed sites; however, under a 180-day criterion, the proposed sites in the Capline Complex would require expansion of the terminal by construction of up to two new docks plus up to two new tanks to handle an additional 0.4 MMB of marine outloading capability. Expansion of the St. James Terminal would also entail installation of custody transfer meters.

3.6.1 Description of Existing Facility

The St. James Terminal is a DOE-owned facility located in St. James Parish, approximately 45 miles west of New Orleans and 30 miles southeast of Baton Rouge, on the west bank of the Mississippi River. The terminal is situated in a mostly rural area; sugar cane cultivation and cattle grazing are the dominant land-use activities in the surrounding area. Some agricultural land use in the area has, however, been supplanted by industrial activities.

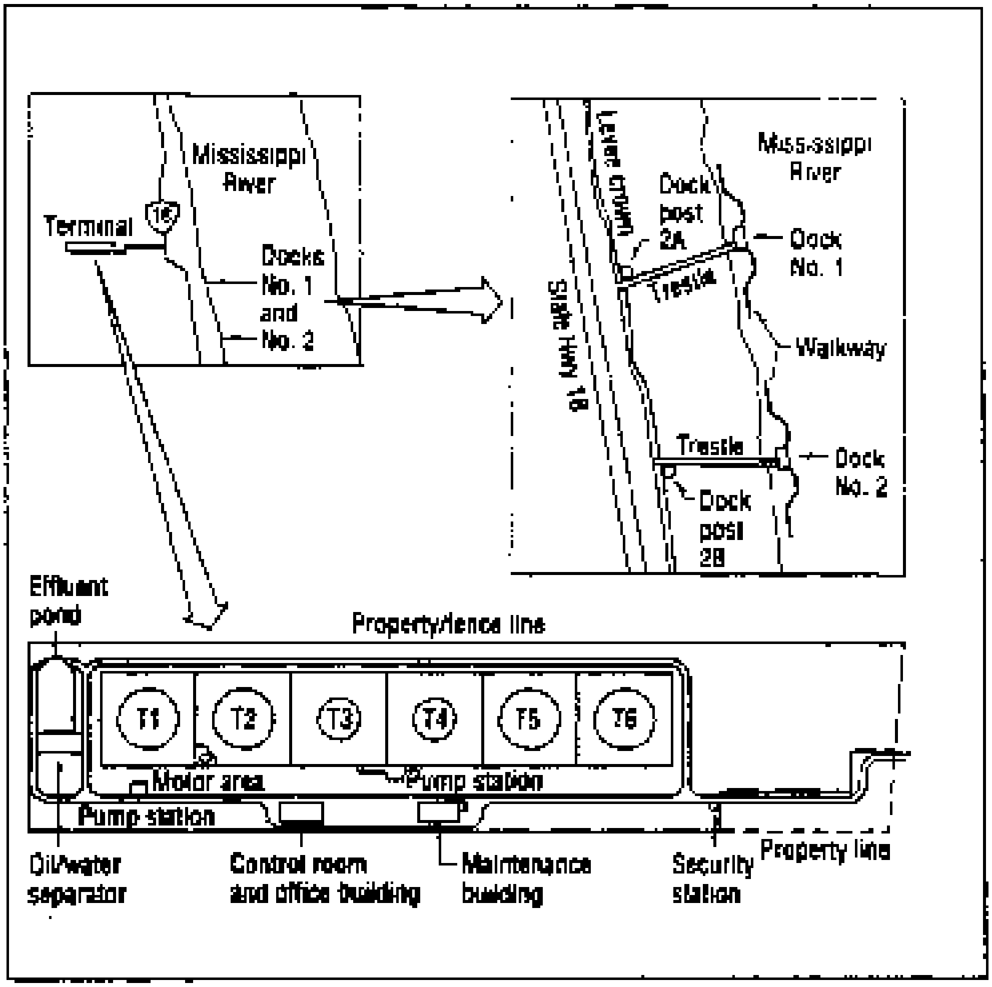
The vegetation in the area is currently maintained by DOE and consists of Rye Grass, White Clover, and Bermuda Grass. Nongame fish of little commercial or recreational value inhabit the Mississippi River. There are no endangered plant or animal species within one mile of the terminal. The land area adjacent to the dock facility is a freshwater wetland. The eight water bodies within five miles of St. James Terminal are also predominantly fresh. The parish has a total population of about 21,400 and the only two incorporated towns are Lutcher and Gramercy, with a total combined population of about 5,900.

The main site occupies approximately 105 acres of land acquired from a private landowner in 1978. Construction of the terminal was completed in 1981. The dock facility is located about two miles southeast of the terminal, occupies an additional 48 acres, and is connected to the main terminal by two 42-inch pipelines.

The St. James facility is part of the Capline Complex and serves as the fill and distribution terminal for the Bayou Choctaw and Weeks Island SPR facilities. Pipeline connections include a 36-inch, 37-mile pipeline to Bayou Choctaw, a 36-inch, 67-mile pipeline to Weeks Island, and a 36-inch, two-mile pipeline to the commercial Capline facility. The main terminal contains four 0.4-MMB and two 0.2-MMB tanks, giving the facility a total storage capacity of two million barrels. The storage tanks, divided by tank capacity, are located within a levee system designed to contain the volume of any tank in the group. A layout of the St. James facility is illustrated in Figure 3.6-1.

There are two existing docks at St. James. Oil can be unloaded from a tanker at a rate of 0.04 MMB barrels per hour or approximately 0.35 MMBD. Both docks are equipped with eight mooring and breasting dolphins (used as shock absorbers to protect the docking platform from the impact of a tanker as well as to tie-off the tanker in the docked position), one anchor buoy, three loading arms, a dock crane, a control room, a foam proportioner station, and spill containment equipment and can accommodate vessels up to 100,000-DWT maximum loaded displacement. The loading platforms are designed to contain approximately 700 barrels of oil (equivalent to a one-minute spill at the maximum flow rate of 0.04 MMB per hour).

Figure 3.6-1
St. James Facility Layout and Location



Source: U.S. Department of Energy. *Strategic Petroleum Reserve: Energy for America*. DOE/FE-011L

3.6.2 Description of Expansion Requirements

The expansion of the St. James facility would entail construction of up to two additional docks, up to two 0.4-MMB storage tanks, and installation of additional pumps, fire protection and electrical facilities. For a discussion of the estimated number of workers for the construction and operation phases of development, see section 7.6.9. Because expansion would take place within current property boundaries, DOE would not have to acquire additional land.

Site preparation would commence upon completion of ground survey studies to delineate site boundaries, and locate dock facilities. The extent to which clearing of vegetation would occur will depend on the precise location of the docks. If no wooded vegetation is present, then the clearing operation would be limited to the removal of top soil to a depth of approximately six inches.

Docks would be constructed of concrete and steel. Each dock would be designed to load or unload one tanker with a maximum loaded displacement of 100,000 DWT. The docking facilities would consist of several structures including the docking platform, loading arms, dolphins, and a control room. Loading and unloading equipment are supported and operated from the docking platform. The dock would be connected to an access road by means of a road or ramp. A minimum 1,200-foot separation between docks would provide at least 200 feet of buffer when two tankers are docked at the same time.

The area that would be required for the two docks is estimated to be about 66 acres. The dock area would have to be dredged to a depth of 40 feet and the total volume dredged would be about two million cubic yards. Disposal of the spoils from dredging would entail dispersal of dredged material at depression points in the river below the -50-foot contour. Exact disposal locations would be determined at the time of construction after consultation with the U.S. Army Corps of Engineers (COE).

The two new 0.4-MMB storage tanks would be designed to provide 48 hours of storage, and would be built on ring wall foundations. Each tank would be surrounded by an earthen dike that would contain the entire volume of the tank.

3.7 No Action Alternative

The No Action alternative to the proposed expansion would limit SPR storage capacity to the 750 MMB currently available and would limit distribution during an SPR drawdown to a maximum of 4.5 MMBD.

No Action would not only be contrary to the national goal for the storage of up to one billion barrels of crude oil and petroleum products but also to the intent of EPCA of 1975 and its amendments of 1990. In addition, No Action could directly affect the nation's capability to deal effectively with international oil supply disruptions.

Absent a sufficiently large strategic reserve, an embargo or other disruption of normal crude oil supplies would have an adverse impact on the petroleum industry, the economy, and national security. Limiting the size of the SPR to 750 MMB could adversely affect the U.S. in the event of a major disruption in U.S. oil supplies. The need for the expanded reserve and its overall importance to the nation is discussed in more detail in Chapter 1.

Crude oil imports to the refineries connected by pipeline to the Capline, Seaway, and Texoma Complexes are forecast to increase dramatically to replace declining production from the Midwest and South-Southwest areas of the U.S., and the disappearance of Alaskan crude oil from the Gulf Coast market. Increased SPR storage and distribution capacity in the U.S. Gulf is required to respond to the increased dependence on imported crude oil. By the year 2000, U.S. crude oil requirements (including the U.S. Virgin Islands and Puerto Rico) are projected to be about 14.5 MMBD.[17] Due to increasing U.S. oil consumption and declining domestic crude oil production, total crude oil imports are projected to rise to 9.5 MMBD.

Environmentally, the No Action alternative would limit impacts from SPR construction and operation to those that have already occurred or that will occur as part of the 750 MMB program at the existing SPR sites in the Capline, Seaway, and Texoma Complexes. The Cote Blanche, Stratton Ridge, and Richton proposed expansion sites and portions of the Big Hill and Weeks Island sites would remain with the existing private owners. These sites could continue to be used as commercial salt or brine production sites, could be developed as petrochemical production and/or storage sites by the private sector, or could be subdivided and developed for other purposes. Land use, air quality, socioeconomic concerns, species and habitats, archaeological, historical and cultural resources, and natural and scenic resources affected by an expanded SPR program would be undisturbed.

The overall environmental impacts of an inadequate national crude oil reserve cannot be accurately determined because of the large number of variables involved. Of course, hardships could be created in the event of a long disruption in the supply of imported crude oil through higher unemployment and other effects of decreased economic activity.

ENDNOTES

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2. Boeing Petroleum Services, Inc., *Big Hill Operations Manual, Volume I,* U.S. Department of Energy, Strategic Petroleum Reserve, New Orleans, LA, June 1988, Document Number D506-02163-08.

3. *Ibid.*

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12. Personal communication, *Conversation with Jocylin Guarisco*, U.S. Department of Energy, Strategic Petroleum Reserve Project Management Office, August 1992.

13. U.S. DOE, *Evaluation of Richton Salt Dome for Expansion of the Strategic Petroleum Reserve*, PB-KBB, Incorporated, Houston, TX, October 1991, Contract No. DE-AC01-91FE62075. (330.3)

PB-KBB, Inc. *Evaluation of Richton Salt Dome for Expansion of the Strategic Petroleum Reserve*, U.S. Department of Energy, October 1991, Contract Number DE-AC01-91FE62075.

14. *Ibid.*

15. Neal, J.T. and T.R. Magorian, *Preliminary Geological Site Characterization for Strategic Petroleum Reserve Expansion Candidate Sites: Richton Salt Dome, Mississippi*, Sandia National Laboratories, Albuquerque, NM for U.S. Department of Energy, November 29, 1991. (330.4)

16. U.S. DOE, *Environmental Assessment, Richton Dome Site, Mississippi, Volume 1*, Office of Civilian Radioactive Waste Management, Washington, DC, May 1986, DOE/RW-0072.

17. U.S. Department of Energy, *Report to Congress on Candidate Sites for Expansion of the Strategic Petroleum Reserve to One Billion Barrels*, Office of Strategic Petroleum Reserve, March 1991, Document Number DOE/FE-0221P, p A-14.

4.0 DESCRIPTION OF THE REGIONAL AFFECTED ENVIRONMENT

The purpose of this chapter is to present a regional overview of the environment that potentially may be affected by SPR expansion. The description of the affected regional environment includes discussions of geological, hydrogeological, ecological, and socioeconomic characteristics, the water environment, climate and air quality, natural and cultural resources, ambient noise, and land and water use plans, policies, and controls.

4.1 Geological Characteristics

All existing and proposed SPR storage facilities lie within the surface region of the Gulf Coastal Plain Province that encompasses the subsurface region that was once the Louann Salt Basin. The surface region is characterized by gently rolling hills, distinctly belted topography due to surface formations with different erosional resistances, flat lying Pleistocene to Recent (see Table 4.1-1 for geologic time scales) unconsolidated deltaic sediments, and the Chenier Plain, which is a continuous ridge of beach material built up on marshy deposits. Two major structural features characterize the region: the Gulf Coast Geosyncline, a trough-like depression containing sedimentary rock that descends toward the coast, and the occurrence of diapiric structures known as salt domes.[1] The geosyncline corresponds roughly to the outline of the Gulf Coast and contains up to 15,000 meters of Cenozoic sediments that were deposited over an extremely thick layer of unconsolidated sandstone, shale, minor limestone, and mineral salts. The evolution of the salt domes from these Mesozoic salts provides topographic relief of 30 feet or more in some areas of the Gulf Coast region.[2]

4.1.1 Salt Dome Evolution

The salt in the Louann Salt Basin was originally deposited during the upper Triassic to lower Jurassic periods (i.e., approximately 200 million years ago) from a broad shallow sea that covered the entire region. The area was slowly covered by thousands of feet of fluvial and marine sediments followed by diagenesis (i.e., the formation of sedimentary rock). This thick layer of dense rock sinking into the much less dense salt layer caused isostatic adjustment to occur as the less dense salt rose to compensate for the sinking sedimentary overburden. Initially the uplift of the salt layer resulted in a stretching of the sedimentary layer, but eventually the much more elastic salt caused local faulting with sediment blocks being either tilted to the side or displaced vertically ahead of the rising salt. As this process was occurring, physical and chemical changes took place because of the dissolution of the soluble components at the top of the salt dome as they rose through saturated zones. These changes resulted in the deposition of the residual insoluble components (e.g., sulfur, limestone, anhydrite, and clay) as the caprock of the salt dome. The dome continued to push through the overlying rock until the density of the overlying rock was equal to that of the salt. As the salt welled up at the center of the dome, it flowed outward at the top, and then curled back under itself in a manner similar to a mushroom cloud. This concept of salt near the top of the dome flowing toward the outside edges, known as toroidal growth, may account for the bulb shape and overhangs of some salt domes.[3] The rate of salt dome growth is extremely slow, approximately 5.8 x 10^{-4} cm/yr, and offers no threat to storage cavern integrity.[4,5]

Table 4.1-3
Geologic Column and Scale of Time

Geologic Era	Periods of Time/ Systems of Rocks	Epochs of Time/ Series of Rocks[a]	Years Before Present[b]
Cenozoic	Quaternary	Recent (Holocene)	11,000
		Pleistocene	2.5 million
	Tertiary	Pliocene	10 million
		Miocene	27 million
		Oligocene	38 million
		Eocene	55 million
		Paleocene	70 million
Mesozoic	Cretaceous		130 million
	Jurassic		180 million
	Triassic		225 million
Paleozoic	Permian		270 million
	Pennsylvanian		315 million
	Mississippian		350 million
	Devonian		405 million
	Silurian		440 million
	Ordovician		505 million
	Cambrian		570 million
Precambrian			4.5-5 billion

[a] Provided only for the Cenozoic Era.
[b] Dates are for beginning of time divisions.
Source: *McGraw-Hill Encyclopedia of Science and Technology, 6th Edition, Vol. 8.* New York: McGraw-Hill Book Company, 1987; p. 35.

4.1.2 Subsidence

Scientists have recognized for many years that subsidence was occurring throughout the region. For example, some areas of coastal Louisiana are sinking at a rate of approximately one meter per century, and a subsidence rate of 0.69 cm/yr was reported for New Orleans.[6] This loss of land mass is primarily occurring as a result of human activities. Of these factors, the overpumping of groundwater and the extraction of hydrocarbons have been cited as the most important, but other factors such as erosion and global sea level rise also play a role.[7,8] Over a longer time period, natural subsidence is occurring because of sediment deposition along the Gulf Coast Geosyncline.

4.2 Hydrogeology Characteristics

The following sections describe the dominant aquifer systems along the Gulf Coast and the groundwater characteristics of these aquifers, including recharge and discharge patterns, groundwater quality, and predominant groundwater uses.

4.2.1 Major Aquifer Systems

The Gulf Coast aquifer system from Southeastern Texas to Southeastern Louisiana consists of three main aquifers (or their equivalents) and occasional alluvial aquifers. The three main aquifers, in order of descending depth, are the Chicot, Evangeline, and Jasper.

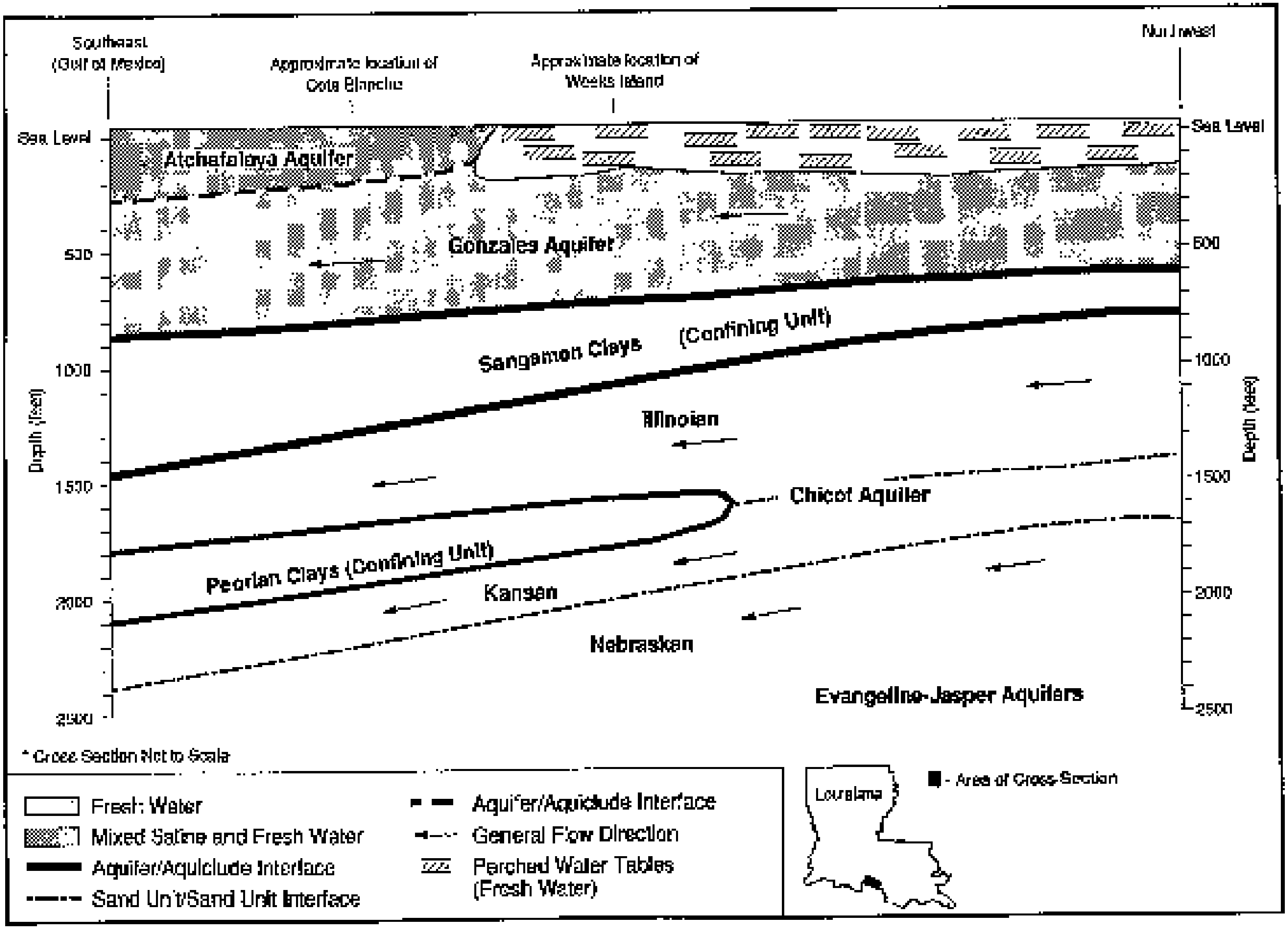
In Texas, the Chicot is subdivided into two major units, the Upper Chicot and the Lower Chicot, and in Louisiana, it is commonly divided into various sedimentary levels differentiated by lithology and permeability.[9] The Upper Chicot/Lower Chicot and Lower Chicot/Evangeline interfaces are separated by discontinuous clay beds that are rather impermeable. The Evangeline is separated from the Jasper by the Burkeville Aquiclude, consisting of thick, impermeable sedimentation that separates the two zones into distinct aquifers.[10] There is no evidence of karst hydrogeology (i.e., irregular solution cavities) in the region.[11]

The Atchafalaya aquifer is a shallow alluvial aquifer that exists in the coastal Louisiana region (see Figure 4.2-1). It is in direct hydrologic contact and usually above the Gonzales Aquifer, another freshwater-bearing unit that is equivalent to the Chicot. On its western boundary, the Atchafalaya aquifer is in contact with the Cote Blanche site, but not Weeks Island.[12] The Atchafalaya and Gonzales are separated from the saline aquifers that lie below by a thick and highly impermeable confining unit named the Sangamon Clays.

Farther to the east, such as near the St. James Terminal in Louisiana, St. James Parish is underlain by four main aquifers; in order of descending depth, these aquifers are the Mississippi River Alluvial (MRA) aquifer, the Gramercy aquifer, the Norco aquifer, and the Gonzales-New Orleans aquifer. These aquifers are hydrologically equivalent to the Chicot aquifer of coastal Louisiana[13] and the hydrologic units below 650 meters are equivalent to the coastal Evangeline aquifer.[14] The subdivided aquifers are differentiated by depth, lithology, permeability, and commonly by discontinuous clay beds that allow the aquifers to merge occasionally.[15] The hydrologic units are composed of gravel, sand, silt, and clay from the Miocene, Pliocene, and Pleistocene ages.

Figure 4.2-1

Generalized Hydrogeologic Cross-Section of St. Mary and Iberia Parishes, Louisiana



Southern Mississippi, in Perry County where the proposed Richton site is located, is characterized by three main aquifers: the Upper Aquifer, the Upper Claiborne Aquifer, and the Wilcox Aquifer (see Figure 4.2-2). The Lower Claiborne unit separates the Upper Claiborne Aquifer from the Wilcox Aquifer. Although sparse data exist on the hydraulic properties of the Lower Claiborne, available data suggest that appreciable horizontal flow does not occur through this unit.

There are several Upper Aquifer formations in Mississippi that are commonly exposed at the surface, or occur just below the surface soils.[16] These aquifer sands have rather high permeability and are some of the most productive in the region. The Upper Aquifer is underlain by a relatively impermeable, mostly clay layer; however, there are some small lenses of sands that act as groundwater sources.[17] The permeability of the Upper Claiborne is rather low, yet the thickness of the aquifer sands makes withdrawal by industry possible. The permeability of the Wilcox can be more characteristic of clays or sands depending upon specific location.

To the south in Jackson County, where the Pascagoula Terminal would be located, there is an approximately 3-meter thick water table aquifer that overlies four fresh water-bearing regional aquifers: the Citronelle Aquifer, the Graham Ferry Aquifer, the 600-foot Pascagoula Aquifer, and the 800-foot Pascagoula Aquifer. The Citronelle Aquifer and both of the Pascagoula Aquifers are confined by impermeable clay layers.[18]

4.2.2 Groundwater Characteristics

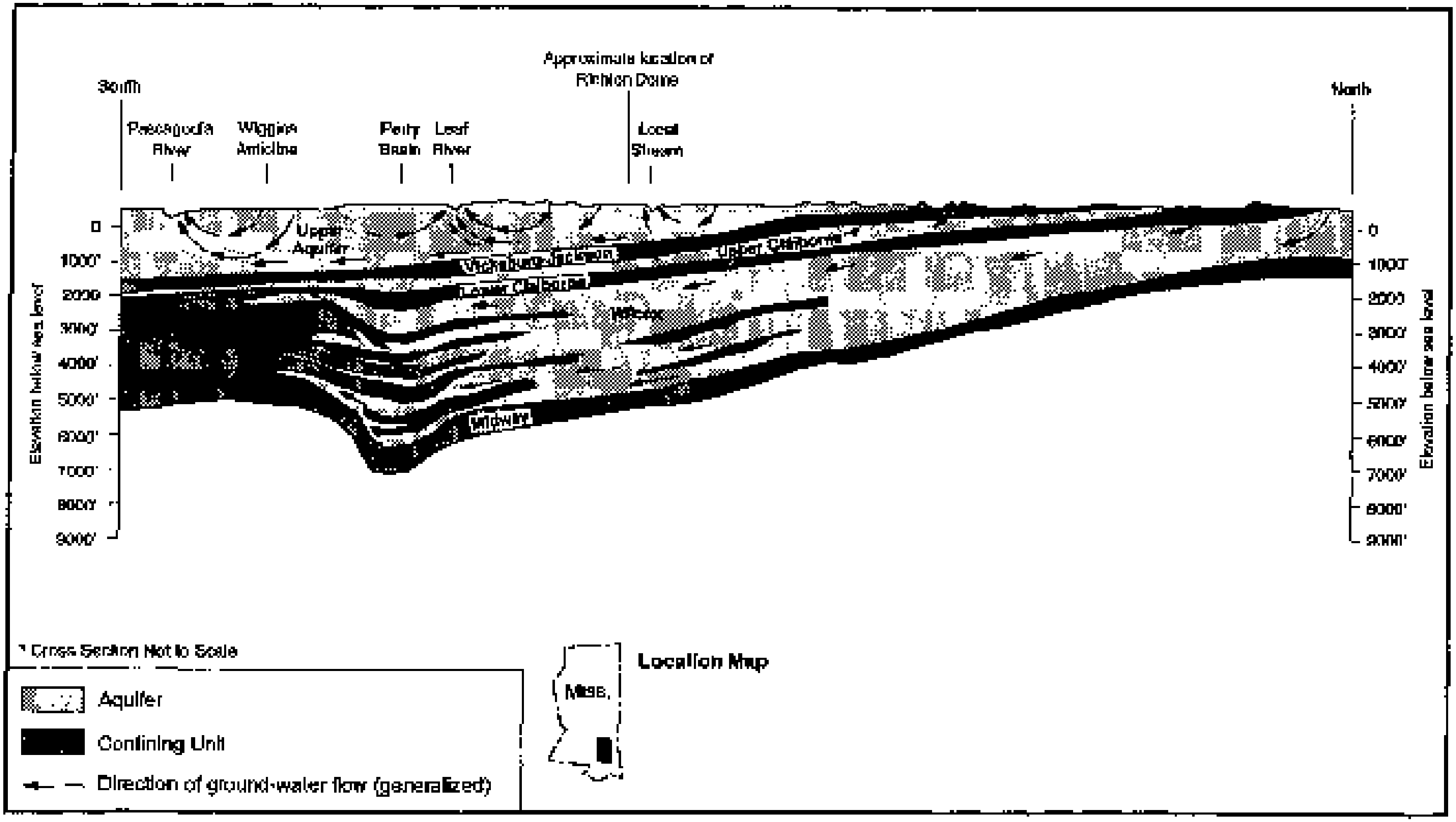
Although the entire Gulf Coast area is generally recharged by precipitation, there are some exceptions. The areas around Weeks Island, Cote Blanche and St. James Parish receive some recharge from the Mississippi and/or Atchafalaya Rivers. Additionally, the Citronelle, Graham Ferry, and Pascagoula aquifers in southern Mississippi are partially recharged by hydraulic connection with surface waters.[19]

Groundwater flow direction in the region is generally southerly, toward the coast. In Mississippi, nearby streams and rivers accept discharge and can change the flow in localized areas. Human use of groundwater, which represents the major mode of discharge from aquifers in the region, has influenced the directional flow of the aquifers in the area (see site-specific descriptions in Chapter 5 for effects on the proposed individual sites).

The quality of water in aquifers in this region generally ranges from freshwater to moderately saline to brine, as depth increases. Specifically, in Texas, the Upper and Lower Chicot and the Evangeline are characterized as freshwater to moderately saline, while the Jasper is characterized as moderately saline to brine. In South Central Louisiana, the Atchafalaya and Chicot are mostly freshwater but very saline or brine near the salt domes. In Mississippi, the Upper Aquifer and Upper Claiborne aquifers are characterized as fresh to slightly saline, and the Wilcox is characterized as very saline to brine.

Major groundwater uses along the Gulf Coast include municipal water supplies, agricultural uses, and industrial uses. Though much of the Chicot is unsuitable for public drinking water or agricultural use, the Chicot aquifers are the major groundwater sources in the region. Along the immediate coastal area, the Chicot contains sufficient pockets of freshwater and slightly saline water to support the local towns, farms, and highly developed industry.[20,21] Some towns near salt domes such as Big Hill and Stratton Ridge must rely upon slightly saline

Figure 4.2-2
Generalized Hydrogeologic Cross-Section of Richton Dome, Mississippi



Source: Williams, 1989, Map.

groundwater for their supply.[22] This will become an increasing problem as rising groundwater pumpage rates from increased population and industrial growth move the freshwater/saltwater interface upward and toward centers of population.[23] The Evangeline represents a source of freshwater in certain areas in Texas. In Mississippi, most groundwater wells tap the Upper Aquifer. Some groundwater is withdrawn from formations within that aquifer, where sands are lanced into clays and relatively insulated from saline water encroachment.[24] None of the aquifers in the area have been designated as sole source aquifers.[25]

4.3 Surface Water Environment

This section provides a description of the regional surface water environment of the Gulf of Mexico Coast, including an overview of the drainage basins within that region containing the candidate expansion sites. Descriptions of the local surface water environments that may be affected by each of the candidate sites are provided in Chapter 5.

4.3.1 Regional Overview

The surface water systems containing the candidate expansion sites are located in the Texas, Louisiana, and Mississippi segments of the Gulf Coast Plain Province. The surface waters of this region are complex, consisting of interconnected water bodies of varying types, salinities, and tidal influences. Major bodies of water that are of primary importance in the region in Texas, Louisiana, and Mississippi are shown in Figures 4.3-1, 4.3-2, and 4.3-3, respectively. In terms of size and influence, the Gulf of Mexico serves as the dominant hydrologic unit in the region. However, the region's major rivers are no less important in determining local hydrologic, water quality, and ecological characteristics. The most sizable rivers of the region include the Colorado, Brazos, Trinity, Neches, Sabine, Calcasieu, Atchafalaya, Mississippi, Pearl, and Pascagoula Rivers. The Colorado and Brazos Rivers flow into the Gulf to the southwest of the Texas sites (Big Hill and Stratton Ridge). The Neches, Sabine, and Calcasieu Rivers lie between the Louisiana sites (Weeks Island and Cote Blanche) and the Texas sites. The Atchafalaya, Mississippi, and Pearl Rivers lie between the Louisiana sites and the Mississippi site (Richton). In addition to rivers, the Gulf Coast in this region is fringed by numerous lakes, bays, and extensive expanses of marsh and swamp. These features support abundant recreational and commercial fisheries, and provide habitat for wildlife. The primary manmade water body within the region is the ICW. The ICW is located five to 20 miles inland from the Gulf, running roughly parallel to the coastline.[26]

The majority of the surface water recharge in the Gulf Coast is supplied by relatively heavy rainfall. Precipitation over the area ranges from about 40 inches per year in Texas to about 60 inches per year in Mississippi. Rainfall is distributed fairly uniformly throughout the year, but generally peaks in the winter and spring months.[27,28] Rainfall is not only heavy, but also intense. The intensity of rainfall, combined with the level of precipitation, is normally expressed in terms of the rainfall factor. The value of this factor for the region ranges from 350 to 550, the maximum value encountered within the continental United States.[29]

4.3.2 Affected Surface Water Basins

In Texas, the most prominent surface waters within the Gulf Coastal Plain Province are the Galveston-Trinity Bay system and Sabine Lake on the Texas-Louisiana border. Large rivers include the Colorado, Brazos, San Jacinto, Trinity, Neches, and Sabine Rivers. The western most of the candidate expansion sites, Stratton Ridge, lies east of the mouth of the Brazos River in the

Figure 4.3-1
Regional Surface Water Map for Texas

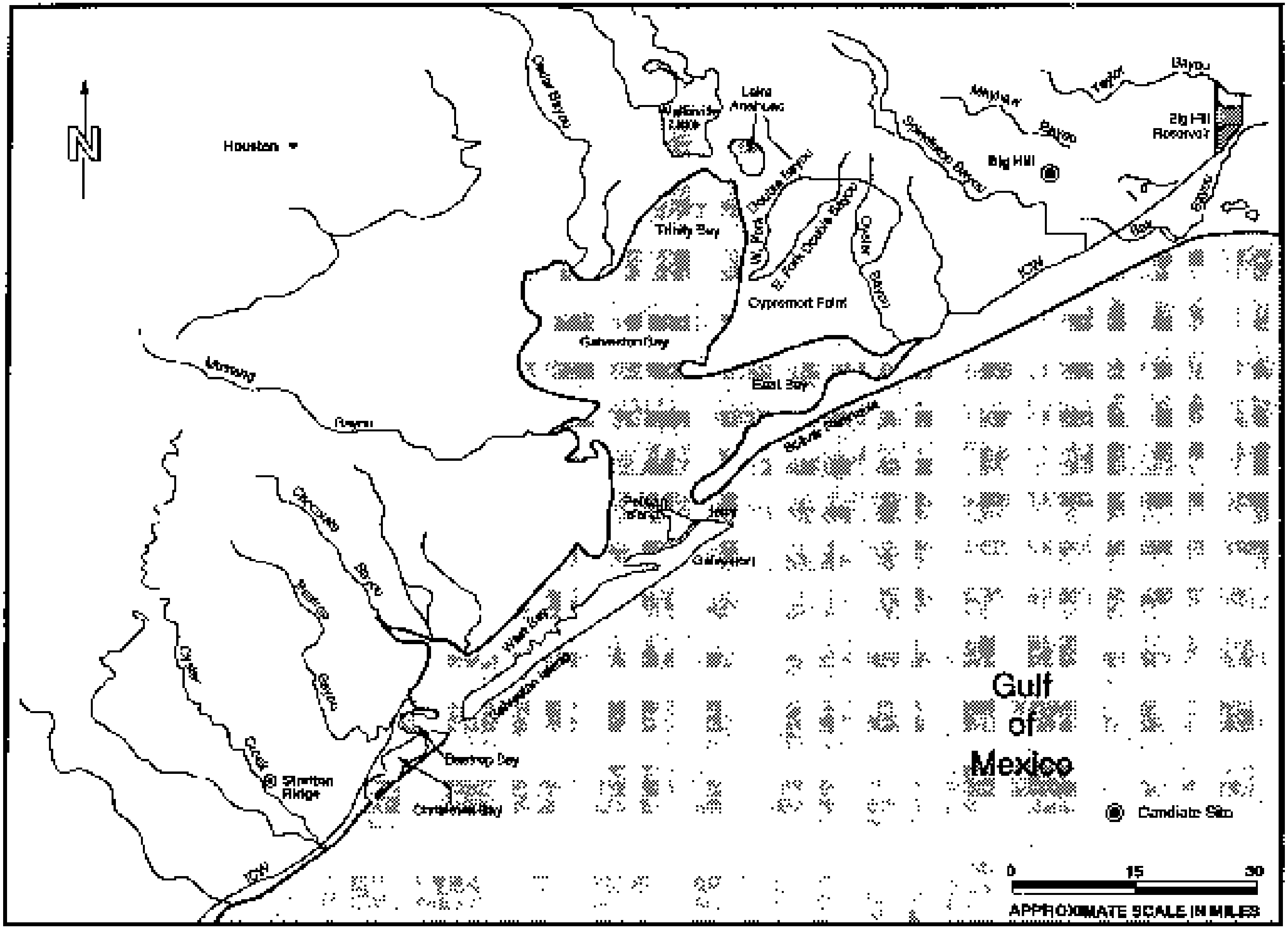
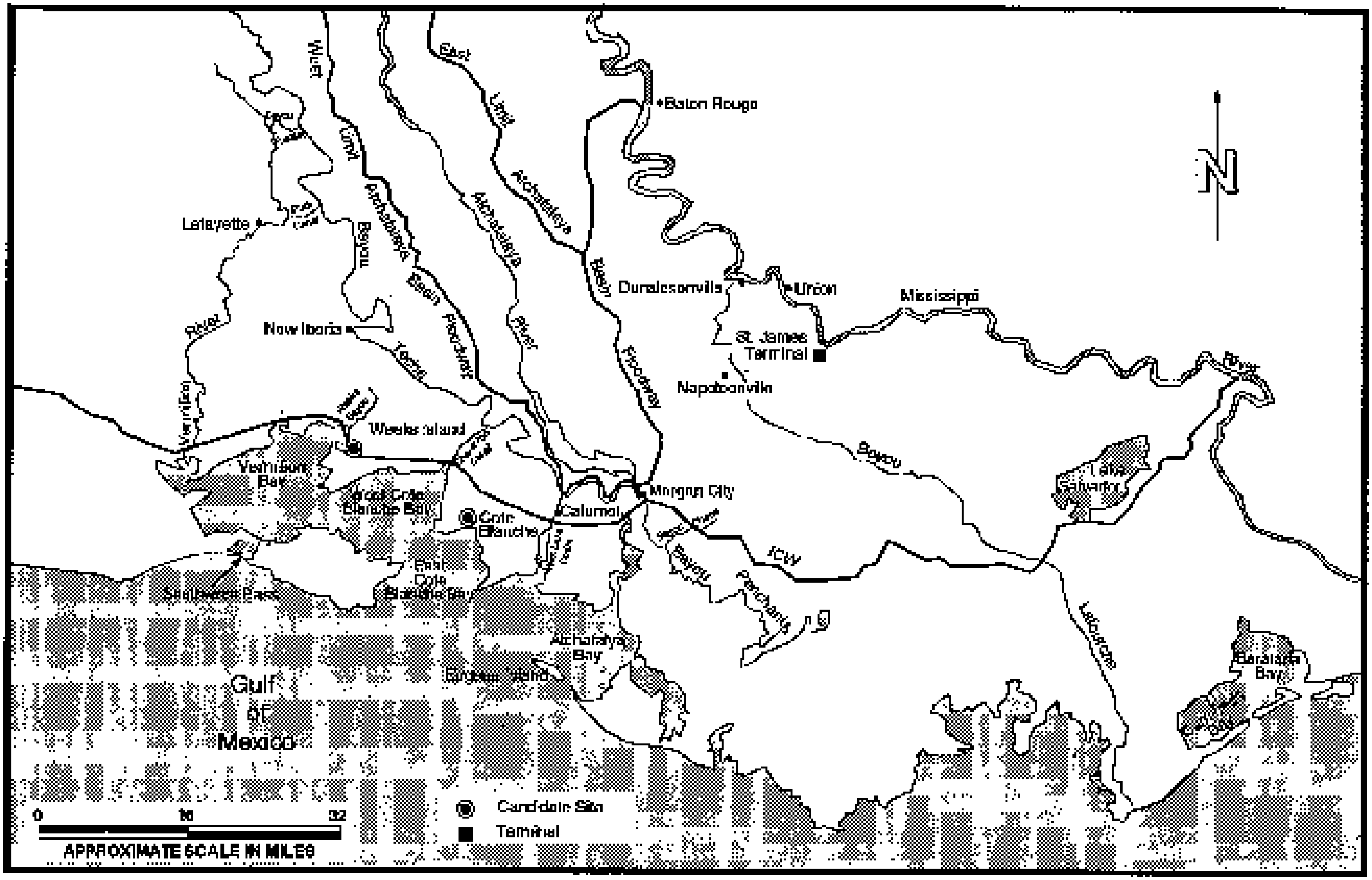


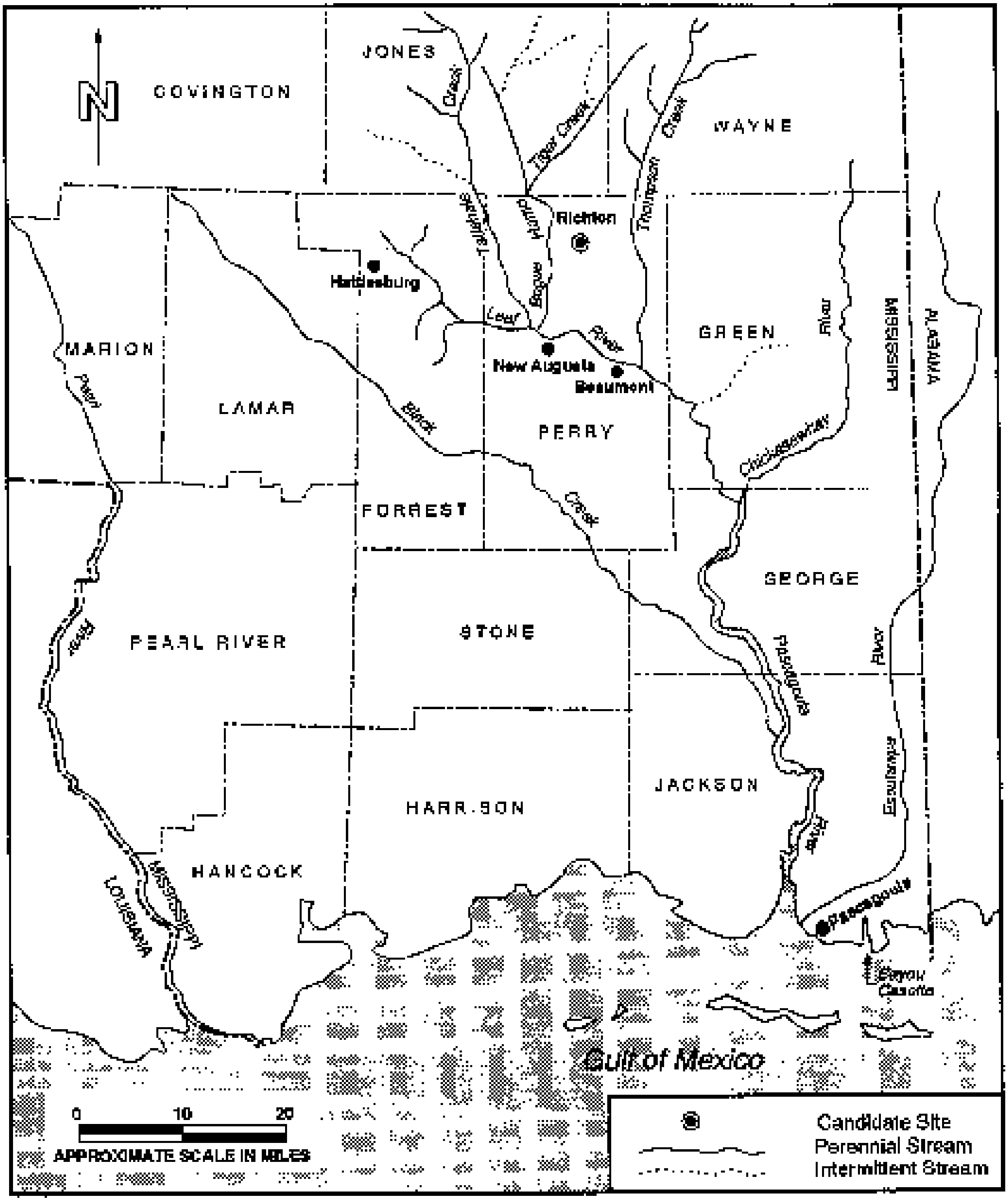
Figure 4.3-2
Regional Surface Water Map for Louisiana



Source: U.S. Department of Energy, Strategic Petroleum Reserve, Final Environmental Impact Statement, Capline Salt Domes, July 1978

Figure 4.3-3

Regional Surface Water Map for Mississippi



San Jacinto-Brazos Coastal Basin. Most of the surface waters in this 1,440 square mile basin flow into Galveston Bay, which forms the eastern border of the basin. More than half of the basin's 50-mile coastline is formed by a large barrier island that separates West Bay from the Gulf of Mexico. The Brazos River, also in the basin, is the only river in Texas currently building a delta.[30] In addition to the Brazos river, important rivers of the basin are Oyster Bayou, Austin Bayou, Chocolate Bayou, Dickinson Bayou, Clear Creek, and Middle Bayou. Cities within the basin are Freeport, Galveston, Texas City, and Lamarque. The city of Houston is located less than five miles north of the basin.[31]

The other candidate expansion site in Texas, Big Hill, is located in the Neches-Trinity Coastal Basin. This basin abuts the Galveston-Trinity Bay Basin to the west, and extends from Galveston and Trinity Bays approximately 60 miles east to the Louisiana border. Prominent surface waters in the Neches-Trinity Coastal Basin are: Galveston, Trinity, and East Bays, Sabine Lake, Sabine River, the ICW, and Taylor Bayou. The total drainage area of the basin is approximately 770 square miles. Major cities in the basin are Beaumont and Port Arthur.[32]

There are several sizable open waters and rivers in the Louisiana segment of the Gulf Coastal Plain Province. The most prominent lakes and bays are: Sabine Lake, Calcasieu Lake, Grand Lake, White Lake, Vermilion Bay, Weeks Bay, East and West Cote Blanche Bays, Atchafalaya Bay, Terrebonne Bay, Lake Pontchartrain, and Lake Borgne. Major rivers of Coastal Louisiana are: the Calcasieu, Mermentau, Vermilion, Atchafalaya, and Mississippi Rivers. The entire coastal plain of Louisiana, and especially the delta low-lands of the Mississippi River and its distributaries, are marshlands and swamps. Within this region, both of the candidate expansion sites in Louisiana are located in the Marsh Island-Bayou Teche Drainage area.[33] The surface waters of this area are relatively fresh for the Gulf Coast due to freshwater inflows from the Atchafalaya River. Marsh Island limits inflow of marine water to Vermilion, Weeks, and West Cote Blanche Bays.

The Richton site is located in the Mississippi portion of the Gulf Coastal Plain Province. Two large rivers, the Pearl River and the Pascagoula River, flow into the Gulf along Mississippi's 75-mile coast. There are no prominent lakes or bays on the Mississippi Gulf Coast. The Richton site is in the Pascagoula River drainage basin. This basin is the second largest in Mississippi, draining 9,700 square miles in southeastern Mississippi and southwestern Alabama into the Gulf of Mexico.[34] A wide valley and floodplain characterize the northern portion of the basin; however, the lower part has a poorly defined floodplain, resulting from the area's poorly drained land that is at or near sea level. The Richton site is located in the Leaf River sub-basin, which drains about 3,600 square miles of the northwestern and northcentral portions of the Pascagoula River drainage basin. The confluence of the Leaf and Chickasawhay Rivers form the Pascagoula River near Merrill, Mississippi.[35] Other major rivers of the Pascagoula River drainage basin are the Red and Black Creeks and the Escatawpa River.

4.3.3 Water Uses and Water Quality

Water quality within the Gulf Coastal Plain Province varies considerably from site to site. Generally, the surface water is soft (i.e., it does not contain significant amounts of dissolved minerals such as calcium or magnesium) and has an intermediate pH. Brackish waters are more common between the Gulf and the ICW; fresh waters occur further inland beyond the ICW. The tendency for saltwater from the Gulf to intrude into freshwater areas during periods of low river flow constitutes the single most important water quality problem in the region. Construction also has resulted in altered salinities in certain water bodies. For example, Sabine Lake now is much more saline than it was before the construction of the Sabine ship channel, which has resulted in strong tides and salt intrusion. Conversely, the Mermentau Basin has been impounded with control structures, and thus, isolated from any tidal influence.[36] Of the five candidate expansion sites, only Richton is located inland beyond any tidal influence.

Surface water systems are used extensively for a variety of purposes throughout the Province. Commercial fishing represents a significant source of income in the region. Many bodies of water serve as recreation sites for boating, fishing, and swimming. Surface water also serves a variety of agricultural uses including: rice farming, consumption by livestock, and irrigation of crops. Industrial users of surface water include the region's large chemical, oil and gas, power generation, and paper industries. Generally, little surface water is used for a human drinking water supply. In addition to these human uses, the surface water systems serve as important habitats for wildlife.[37]

Across the Texas drainage basins containing the Big Hill and Stratton Ridge sites, the predominant surface water quality problems are fecal coliform bacteria, elevated phosphorus levels, and depressed dissolved oxygen.[38] These deficiencies are related to the chemical, petrochemical manufacturing, oil production, agricultural, and shipping industries, and to urban runoff. Industries use a sizeable amount of fresh surface water in their operations and also discharge large volumes of wastewater into the system. The construction of artificial shipping channels and pipeline canals to serve these industries has facilitated saltwater encroachment upon previously fresher waters.

The Louisiana sites are located far away from any major industrial or transportation centers. The area is sparsely populated and there are few surface water users. The primary surface water uses are oil field service and small boat or barge traffic. Potential impacts on barge traffic are discussed in section 7.3.3.3 for Weeks Island, and section 7.4.3.3 for Cote Blanche. Water quality is generally good.

Although the rivers of coastal Mississippi are tidally influenced in their southern-most reaches, tidal influence on the Pascagoula River drainage basin does not extend inland to the Richton site. Throughout the basin, floodplains remain almost totally undeveloped. Fish and wildlife habitat, and shellfish harvesting are the two major uses designated for water bodies in the region. The principal consumptive uses of water in Mississippi are irrigation and industry, especially the paper, petroleum, and electrical power industries. Monitoring in the region indicates that surface water quality is generally good, although criteria for domestic water supply and freshwater aquatic life have not always been met.[39] At various locations in the basin, water quality has been degraded by organic enrichment and metals contamination from industrial point sources. Additionally, commercial fishing bans and fish consumption advisories have been issued for various waters in the basin contaminated by PCB or Dioxin.[40] Meridian, Mississippi is the only city in the entire basin that uses surface water for its public water supply.[41]

4.4 Climate and Air Quality

The climate of the area surrounding the SPR candidate sites is important because of the relationship between weather and potential damage to man-made structures. Extremes of heat, cold, and wind can contribute to weakening of structures, increasing the chance of environmental damage from oil or brine spills. The air quality of the areas surrounding the SPR candidate sites also warrants examination as it may be affected by pollutant emissions during the construction and operation of the sites.

4.4.1 Climate

The climate of the Gulf Coast area of Texas, Louisiana, and Mississippi is classified as humid subtropical with a strong maritime influence. The movement of maritime air from the Gulf of Mexico helps to temper the extremes of summer heat and to shorten the duration of winter cold spells while providing abundant moisture and rainfall. Temperatures exceeding 90°F generally occur more than 70 days per year in the area between Port Arthur and New Orleans, while at Galveston, 90°F is exceeded only about twelve days per year.[42] Temperatures below freezing (32°F) are infrequent, occurring less than about 26 days per year (less than five days per year at Galveston). Precipitation over the area ranges from about 42 inches per year at Galveston to about 57 inches per year at New Orleans and is distributed fairly uniformly throughout the year. The entire area is subject to tropical storms with high winds, heavy rainfall, and tidal flooding.[43]

The Bermuda high, an extensive, persistent high pressure cell located in the southwestern part of the Atlantic Ocean, dominates the spring and summer weather conditions in the Gulf area. Prolonged periods of high pressure and low wind speeds can contribute to air pollution episodes. The prevailing southeasterly winds bring moist air to the area, with the result that humidities are high and showers occur almost daily. The frequency of strong northerly winds increases during the winter months. Although the area is south of the mean winter continental storm track, these intrusions of polar air into the area can cause sudden drops in temperature and occasional snowfall.[44] The cold air masses also tend to lower sea-surface temperatures and are important in the formation of advection-radiation fog, which is prevalent along the coast, especially during winter and spring.[45]

Tropical cyclones produce some of the most extreme meteorological conditions that occur over the Gulf Coast. A tropical cyclone is typically defined as a nonfrontal, low-pressure system that develops over tropical or subtropical waters and has definite organized circulation. The high wind stresses, translational motion, and low-pressure anomalies of tropical cyclones cause strong currents, high waves, higher tides, intense mixing, and movement of larger sediment fractions in coastal waters. In the Gulf of Mexico, tropical cyclones have a "season" in that they occur only between the months of May and October, with the greatest frequency of storms in August and September.

Summer thunderstorm activity and tropical cyclones may potentially damage man-made structures. Wind damage, flooding, lightening strikes, and tornadoes spawned by tropical storms or hurricanes associated with storm activity may cause ruptures, fires, and oil or brine leaks. Probabilities of the occurrence of these hazards at the SPR sites are discussed in Chapter 6.

4.4.2 Air Pollution Potential

The potential for regional air pollution events is largely governed by two meteorological variables, the height of the daytime mixing layer and wind speed. In the classic box model of urban air pollution, the mixing height is the height of the box through which relatively vigorous vertical mixing occurs. The wind speed represents the rate at which pollutants are flushed from the box. Restricted dispersion, and hence high levels of air pollutants, result from the combined effects of low mixing heights and low wind speeds. For purposes of assessing the potential for urban air pollution across the United States, Holzworth[14] calculated mixing heights and vertically averaged wind speeds from surface and upper air data collected at 62 National Weather Service stations.

Two of the stations in the Holzworth compilation are located in southern Louisiana in the general region of the proposed SPR facilities. The Lake Charles station in the southwestern section of Louisiana, is about 30 miles north of the coastline and 30 miles east of Texas. The second station is located on the southeast tip of the Mississippi River delta in Burrwood, Louisiana. As calculated by Holzworth, the annual average afternoon mixing heights were 956 meters and 1,188 meters at Burrwood and Lake Charles, respectively. The corresponding annual average wind speeds were calculated as 5.9 and 6.4 m/sec, respectively. The afternoon mixing heights at these stations are typical of those found along the Gulf and East Coasts of the United States, where the ocean boundary layer exerts a strong influence on the coastal climate. The seasonal variations of mixing height in the Mississippi/Louisiana/eastern Texas region are relatively small and tend towards lower mixing heights in winter (about 800 meters) and higher in summer (about 1,400 meters). With respect to the potential for dispersion of air pollutants, the seasonal variation in afternoon mixing heights tends to be somewhat offset by seasonal variations in wind speed; the lowest seasonal average wind speeds occur in summer (about five m/sec), and the highest in winter (about seven m/sec).

Afternoon mixing heights and wind speeds can be used as a quantitative index of the potential for air pollution episodes. In particular, the National Air Pollution Potential Forecasting Program of the National Weather Service has used wind speeds of less than four m/sec and a mixing height of less than 1,500 meters as criteria for issuance of an Air Pollution Advisory. Based on these criteria, over a five-year period, 18 episodes consisting of a total of 42 episode-days occurred at Lake Charles, and 29 episodes consisting of 86 episode-days occurred at Burrwood. Most of these episodes occurred in summer and autumn. The higher number of occurrences at Burrwood are indicative of the greater influence the Gulf waters have in keeping afternoon mixing layers lower over the delta than over more inland areas of the coast. For comparison to his calculations of episode-days, Holzworth also presents a contour plot of actual forecast-days of high air pollution potential over a five-year period. Across the coast of Mississippi/Louisiana/eastern Texas, the number of forecast-days increase east to west and range from zero to about 15 days. The considerable difference between the derived episode-days and the actual forecast-days are attributable to the forecast requirement that the meteorological conditions noted above be satisfied over a relatively large area (minimum size of 75,000 square miles). When occurring on such a scale along the Gulf Coast, the conditions are usually associated with a stagnating or slow-moving anticyclone, rather than the regional influence of the Gulf.

Whether looking at the number of derived episode-days or actual forecast days, the potential for air pollution in the coastal region of Mississippi/Louisiana/eastern Texas is fairly typical of the entire Gulf Coast as well as the Atlantic Coast in the southeastern United States. The air pollution potential in these coastal areas can be characterized as relatively moderate in comparison to the very low potential in the central Great Plains (where typically no or few forecast days are seen) and the very high potential in the West Coast (where as many as 70 forecast days can occur in a five-year period).

4.4.3 Air Quality Data

Available air quality data for the northwest Gulf Coast indicate that the National Ambient Air Quality Standard (NAAQS) for ozone, which is 0.12 parts per million (ppm) for a one-hour averaging time, has been exceeded at several locations. The highest one-hour average measurement during 1989 was 0.27 in the Houston area.[47] Those regions showing high ozone concentrations are generally associated with petrochemical industries and urban areas along the Gulf Coast. Additionally, in 1989, two exceedances of the sulfur dioxide standard were recorded at a monitoring site in Port Arthur. One was caused by upset conditions at a nearby industrial facility and declared an exceptional event; the remaining exceedances of the three-hour and 24-hour NAAQS do not constitute a violation of the NAAQS.[48] Regional air quality data are summarized in Table 4.4-1.

The Clean Air Act air pollution control program requires that all areas in each of the Air Quality Control Regions (AQCRs) meet the NAAQS for all air pollutants in order to be assigned "attainment" status. In the Louisiana portion of AQCR 106, which includes the St. James Terminal in St. James Parish, the Cote Blanche site in St. Mary Parish, and the Weeks Island site in Iberia Parish, 17 of the 39 parishes in the AQCR are classified as nonattainment for ozone (40 CFR 81.319). AQCR 106 extends into Texas and includes the Big Hill site in Jefferson County; of the 16 Texas counties in the Region, only three (Jefferson, Hardin, and Orange Counties) are classified as nonattainment for ozone (40 CFR 81.344). Of the twelve Texas counties in AQCR 216, which includes the Stratton Ridge site in Brazoria County, eight are classified as nonattainment for ozone (40 CFR 81.344). All AQCRs in Mississippi are classified as attainment for ozone (40 CFR 81.325). AQCR 106, ACQR 216, and all counties in Mississippi are either unclassified or better than national standards for sulfur dioxide, carbon monoxide, nitrogen dioxide, and particulates.

4.5 Ecological Characteristics

This section describes the general ecological setting of the proposed SPR expansion site area and provides a context for understanding the site-specific descriptions presented in Chapter 5.[49] Emphasis is on the plant and animal communities occurring in the region, and the section includes a brief description of the animals, ecosystems, and wetlands and other vegetative communities.

The alternative sites for the proposed expansion of the SPR are located in Texas, Louisiana, and Mississippi in the Gulf Coastal Plain Province. Based on a map of ecoregions of the United States,[50] the five sites lie within three ecoregions: Outer Coastal Plain Forest Province (Weeks Island, Cote Blanche, and Richton sites), Southeastern Mixed Forest Province (Big Hill site), and Prairie Parkland Province (Stratton Ridge site). With the exception of Stratton Ridge, the sites are in the subtropical division, characterized by the absence of exceptionally cold winters and the presence of high humidity. Stratton Ridge is located within the prairie division, characterized as having a subhumid climate. These ecoregions, provinces, and divisions are shown in Figure 4.5-1.

Gosselink et al.,[51] Gosselink,[52] and Cahoon and Groat[53] have conducted extensive ecological characterizations of the Gulf Coastal Plain region, with emphasis on marshes and wetlands. The Gulf Coastal Plain region is divided into two ecosystems: the Chenier Plain ecosystem, which extends east along the Gulf Coast from the eastern portion of Galveston Bay

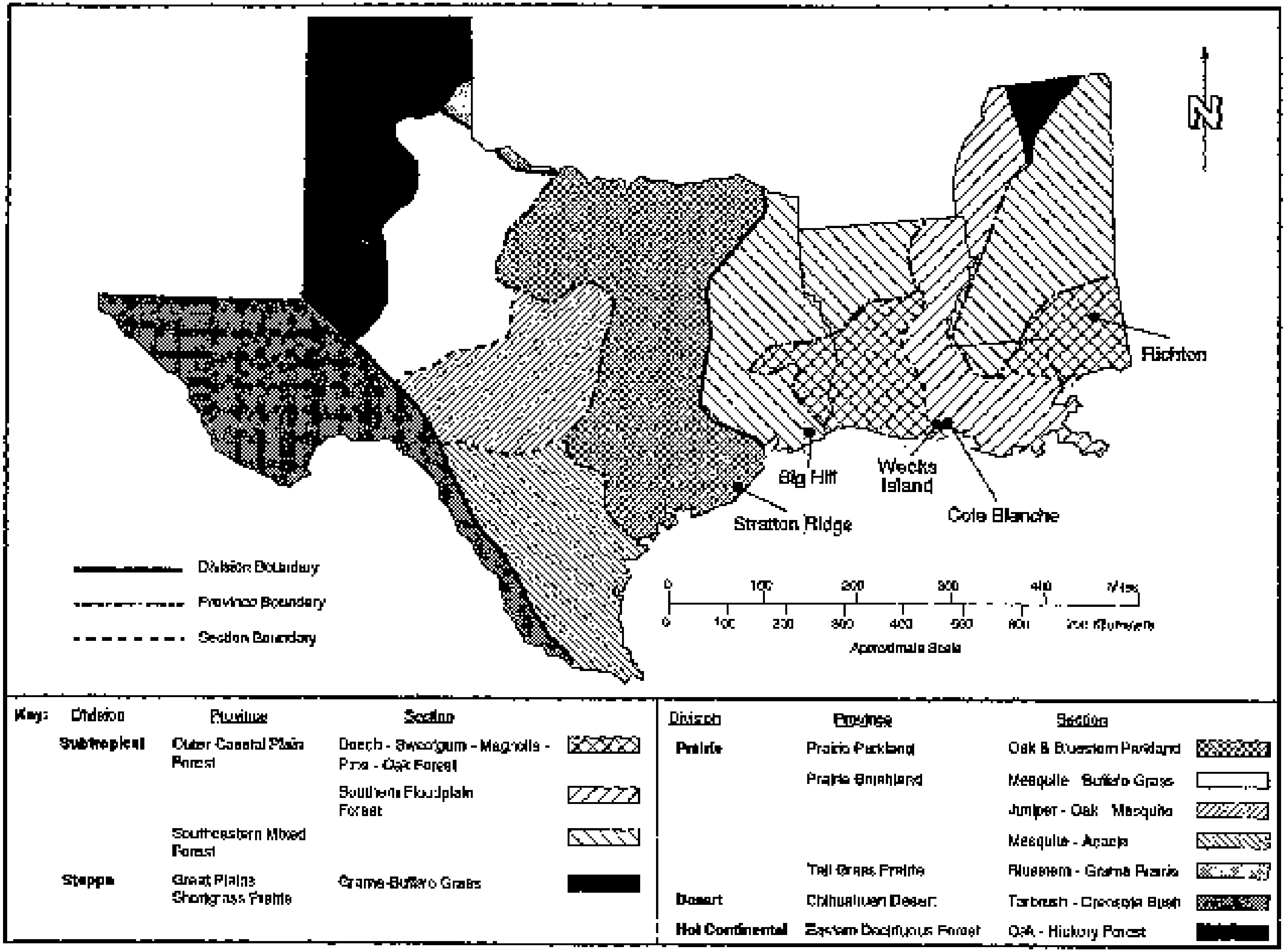
Table 4.4-1
Regional Summary of 1989 Air Quality Data at Continuous Monitoring Stations in the Region

Site Location	Ozone (highest)	Ozone (days above standard)	Carbon Monoxide (2d highest hour)	Carbon Monoxide (2d highest 8-hours)	Sulfur Dioxide (2d highest 24-hours)	Sulfur Dioxide (annual mean)	Sulfur Dioxide (2d highest 3-hours)	Nitrogen Dioxide (annual mean)
NAAQS	0.12 parts per million (ppm)	Avg. one day for 3 yrs.	35 ppm	9 ppm	0.14 ppm	0.03 ppm	0.5 ppm	0.05 ppm
Houston, East (TX)	0.22	12	6.7	4.1	0.02	0.007	0.08	0.21
Aldine (TX)	0.27	9	9.1	5.9				0.014
Texas City (TX)	0.16	5			0.04	0.006	0.10	
Deer Park (TX)	0.18	13			0.01	0.002	0.09	
Seabrook (TX)	0.19	5						
Houston, Manchester (TX)	0.19	9			0.05	0.008	0.12	
Beaumont (TX)	0.16	1	3.6	2.0	0.05	0.008	0.14	0.005*
Port Arthur (TX)	0.17	7			0.12	0.007	0.55	
Morgan City (LA)	0.109	0						
Thibodaux (LA)	0.114	0						
Mobile (AL)	0.087	0			0.05	0.009	0.16	
Pascagoula (MS)	0.097	0			0.02	0.006	0.05	
Jackson (MS)	0.092	0	11	6.1	0.01	0.005	0.03	
Natchez (MS)	.13	3						

* Annual Mean is not valid since there was less than 75 percent data return.

Source: Texas Air Control Board, *1989 Network Data Summaries: Continuous Air Monitoring*, May 1990; State of Louisiana, Department of Environmental Quality, *Ambient Air Quality Data: Annual Report 1989*, and Mississippi Department of Environmental Quality, Bureau of Pollution Control, *Ambient Air Quality Summary, Calendar Year 1989*, Alabama Department of Environmental Management, May 12, 1992.

Figure 4.5-1
Ecoregions of Texas, Louisiana, and Mississippi



Source: Description of the Ecoregions of the United States, Robert G. Bailey, 1980

(East Bay), Texas, to the western portion of Vermilion Bay, Louisiana, and the Delta Plain ecosystem (referring to the Mississippi River Delta), which continues along the Gulf Coast from eastern Vermilion Bay east to the Pearl River in Louisiana. Table 4.5-1 summarizes the locations in terms of province, basin, and ecosystem for each of the five proposed sites.

The area southwest of the Chenier Plain, referred to as the Barrier Strand Plain, is not covered by the above sources. Stratton Ridge is located in the eastern portion of this ecosystem in an area that is most likely a transition area between Barrier Strand Plain and Chenier Plain ecosystems. Therefore, the Stratton Ridge area probably exhibits characteristics of both ecosystems. As a result, information on the Chenier Plain should be partly representative of the characteristics of the Stratton Ridge site.

Several major vegetative communities occur in the region. Most areas have been subject to some degree of human disturbance historically and/or presently and do not necessarily reflect the climax community that might be found in that area if it had not been disturbed. For example, many of the low-lying areas within the region have been altered by man-made canals and levees to increase the amount of arable land.

The vegetative communities in the region can be broadly grouped into two general categories: wetlands and uplands. Each of these vegetative communities is discussed in the following sections.

4.5.1 Wetlands

In general, wetlands are defined as any area that has water at or sufficiently near the surface to have resulted in hydric soils and hydric vegetation.[54] The Delta Plain, which encompasses Weeks Island and Cote Blanche, contains the largest continuous wetland system in the United States with approximately 1,840,000 acres of wetlands. The Chenier Plain, which encompasses Big Hill, also contains large expanses of wetlands totalling approximately 1,240,000 acres. Information regarding wetland acreage of the Barrier Strand Plain, which encompasses Stratton Ridge, and in the Gulf Coastal Plain in Mississippi could not be located. The dominant wetlands in the region are estuarine intertidal and both forested and emergent palustrine based on the National Wetland Inventory (NWI) classification scheme.[55] These types of wetlands and their functional values are detailed in Appendix B.

4.5.2 Upland Vegetative Communities

Upland (nonwetland) communities consist primarily of forests and agricultural areas. The dominant or characteristic species of each type is described below.

4.5.2.1 Forests

Based on forest statistics compiled by the U.S. Forest Service,[56] southeast Texas (which extends from Red River County south to Jefferson County, and from Leon County east to Sabine County) has over six million acres of land classified as timberland, out of a total of twelve million acres of land in this area. Parishes in Louisiana's south delta region (extending along the Louisiana coast and up as far as Avoyelles Parish in central Louisiana) have nearly two and a half million acres of timberland out of a total area of eleven million.[57] Counties in Mississippi's southern region (which extends from Lawrence and Walthall Counties east to Wayne County and

Table 4.5-1
Classification of the Five Alternative Strategic Petroleum Reserve Sites Within the Gulf Coast Region

Site	Province	Basin	Ecosystem
Stratton Ridge (Brazoria County, TX)	Prairie Parkland	--	Barrier Strand Plain
Big Hill (Jefferson County, TX)	Southeastern Mixed Forest	Sabine	Chenier Plain
Cote Blanche (St. Mary Parish, LA)	Outer Coastal Plain Forest	Vermilion-Teche	Delta Plain
Weeks Island (Iberia Parish, LA)	Outer Coastal Plain Forest	Vermilion-Teche	Delta Plain
Richton (Perry County, MS)	Outer Coastal Plain Forest	--	--

Source: Bailey, 1980; Gosselink, 1984.

south to Hancock, Harrison, and Jackson Counties) contain over four million acres of timberland out of a total area of six million acres.[58] In Texas, the most prevalent tree species in timberland (by acreage) are loblolly and shortleaf pine and oak, while in Louisiana oak-gum-cypress associations are the most prevalent. The most prevalent tree species in Mississippi timberland are pines (loblolly, shortleaf, longleaf, and slash) and oak.

In the Outer Coastal Plain Forest Province, which covers much of the eastern and central Gulf Coast, including the proposed Weeks Island, Cote Blanche, and Richton sites, temperate rainforest (also called temperate evergreen forest and laurel forest) is the characteristic climax community. The canopy is dominated by evergreen oaks (such as live oaks and water oaks and members of the laurel and magnolia families). Woody vines and epiphytes (e.g., spanish moss) are abundant. The principal vegetative communities in this province are deciduous (beech, sweetgum, magnolia, and oak) forests and southern floodplain forest.[59]

The Southeastern Mixed Forest Province, which encompasses the Big Hill site, extends from parts of the midwestern United States down into a small portion of coastal Texas. This province extends along the Gulf Coast from Sabine Lake to the southwestern side of Galveston Bay. Another portion of this province occurs to the north of the proposed Richton site in Mississippi. The climax vegetation is medium to tall forests of broadleaf deciduous and needle-leaf evergreen trees. At least 50 percent of the stands are loblolly pine, shortleaf pine, or other southern yellow pines which occur in single or in mixed species stands. Common associated species include oak, hickory, sweetgum, blackgum, red maple, and winged elm. The main grasses are bluestem, panicums, and longleaf uniola. Dogwood, viburnum, haw, blueberry, American beauty berry, yaupon, and numerous woody vines are common understory species.

In the Prairie Parkland Province, which continues south from Galveston Bay down to Corpus Christi and includes the proposed Stratton Ridge site, dominant communities are prairies, groves, and strips of deciduous forest. The upland forest is dominated by oak and hickory. On floodplains and moist hillsides, there is a richer forest of deciduous trees. The portion of this province along the Gulf of Mexico is the Oak-Bluestem Parkland.

4.5.2.2 Agricultural Land

Crops typically produced on agricultural land in the region include sugar cane, rice, cotton, soybeans, and various truck crops. Rice is one of the most important commercial crops within the Chenier Plain area. Cattle production is also commercially important. Impounded rice fields and other agricultural areas provide seasonal habitat for some amphibians and reptiles. Agricultural lands also provide a seasonal concentrated food source for many bird species. Overall, however, they are not as diverse as natural systems.

4.5.3 Terrestrial Wildlife

The region supports a wide variety of terrestrial wildlife species. Some of the species considered typical of the region are identified below.[69]

4.5.3.1 Birds

The diverse habitats in the region support equally diverse bird populations. Over 200 species of birds have been recorded in the Chenier Plain ecosystem. The coastal wetland areas provide extensive breeding habitat for numerous species of migratory waterfowl including mallard, pintail, and green-winged teal. Herons, egrets, and glossy and white ibis are widespread. Red-tailed hawk, red-shouldered hawk, and marsh hawk are common winter residents. Gulls and terns are abundant along the coastal areas. Rails, gallinules, and coots also are common.

In the southeastern mixed forest, the eastern wild turkey, bobwhite, and mourning dove are widespread. Other species include pine warbler, cardinal, summer tanager, Carolina wren, ruby-throated hummingbird, blue jay, hooded warbler, eastern towhee, and tufted titmouse. Barred owls are common inhabitants of swamps and bottomland hardwood forests.

4.5.3.2 Mammals

Approximately 40 species of mammals have been recorded for the Chenier Plain. Small mammals are predominant species. Common small mammals include raccoon, opossum, armadillo, tree squirrel, swamp rabbit, muskrat, nutria, and a variety of ground-dwelling rodents. With the exception of isolated pockets of Louisiana black bear populations (such as at Weeks Island), the only large indigenous mammal in the outer coastal plain province is the white-tailed deer.

4.5.3.3 Amphibians/Reptiles

Approximately 20 species of amphibians and 40 species of reptiles have been recorded in the region. Most amphibians are not found in salt marshes because their skin is highly permeable and is subject to desiccation from salt exposure. Newts, salamanders, toads, and frogs inhabit all habitats except salt marshes, but are most commonly found in freshwater habitats. Alligators, the largest reptiles in the region, are commonly found in freshwater to brackish marshes and impoundments, and may be frequently observed sunning themselves along canals, bayous, and roadside ditches during the day.

Forest snakes in the southeastern mixed forest include copperhead, rough green snake, rat snake, coachwhip snake, and speckled kingsnake. The Texas coral snake and several species of rattlesnake occur in this region as do water snakes such as cottonmouth. Turtles found in the region include aquatic species such as snapping turtle and Mississippi mud turtle, and terrestrial species such as southern painted turtle.

4.5.4 Aquatic Life

Aquatic populations vary by habitat type. Some species occur only in the higher salinity waters of the Gulf of Mexico, while others occur only in freshwater riverine systems. In the following sections, typical aquatic species for inland habitats, biological communities in the Gulf of Mexico, and unique or important habitats in the region are discussed.

4.5.4.1 Inland Aquatic Habitats

Inland aquatic habitats range from highly saline to completely freshwater containing both invertebrate and vertebrate species. Invertebrate species are important ecologically because they comprise the base of the food web in most ecosystems. Crayfish, grass shrimp, clams, snails, aquatic insects, dragonflies, water bugs, beetles, and flies (including mosquitoes, horseflies, and midges) are only a few of the invertebrate species that abound in inland aquatic habitats. Oysters, brown shrimp, and white shrimp use mesohaline (brackish) and oligohaline (intermediate) palustrine emergent wetlands as nursery areas.

Many fish species spend all or part of their life cycle in inland aquatic habitats. Spotted gar, bowfin, carp, gizzard shad, grass pickerel, smallmouth buffalo, and largemouth bass are limited to freshwater or nearly freshwater areas. Shiners, darters, and catfish also show a preference for freshwater areas. Sea catfish, pinfish, black drum, and mullet occur in both freshwater and saltwater areas. Sunfish, largemouth bass, sand seatrout, and catfish occur in both lakes and streams, whereas black crappie and white crappie are generally found in streams.

Other species are euryhaline, meaning that they can tolerate a wide range of salinities and thus may be found in almost any open aquatic system in the region. Seatrout, sheepshead, croaker, and killifish show a preference for higher salinity areas such as the Gulf of Mexico, but are also found in estuarine areas of the bays. Several shark species and stingrays are occasionally found in the lower areas of the bays. Gulf menhaden, Atlantic croaker, red drum, and bay anchovy are the most abundant fish species in the open water systems near the Gulf of Mexico. Palustrine emergent wetlands are important nursery areas for menhaden.

In addition to being important ecologically, aquatic organisms are also important commercially and recreationally in the region. Invertebrate (shellfish) fisheries are most important for commercial uses, whereas vertebrate (finfish) fisheries are important for both commercial and recreational uses. These are discussed in more detail in section 4.5.6.

4.5.4.2 Biological Communities in the Gulf of Mexico

This section provides a summary of the baseline biological conditions in the Gulf of Mexico, focusing on the areas offshore from the proposed sites in Texas, Louisiana, and Mississippi. It covers plankton (both phytoplankton and zooplankton), benthos, and nekton. Appendix C contains additional information about these organisms.

Plankton

The shelf phyto- and zooplankton are more abundant, more productive, and seasonally more variable than the open-Gulf plankton. In these respects, the slope plankton are intermediate but closer to the condition of the open Gulf. Each of the three regions is characterized by some species that are more or less specific to the particular zones. Some east-west differences have been noted, especially among the diatom species. These have been interpreted as representing the differences between normal Gulf waters and those influenced by the Mississippi River.[61]

Benthos

Benthic macroinvertebrates make ideal subjects for studying acute and chronic effects associated with discharge of organic and toxic pollutants into the marine environment. The benthos are primarily non-mobile or slow moving, small organisms that cannot easily escape an environmental stress; those that cannot tolerate the stress perish. If stress is caused by a toxic substance, both numbers of species (diversity) and individuals can be reduced compared with non-impacted control areas.[62]

The benthic communities that comprise the nearshore northern Gulf of Mexico are characterized by numerical domination by a few species with many rare forms also present. Polychaetes and crustaceans are most abundant in these communities. The term "extended estuary" might be used to categorize this region of the Gulf with respect to the benthic community composition.[63]

Nekton

Nekton for the offshore waters are represented by five major taxonomic categories: marine mammals, reptiles, fishes, cephalopod molluscs (octopuses and squid), and certain crustaceans (shrimp and swimming crabs). Members of this group commonly, but not always, range over broad areas. Most nekton, however, are limited to geographic and vertical ranges by the same environmental conditions as less mobile organisms (i.e., temperature, salinity, and available food). Most of the northern Gulf fishes are temperate with incursions of Caribbean faunas, and exhibit seasonal distribution and abundance fluctuations, which are probably largely related to oceanographic conditions.[64]

A recent study off the Mississippi coast found 128 species of demersal fish representing 49 different families, and found greater numbers and diversity of fish closer to shore. Fish most commonly found at a site south of Pascagoula in the Gulf include the least puffer, the blackcheek tonguefish, the dwarf sand perch, and the striped anchovy.[65] Additionally, both brown and white shrimp are abundant in the Gulf off the coast of Mississippi.[66]

It is possible that brine may affect nekton indirectly through its influence on benthic organisms that are important foods for some species. Though few dietary analyses have been conducted on nekton that inhabit the diffuser area, several shrimps and fishes are known to feed on various benthos, especially crustaceans, during part or all of their life histories. This includes brown shrimp, white shrimp, bay anchovy, sand seatrout, silver seatrout, dwarf sand perch, spot, southern kingfish, croaker, southern flounder, longspined porgy, and southern hake.[67]

4.5.4.3 Unique or Important Habitats

In general terms, biologically sensitive areas of the Mississippi-Louisiana-upper Texas coastal waters include species spawning grounds, tidal passes, reefs and hard banks, areas associated with the mouths of rivers, and habitats of rare species. Potentially sensitive areas include the Mississippi delta environments, Mississippi canyon environments, oozy bottoms off Louisiana, oyster lease areas off Texas, and "hill and valley" areas of the outer shelf and upper slope.[68]

Stipulations to leases have been developed by the Department of the Interior to protect certain resources from potential damage due to oil and gas operations. The biological stipulations affect pipelines by prohibiting their emplacement within "No Activity Zones." These zones have been designated to protect topographic features (banks) of the central and western Gulf, and at the Florida Middle Ground in the eastern Gulf of Mexico. These biological stipulation areas are all located more than three miles farther offshore than any of the proposed diffuser sites.[69]

Additionally, in the continental shelf region where sand and silt bottoms prevail, shipwrecks often serve as artificial reefs for a variety of pelagic nekton and fouling communities. Shipwrecks provide a hard, stable substrate for the attachment of fouling organisms (e.g., barnacles, sea urchins, amphipods, green algae, and sponges) and a protective cover for small fish. Fish typically associated with these reefs include the spadefish, sheepshead, greater amberjack, crested blenny, and high hat.[70] Bait fish use shipwrecks to avoid predators. Several shipwrecks have been reported off the Louisiana coast.[71] According to the latest National Oceanic and Atmospheric Administration (NOAA) nautical charts, there are also shipwrecks off the Texas and Mississippi coasts, but no documented shipwrecks within four miles of either the Big Hill or proposed Stratton Ridge diffusers off Texas, or within 3.5 miles of the proposed Richton diffuser off Mississippi.

Unique reef communities found offshore in the Bryan Mound diffuser area play an important role in the support of local fisheries. The red drum is known to spawn near reef communities. White shrimp are known to spawn in the vicinity of the Bryan Mound diffuser site.[72] Additionally, a number of artificial reefs occur in the Gulf off the coast of Mississippi. These reefs provide habitat for fish species such as grouper, snapper, and triggerfish, which would not otherwise be found in sandy-bottomed areas.[73]

4.5.5 Rare, Threatened, or Endangered Species

Information regarding rare, threatened, or endangered species and habitats was obtained from the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the Texas Natural Heritage Program (Texas Parks and Wildlife Department), the Louisiana Natural Heritage Program (Louisiana Department of Wildlife and Fisheries), the Mississippi Natural Heritage Program (Mississippi Department of Wildlife, Fisheries, and Parks), the Alabama Natural Heritage Program, and the Alabama Department of Conservation and National Resources.

There are two types of information presented on rare, threatened, or endangered species. Appendix D presents the Federal and state status for all species that have been formally listed under the Endangered Species Act (ESA) or under similar state statutes. Complete species lists are presented for all counties and parishes which could be involved in the proposed action (e.g, counties/parishes where sites could be located and counties/parishes where off-site pipelines, terminals, raw water intake structures, pump stations, or tank farms could be located). The numbers of endangered or threatened species formally listed for counties/parishes affected by each proposed site (under all drawdown options) are listed in Table 4.5-2.

To provide additional information for decision-makers, a shorter list of species likely to be present near the proposed sites and proposed off-site locations was assembled based on conversations with the Texas, Louisiana, and Alabama offices of USFW and the Florida office of NMFS. These offices reviewed detailed maps of the proposed site locations and associated pipelines and identified Federally threatened and endangered species which might be present in their vicinity; they did not review species protected under state designations.

Biological assessments were conducted for the species identified as of potential concern by the Federal agencies. For these species, additional information was collected from state agencies and through literature reviews; a preliminary assessment of potential impacts of the proposed action was prepared. These assessments are presented in Appendix E for species under NMFS jurisdiction and in Appendix F for species under USFW jurisdiction.

These appendices were circulated prior to the publication of the Draft EIS to USFW and NMFS. DOE will initiate additional consultation to ensure compliance with the ESA (see section 8.1.4.6).

4.5.6 Commercially Important Species

In the area of the proposed SPR sites, there are a number of species both aquatic and terrestrial, which represent important commercial interests.

4.5.6.1 Aquatic Species

The Gulf of Mexico off Texas, Louisiana, and Mississippi supports major commercial and recreational fisheries. About 40 percent of the nation's commercial fish landings and one-third of the marine recreational fishing activity are concentrated in the Gulf, and much of this occurs on the Texas-Louisiana continental shelf.[74] Estuary-dependent species dominate the commercial fishery resources in the Gulf of Mexico. Approximately 40 percent of those southeastern United States wetlands and estuaries important to fisheries are located along the Gulf of Mexico. Louisiana is the most productive State in the Gulf region in terms of commercial fisheries because of its extensive estuaries, coastal marshes, and nutrient input from the Mississippi and Atchafalaya Rivers. Louisiana ranked first among central and western Gulf States in total commercial fishery landings for 1989. Texas ranked third among the central and western Gulf States in total commercial fishery landings for 1989.[75]

Table 4-5.2
Number of Endangered or Threatened Species in Counties, Parishes, or Gulf of Mexico in Which Proposed Sites, Pipeline Routes, and Related Structures are Located[a]

Type of Species	Big Hill (3 counties)	Stratton Ridge (1 county)	Weeks Island (4 parishes)	Cote Blanche (4 parishes)	Richton (11 counties)	St. James (2 parishes)
Terrestrial/Freshwater						
Plants	1	0	0	0	0	0
Fish	3	0	0	0	2	0
Reptiles/Amphibians	7	5	0	0	15	0
Birds	13	15	3	3	20	1
Mammals	4	1	2	2	7	1
Invertebrates	0	0	0	0	1	0
Insects	0	0	0	0	1	0
Marine/Estuarine						
Fish	0	0	0	0	2	1
Reptiles	4	4	4	4	4	0
Mammals	15	15	15	15	16	0
TOTAL	47	40	24	24	68	3

[a] See Appendix D for listings of individual species and their endangered/threatened status within each state.

The commercial fisheries offshore of Texas, Louisiana, and Mississippi depend on two major components: shellfish and saltwater finfish. Shellfish are the most important economically, with shrimp bringing in the highest revenues. Shrimp are the most important commercial seafood product in Texas, constituting 82 percent of the weight and 92 percent of the ex-vessel value of the total seafood landed. Finfishery has traditionally relied, almost exclusively, upon the menhaden and several species of the drum family, all estuary dependent species. The fishery expanded, however, during the 1980s, tripling the number of major species landed, including up to nine species with commercial values of over one million dollars. This expansion may have been due to the ever-increasing amount of hard substrate being added by new offshore petroleum platforms and/or the increased demand from U.S. markets.[76] Coastal Louisiana and Mississippi also provide an exceptionally suitable habitat for one of the major fisheries areas in the United States. Its high level of productivity is largely due to the interaction of the Mississippi River Delta system with the Gulf of Mexico.

Since the 1970s, there has also been a major expansion of the marine recreational fishery, with much of the activity centered off Mississippi, Louisiana and east Texas. A considerable amount of recreational fishing takes place from shore or within State waters, but offshore fishing is also actively pursued from charter boats and private or rented crafts. Twenty-eight percent of marine fishing trips for Texas residents are to offshore rigs and platforms where 80 percent of the catch (exclusive of marine catfish) is composed of red snapper, sand seatrout, and Atlantic croaker.[77] Sportfishing in the Louisiana coastal area is extremely popular and provides for a large industry. The bays and nearshore regions yield Atlantic croaker, spot, red drum, seatrout, black drum, southern flounder, sheepshead, and spadefish. Oil rigs provide a reeflike environment with assemblages of cobia, crevalle jack, greater amberjack, sheepshead, great barracuda, king mackerel, blue runner, and Atlantic spadefish.

This section discusses the individual commercially important species in terms of their dollar value. Because these species are expected to be the same throughout the SPR region, no site-specific characterization of these species is presented in Chapter 5. Additional information on impacts of brine disposal on commercial fisheries is found in Appendix G.

Shellfish

Based on statistics provided by the NMFS,[78,79] shrimp, blue crab (*Callinectes sapidus*), and oysters are among the most commercially important species caught off the coasts of Louisiana, Mississippi, and Texas. Shrimp species include the brown shrimp, white shrimp, pink shrimp, seabobs, and royal red.

Shrimp is both a high value and high volume fishery. Individual species profiles, published by the NMFS, indicate that the shrimp are the most valuable fishery in the United States. The shrimp fishery is essentially based upon the two species: *Penaeus aztecus* (brown shrimp) and *Penaeus setiferus* (white shrimp).[80] Historical data indicate that from 1981 through 1987, the average annual white shrimp landings (amount of catch brought into port) were 3.9 million, 5.2 million, and 24 million pounds for Texas, Mississippi, and Louisiana, respectively. The corresponding values from the three States for brown shrimp during the same period were 21 million, 8.4 million, and 18 million pounds.[81] Based on data from 1987 through 1990, commercial shrimp landings in Brazoria County (where Stratton Ridge is located) and Jefferson County (where Big Hill is located) comprise approximately 20 percent of total shrimp landings for the State of Texas. More recent shrimp landings data from Louisiana, Mississippi, and Texas are summarized in Table 4.5-3.

Table 4.5-3
Shrimp Landings Data for Louisiana, Texas, and Mississippi*

	Louisiana		Texas		Mississippi	
	Weight (million pounds)	Value (million dollars)	Weight (million pounds)	Value (million dollars)	Weight (million pounds)	Value (million dollars)
1988	63.5	199.0	39.3	127.4	11.8	24.1
1989	56.1	188.4	40.6	119.6	16.3	29.8
1990	70.7	210.6	54.5	175.0	15.0	25.3

* Data reflect totals for brown and white shrimp combined.
Source: National Marine Fisheries Service -- Shrimp Landings Data (1993).

Historical as well as recent data indicate that shrimping has remained a high value industry in the Gulf. Annual brown and white shrimp catches valued at over $100 million can be expected in Texas and Louisiana. Brown and white shrimp are, therefore, the principal shellfish species of concern in this analysis of commercially important species.

Although the majority of the shrimp are found in the Gulf of Mexico, the primary locations of the crab and oyster fisheries are in the numerous bay systems that occur along the Gulf of Mexico. Of the bay systems, Galveston Bay is considered the most productive.[82] Numerous oyster reefs are located in Galveston Bay, and the annual oyster landings in this bay average over 2,574,000 pounds. Texas oyster fishery comprised ten to 15 percent of the U.S. total from 1983 through 1985. The oyster fishery in Iberia Parish, Louisiana (where Weeks Island is located) is much smaller, averaging 135,000 pounds in 1987. Crayfish also are commercially important species that occur in nearly all types of freshwater systems throughout the region.

For the purposes of the impacts analysis, brown and white shrimp will represent all shellfish. Seabobs and royal red shrimp species are extremely seasonal, therefore the catch is small. Seabobs have a low commercial value. The royal red is a higher value species, but populations available to the fishermen are scarce because their habitat is far offshore. Oyster and crab species inhabit estuaries or other inland waters and are not generally expected to be found in the area of the Gulf where the brine diffusers from SPR facilities would be located. However, the important commercial interest of oyster and crab species will be taken into consideration in pipeline routings..

Finfish

Over 100 individual species comprise the saltwater finfish in the Gulf. Of the approximately 50 major species of finfish taken commercially off the shores of Texas, Mississippi, and Louisiana, Gulf menhaden (hereafter referred to simply as menhaden) is the most important. NMFS data were examined to select a focus group of other commercially important species that are brought ashore in Louisiana, Mississippi, and Texas. Table 4.5-4 summarizes the combined landings data for Texas, Mississippi, and Louisiana from 1981 through 1989. Only the species for which landings consistently exceeded one million dollars in value are shown. As Table 4.5-4 shows, the number of species that contribute significantly (over one million dollars) to the economy of the finfishery has increased since 1981.

In evaluating the socioeconomic effects of the expansion of the SPR on commercial fishing in Chapter 7, only the species that are most important to the local fisheries economy are considered. Evaluation of landings data indicates that potential impacts on the shrimp and menhaden catches would cause the greatest socioeconomic impacts. Further, although the dollar value and poundage for the additional finfish species are relatively small in comparison to the shrimp and menhaden, they nevertheless contribute significantly as a group. The impact on these commercially important finfish, therefore, is also addressed.

4.5.6.2 Terrestrial Species

Hunting and trapping statistics compiled for Texas and Louisiana were obtained from the Texas Parks and Wildlife Department,[83] Louisiana Department of Wildlife and Fisheries,[84] and the Mississippi Department of Wildlife, Fisheries, and Parks.[85] Based on these statistics, the six most frequently taken furbearing mammals in Texas are raccoon, coyote, opossum, gray fox, skunk, and ringtail. In Louisiana, nutria, muskrat, raccoon, mink, opossum, and otter are the most frequently taken species, while in Mississippi, they are raccoon, beaver, opossum, muskrat, mink, and gray fox. The fur industry in both Texas, Louisiana, and Mississippi has experienced a drastic decline, particularly in the past few years. The industry in Louisiana and Texas has dropped from an eight million dollar annual industry in the years 1981 through 1987 to a one million dollar industry in 1988-1989. Although similar industry totals were not available for Mississippi, another statistic for this state -- the total number of trapping licenses sold -- is also reflective of a decline in the fur industry: in the 1982-83 season, 2,404 licenses were sold, whereas in the 1990-91 season, only 337 licenses were sold. This may be largely attributed to the decreasing demand for fur and a corresponding drop in pelt prices. For example, in the 1989-1990 season, one gray fox pelt in Texas brought only $4.95, compared to $10.00 in 1988-1989.[86]

Controlled alligator harvests constitute a ten million dollar industry in Louisiana.[87] In Texas, the species was listed as a Federal endangered species until 1983 when the population showed signs of recovery. Since then, controlled harvests have occurred in Texas as well. In Mississippi, the alligator was listed as a federal endangered species until 1987. Since then, the state of Mississippi has listed it as a game species, although due to its relative scarcity in the state there is no hunting season. There are reportedly seven alligator "ranches" in Mississippi, where young alligators are raised to adult size and sold. Prices for alligator hides are reportedly low because of their abundance in Louisiana.[88]

Recreationally important waterfowl species include mallard, green-winged teal, northern pintail, and lesser snow goose. Upland game birds such as the bobwhite and wild turkey also are hunted.

Table 4.5-4
Finfish Species With Over $1 Million in Landings

	Total Annual Value (Million Dollars) of Finfish Landings								
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988 ***	**1989 ***
Menhaden	$36.2	$56.3	$67.1	$60.1	$55.9	$53.5	$55.1	$57.0	$40.8
Red Snapper	$2.3	$2.8	$3.5	$4.4	$4.3	$4.8	$3.3	$6.0	$4.6
Spotted Seatrout	$1.0		$1.1			$1.4	$1.4	$1.5	$1.4
Black Drum		$1.0	$1.4			$1.7	$2.2	$2.9	$2.4
Red Drum			$1.1	$1.4	$2.0	$3.9	$4.5		
Yellowfin Tuna						$2.9	$10.8	$20.9	$21.8
Bluefin Tuna							$1.3	$4.0	$1.7
Vermillion Snapper							$1.2	$1.1	$1.0
Swordfish							$2.1	$2.2	$3.9

* The total dollar value for finfish landings in 1988 and 1989 for the states of Texas and Louisiana was summarized from NMFS data.

Source: The dollar value of landings for 1981 through 1987 was summarized from Offshore Texas and Louisiana Marine Ecosystems Data Synthesis, Vol II; Synthesis Report, U.S. DOI, Minerals management Service, Louisiana, Nov., 1988. Doc. No. 88-0067.

4.6 Natural and Scenic Resources

The Gulf Coast region is rich in natural and scenic resources, including coastal wetlands, timberland, and agricultural land. Ecologically important areas in the region have been preserved in wildlife refuges, State parks, wilderness areas, and recreation areas. These protected areas range in size from the eight-acre Shell Keys National Wildlife Refuge in Louisiana to the 84,500-acre Big Thicket Refuge in Texas. Many of these areas are wetlands, which are numerous throughout the region and especially in Louisiana. Wetlands improve water quality, reduce flood and storm damages, sustain important fish and wildlife habitat, provide shoreline erosion control, support hunting and fishing, and provide opportunities for other recreation activities and aesthetic appreciation. Coastal wetlands are especially important habitats for estuarine and marine fish and shellfish, various waterfowl, shorebirds, wading birds, and several mammals.

4.7 Archaeological, Historical, and Cultural Resources

The Gulf Coast Region is rich in archaeological sites; there are more than 700 known sites in coastal Louisiana alone. Prior to the enactment of the National Historic Preservation Act (NHPA), such sites received little protection and many were destroyed either by accident or purposely by amateur collectors. Under Federal and State archaeological programs, such sites must be preserved intact, except in such cases where human welfare would be improved as a result of some action (e.g., construction) that would alter a site. If an action is proposed, a search is conducted to determine whether any such sites potentially could be affected. Prior to potential disturbance of an identified site, an investigation of the site must be undertaken.

A number of historical sites in the SPR region are listed or proposed for listing on the National Register of Historic Places; several are listed on State registers and given protection by various State laws. These sites are detailed in Chapter 5.

4.8 Socioeconomic Characteristics

Four of the five SPR candidate sites, Big Hill, Stratton Ridge, Weeks Island, and Cote Blanche, are either existing Gulf Coast SPR facilities or located near existing SPR sites or major distribution facilities in the region. Either Big Hill or Stratton Ridge, would become part of the Seaway Complex. Expansion in the Capline Complex would occur by developing storage caverns at Weeks Island or Cote Blanche in Louisiana or by developing Richton in Mississippi. Although the potential economic impacts on these surrounding small communities could be substantial, impacts to the existing social infrastructure, including demographics, energy use, transportation systems, housing and public services, and emergency response capabilities, will be minimal.

4.8.1 Historical and Cultural Patterns

The cultural background of the Gulf Coast regions of Mississippi, Texas, and Louisiana is similar. Prior to French and Spanish settlement in the area, the Gulf Coast region was inhabited by different Native American tribes, primarily the Choctaw, the Karankawa, and the Atakapas Indians in what are the present-day coastal areas of Mississippi, Texas, and Louisiana, respectively. French and Spanish settlement of the Gulf Coast region began in the mid-to-late eighteenth century. Following the Louisiana Purchase in 1803, the Anglo-Americans began to establish settlements in the region. Further cultural and historical descriptions of each site are provided in Chapter 5 of the DEIS.

The discovery of oil in Calcasieu Parish, Louisiana, in 1886 and the drilling of the first oil well in 1901 at Spindletop, Texas, resulted in a rapid industrialization and a major population increase in the region. Today, as a result, the Gulf Coast region is well-known for its petrochemical production and refining industry. Although present day regional economies continue to diversify, the influence of the petrochemical industry remains evident throughout nearly all of the region, with the exception of the Mississippi site known primarily for its forestry.

4.8.2 Demographic Patterns

Over the past decade, the Texas, Louisiana, and Mississippi Gulf Coast regions have experienced similar demographic trends. The population of the region generally increased until about 1984. Following the economic downturn in the oil and gas industry in the mid-1980s, the Gulf Coast region experienced substantial unemployment and, as a result, population growth leveled off by the mid-1980s and decreased in 1987 and 1988. This was particularly true for the counties surrounding candidate SPR sites in Louisiana and Mississippi. Recently, the regional population and economy appears to have begun to grow again. The year 1990 suggests some growth over declines seen in the later 1980s. However, such an increase may reflect low statistical projections between the census years 1980 and 1990, and may not necessarily denote actual growth during 1990.

4.8.3 Energy Systems

The utility capabilities of the Gulf Coast region appear to be sufficient to satisfy the estimated energy demands of the five potential sites. Weeks Island, Cote Blanche, and Big Hill would be serviced by Gulf States utilities. Stratton Ridge would receive power from Houston Lighting and Power Company (HL&P), while Richton and the Pascagoula Terminal would be serviced by either Dixie Electric Power Association (Dixie EPA) or Mississippi Power Company. The St. James Terminal would receive power from Louisiana Power and Light. Potable and utility water would be supplied either by on-site wells, vendor suppliers, or local water systems. In the case of fire, utility water would be supplemented by various sources.

4.8.4 Transportation Systems

The Gulf Coast region is serviced by a diversified commercial and public transportation network. This network includes Federal, State, and county roads for vehicular traffic, and an extensive system of canals, bayous and rivers, including the ICW, that service commercial barge traffic to the many regional deepwater ports. Commercial airports are accessible to all the candidate sites, and several general aviation airports are also available to travelers in the region. Commercial freight moves along several rail lines and trucking routes, and public bus line service is available for passenger travel throughout the region.

4.8.5 Housing and Public Services

The social infrastructure for housing, medical, and educational facilities, are well established throughout the region. As a result of the economic downturn and regional out-migration in the mid-1980s, housing utilization in the Gulf Coast region is currently low. Throughout the region, since the mid-1980s, vacancy rates for non-rural properties ranged from between two and three percent to as high as 20 percent; vacancy rates for rental units in the region have been significantly higher than housing rates.

Although the candidate sites are in predominantly rural areas of the Gulf Coast region, they are reasonably close to urban centers and medical facilities. Further information about the proximity of the candidate sites to urban centers in the region is presented in Chapters 3 and 5. For the regions surrounding the candidate SPR sites, current ratios of residents to physicians, and residents to hospital beds are nearly equal to, or somewhat higher than, the Louisiana, Mississippi, and Texas state averages.

A substantial number of public, private, and vocational school systems (K-twelve) can be found in most major communities surrounding the SPR candidate sites. Educational opportunities for post-secondary education exist in the urban centers in the region. Several vocational high schools and post-secondary training centers are also located in the region, particularly in the Big Hill area.

4.8.6 Economic Activities

The manufacturing and service sectors dominate the regional economy in terms of industry earnings and workers per industry. The public sector is also a significant factor in the Gulf Coast regional economy. Mining is strong near the Louisiana sites, while forestry fuels the economy near the Mississippi site. A commercially important fishing industry exists in the Texas and Louisiana Gulf Coast region. Additional information regarding the economy of the areas surrounding the candidate sites is presented in Chapter 5.

4.8.7 Government Expenditures

During the past several years, the Federal government has spent a significantly larger amount of revenue in the Texas Gulf Coast region, than in either region in Louisiana or Mississippi. In Texas, the majority of the money spent was in Jefferson County, the county in which the Big Hill site is located. Local governments in communities around the region derive a majority of their revenues from a large and diverse tax base. The SPR candidate sites themselves represent only a small portion of the taxable property in the Gulf Coast region.

4.8.8 Public Concerns

Public scoping meetings were held in Texas and Louisiana to allow DOE to define the issues of the SPR expansion, as well as to identify the many different values and assumptions that exist among the public in potentially affected local communities. In addition, the meetings furnished concerned citizens, agencies, and industries with the opportunity to express their thoughts and concerns regarding SPR expansion directly. As was expected, both concern and support were expressed through written documents and verbal comments made at these meetings by a variety of individuals representing many different public and private interests.

The major public concerns raised at the meetings focused on the potential for loss of access to natural resources for future growth in competitive industries (primarily, mining petrochemical, and fishing) throughout the region. Another concern expressed at the public meetings was the potential for job loss that the SPR expansion might cause for competitive industries, as well as for support industries surrounding the candidate sites. There was also some concern that removing land from tax rules of the communities surrounding the sites would result in a decrease in revenues for the local school districts.

In addition, in response to concerns raised after the official scoping period, the Richton candidate was added to the assessment in this DEIS.

For a more detailed description of the scoping process, see Appendix A.

4.9 Ambient Noise

Ambient noise levels in the areas of the proposed sites are produced by diverse sound sources. In general, noise sources at or near the sites include salt mines, barge traffic on the ICW, human activity in population centers, and existing SPR site operations. Quantitative sound level values directly correlate with land use activity and/or population densities. For this reason, relatively accurate estimates of ambient noise levels can be made based on local land use activities. In Appendix H, the methods used for estimating ambient noise are discussed and correlated with general land use.

The current noise sources in the areas of all candidate sites are likely to produce sound levels ranging from 53 decibels (dBA) (comparable to a suburban area) to 68 dBA (comparable to a noisy urban area), based on EPA's method of estimating noise as a function of land use. Some rural areas, surrounding the proposed expansion sites, experience background sound levels of 45 to 55 dBA from insect and animal noise, wind noise, and traffic on rural roads.

4.10 Land Use and Water Use Plans, Policies, and Controls

Land use and water use plans, policies, and controls take the form of a number of statutes and regulations that may affect the proposed SPR sites. There are no municipal restrictions on any of the SPR sites because the sites are not within any city or town limits. However, there are restrictions on the county, state, and Federal level. The impact of these restrictions on the SPR program is not extensive but warrants analysis.

4.10.1 Federal Land Use and Water Use Laws and Regulations

There are a number of Federal statutes and regulations affecting land use that have bearing on the SPR expansion. However, these land use laws and regulations are linked to ecological resource issues and are examined in section 8.1.4 "Regulations Relating to Ecological Resources." Section 8.1.4 includes descriptions of: the Permits for Actions in Wetlands (the Clean Water Act section 404 wetlands program), the Executive Orders Regarding Wetlands and Floodplains (requiring Federal agencies to amend procedures to ensure consideration of flood risks and wetlands protection in decision making), the National Flood Insurance Program (dealing with the prevention of flood hazards), the Coastal Zone Management Act (protecting the nation's coastal zone), the Coastal Barrier Resources Act (restricting Federal expenditures that could encourage development in coastal barriers), the Endangered Species Act (protecting endangered or threatened wildlife and plants), the Farmland Protection Policy Act (requiring minimization of any impacts on prime farmland), and the Fish and Wildlife Coordination Act (restricting structural modification of a natural stream or body of water).

4.10.2 State Land Use and Water Use Laws and Regulations

The following sections describe the state laws and regulations governing land use and water use in each of the states where an SPR site has been proposed. Zoning issues have been included in the land use section.

4.10.2.1 Texas

The State of Texas has no limits on land use that would affect the SPR project. There are, however, limits on water use. In Texas, there is a permitting system and a priority appropriations system for water. The Texas State regulations are outlined below.

Land Use

The State of Texas has no land use or zoning statutes that would affect the proposed expansion of the SPR. Local Government section 211.003 of the Texas Statutes governs zoning regulations and grants the governing body of a municipality the ability to regulate building specifications, population density, and the location and use of buildings, other structures, and land, for business, industrial, residential, or other purposes. Although Texas law grants municipalities the authority to regulate, municipalities can only do so within their city limits. Their power does not extend to their extra-territorial limits. Therefore, because the proposed sites for SPR expansion are not within any city limits, municipal zoning ordinances will not affect the SPR project in Texas.

Water Use

The State of Texas regulates water use through a permitting system. In Texas, under the Texas Water Rights Statute section 11.021, the definition of state water is broadly construed and includes the water of every flowing river, natural stream, and lake, and of every bay or arm of the Gulf of Mexico. The right to the use of state water may be acquired by appropriation in accordance with Texas law. Texas law allows appropriation of water for certain listed uses as well as for "any other beneficial use." Texas has a constructive public policy regarding preferences between water uses. According to Texas Water Rights Statute section 11.024, preference in appropriating state water is given first to domestic and municipal uses, and second to industrial uses. Industrial uses are defined as processes designed to convert materials of a lower order of value into forms having greater useability and commercial value. It is likely that any water used for the SPR expansion would be classified as an industrial use.

Section 11.121 of the Texas Water Rights Statutes requires a permit to appropriate state water. This permit must be obtained from the commission before either appropriation or construction of any work designed for the taking of water. The commission will give preference to applications in the order declared in section 11.024 and to applications that will effectuate the maximum utilization of water and are calculated to prevent the escape of water without contribution to a beneficial public service.

Section 11.138 grants the commission the authority to issue temporary permits for beneficial uses to the extent that they do not interfere with or adversely affect prior appropriations or vested rights. No temporary permit issued without notice and hearing shall authorize more than ten acre feet of water, nor may be in a term in excess of one year. Even if there is notice and hearing, the commission may not issue a temporary permit for a period exceeding three calendar years. In times of water shortage, section 11.039 provides that water shall be divided among all customers pro rata.

4.10.2.2 Louisiana

Louisiana has state regulation concerning both land and water use. There are a few statutes that are related to the SPR project, but there are no statutes which would impede the SPR expansion.

Land Use

Louisiana has no land use statutes that would significantly affect the SPR project, however, a number of land use statutes are related to the Louisiana proposed sites. Section 33:1236(38) of the Louisiana Statutes grants Louisiana parish governing authorities the power to pass zoning ordinances, subdivision regulations, and building codes, and to provide standards and effective enforcement provisions for the prudent use and occupancy of flood-prone and mud-slide areas insofar as is necessary for a parish to use such powers and authority to qualify for the National Flood Insurance Act (NFIA) of 1968. Currently, Iberia, St. Mary, and St. James Parishes have no NFIA regulations which would affect the SPR sites.

The State of Louisiana also grants municipalities the ability to zone. Section 33:4721 provides that the governing authority of all municipalities may regulate and restrict the height, number of stories, and size of structures, the percentage of lot that may be occupied, the size of yards, courts, and other open spaces, the density of population, and the location and use of the buildings, structures, and land for trade, industry, residence, or other purposes. Section 33:4722 states that districts within municipalities can be granted the same power. Because none of the SPR sites are within municipal limits in Louisiana, this law would have no affect on any proposed SPR site in Louisiana.

According to section 3:1209, the Soil Conservation District has the authority to formulate regulations governing the use of lands within the district in the interest of conserving soil and soil resources and preventing and controlling soil erosion. This limited authority would not significantly affect the SPR project as it tends to be limited to tillage practices and seeding.

Two additional land use statutes are relevant. The first is section 38:2353 of the Louisiana Statutes that created the Atchafalaya Basin Division. The second is section 33:7551 that grants the authority to create environmental protection districts. Section 38:2353 of the Louisiana Statutes created, within the Louisiana Department of Public Works, the Atchafalaya Basin Division. The geographical area of the Atchafalaya Basin includes Cote Blanche, Weeks Island, and associated pipelines. The Atchafalaya Basin Division is a governmental organization designed to protect the basin. The division is authorized to acquire lands and donations to preserve the area. The division must also prepare a land and water use plan for the area and encourage orderly development of the area. Although the SPR sites may fall under the jurisdiction of the Atchafalaya Basin Division, the proposed SPR expansion is not unlike other development in the area. As a result, the Atchafalaya Basin Division will have little effect on the SPR expansion.

Section 33:7551 grants any parish divided by the Mississippi River with a population between 200,000 and 500,000 the authority to create an environmental protection district. St.

James Parish, the location of the St. James Terminal, is split by the Mississippi River, however, the population of St. James Parish is only 20,879. Therefore, St. James Parish would not qualify for an environmental protection district under this statute.

Water Use

Although Louisiana has a number of water pollution statutes it does not have any water use statutes that would affect the SPR project. Louisiana water control law is aimed primarily discharges into state waters and not withdrawal of state waters. These pollution control environmental statutes are addressed in section 8.1.1.2. Only one water use statute is relevant to the SPR project. Louisiana water use is governed by the Louisiana Water Resources Program. This program is designed to plan, develop, and manage Louisiana's Water Resources. Although under section 38:32 the program has no permitting power, it is authorized to maintain records of water users "by requiring diverters of water to provide data as to pump and pipe size used to divert waters, the area or location served, the period of time water is withdrawn, and the purpose for which the diversion is made." This recordkeeping, however, would have little impact on the SPR project.

4.10.2.3 Mississippi

Mississippi state law contains several land use and water use regulations. These are examined below.

Land Use

The State of Mississippi regulates land use through the vehicles of zoning and conservation legislation. Under Mississippi Code section 17-1-3, the governing authority of the county may regulate the height, the number of stories, and the size of any building or other structure, the percentage of the lot that may be occupied, the size of the yards, courts, and other open spaces, the density of population, and the location and use of buildings, structures and land for trade, industry, residence, or other purposes. Additionally, the governing power of the county has the authority to carve the county into zones to facilitate regulation and to encourage the most appropriate use of land. A zoning commission may develop and execute an official plan for bringing out development in accordance with present and future needs of the county. Violations of zoning ordinances are subject to a fine.

Under Mississippi soil conservation law, commissioners of soil conservation districts shall have the authority to regulate the use of lands within the district in the interest of conserving land and water. New regulation is subject to the process of public referendum; two-thirds of landowners, that hold two-thirds of the land in that district, must approve the referendum.

Water Use

Sections 51-3-1 through 51-3-55 encompass Mississippi water use legislation. Notwithstanding exceptions for purely residential use and small wells, any potential water user must apply for a permit from the Permit Board of Mississippi (the Board) to draw from a given source. The Board may permit consumption of water from a stream only in excess of the established minimum flow as computed or recorded by the Commission on Natural Resources of the State of Mississippi (the Commission). The Board may authorize any permittee to use the established minimum flow upon written assurance, supported by such data and reporting requirements that the Board deems appropriate that such water will be immediately returned to the stream in substantially the same amount to ensure the maintenance at all times of the established minimum flow. The Board may authorize a permittee to use the established minimum flow for industrial purposes when such water shall be returned to the stream at a point downstream from the place of withdrawal, where the Board shall find that such use will not result in any substantial detriment to property owners affected thereby or to the public interest. Permits extend for no longer than ten years, although they are reissued without contest unless the Board deems that harm to the public interest may be indicated by the continuation of the permitted usage.

Section 51-3-21 authorizes the creation of the state water management plan, that considers current and future water needs, uses, and resources to determine a long-range plan for optimal water use. Under this plan, the Commission may designate certain uses in connection with a particular source of supply that, because of the nature of the activity or the amount of water required, would constitute an undesirable use for that the Board would deny a permit. Under section 51-3-23, the Commission may require any permit holder to file reports as deemed "necessary and appropriate for proper water management," and those operations that require 20,000 gallons or more of water per day must report under this section.

4.10.3 County Land Use and Water Use Laws and Regulations

Although most of the counties where SPR sites and terminals have been proposed have no land use or water use ordinances, a examination of county level law completes the regulatory framework. Individual sections have been divided by state and county. Land use, zoning, and water use issues have been grouped together.

4.10.3.1 Texas

In the State of Texas, counties have no inherent ordinance-making power. The counties can only pass ordinances when the State legislature has passed enabling legislation. This power has been granted only in limited instances. Currently, counties in Texas have no authority to regulate land use, zoning, or water use. There is county authority to regulate construction in the floodplain. This authority has been granted by the National Flood Insurance Program. That program is explained fully in section 8.1.1.4.

4.10.3.2 Louisiana

The parishes in Louisiana have no land use or water use restrictions which would affect the SPR program. However, each of the Louisiana parishes do have individual pipeline ordinances, as discussed below.

Iberia Parish

There are no land use or zoning restrictions in the unincorporated areas of Iberia Parish that would affect the SPR expansion. Although there are some county ordinances, including ordinances dealing with toxic waste and pipelines, no ordinances deal with land use or water use issues. The construction of pipelines in Iberia Parish is governed by Article II of the Iberia Parish Government Code, sections 20-17 to 20-23. It is necessary to obtain a permit from the Parish police jury before digging or excavating on or under any parish street or road, and the permittee has the duty to repair the street or road, restoring it to its prior condition. A permit and deposit of $10,000 for each road, street, alley, or drainage channel is required whenever it is necessary to cut, break, or do work within the ROW of the public streets, roads, highways or public drainage channels under the jurisdiction of the policy jury. The deposit will be refunded when the repair work has been approved by the police jury. The Code also governs depth of crossings and other technical construction information, as well as penalties for violators of the code.

St. Mary Parish

In St. Mary Parish there are no parish zoning ordinances or other land use regulations that would affect the SPR program. The parish also has no restrictions regulating water use. However, Parish Ordinance Number 643 governs the construction of pipelines in St. Mary Parish. In order to construct a pipeline, it is necessary to obtain a written permit from the parish through the parish engineer, who has the right to clear any ambiguities and correct any mistakes in the construction plans and specifications. The ordinance also includes a deposit and fee schedule based on the length of the line. For example, the deposit for the first complete mile of pipeline is $55.00 and $100.00 for each additional mile; the inspection fee is 20 percent of the deposit. In addition, for every ROW the pipeline crosses, the builder must pay $20.00 per inch of diameter of the line. The ordinance contains construction specifications as well; however, a permit is required to build a pipeline.

St. James Parish

There are no parish government land use or water use restrictions in St. James Parish. There is, however, parish legislation that governs the building of pipelines, canals, and other structures. Ordinance number 79-1, as amended, requires the builder to obtain a permit before beginning construction. Applications for permits are made by writing to the parish council, describing the facility and its purpose, specifications, location, and map of the location. The builder is required to pay a deposit of $1,000 for every parish road, canal, drainage ditch or bayou that the facility will cross. There is a fee for submitting an application ($300), and the applicant will receive permission or denial within 30 days of the application's receipt. The ordinance deals with building specifications, inspection, and certification of construction projects, with a section that requires that the work will done in a manner that does not interfere (except on a temporary basis) with the normal tidal flow in any marsh area.

4.10.3.3 Mississippi

Under Mississippi Code section 17-1-3, the governing authority of the county may regulate land use and the governing power of the county has the authority to carve the county into zones to facilitate regulation and to encourage the most appropriate use of land.

Perry County

Perry County has not exercised its power under Mississippi Code Section 17-1-3. Perry County has no zoning ordinances or other land use regulations that would affect the SPR program, nor does the county have restrictions that regulate water use.

Jackson County

Under some proposed Richton options, a terminal would be located within the unincorporated limits of Jackson County. The proposed site for the terminal is in an area zoned for heavy industrial use. Construction of the terminal would be consistent with this zoning regulation.

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5.0 DESCRIPTION OF SITE-SPECIFIC AFFECTED ENVIRONMENT

The site-specific environmental information needed to assess the impacts associated with the expansion of the SPR to one billion barrels is provided in this chapter. Detailed information is provided for the five candidate expansion sites (Big Hill and Stratton Ridge in the Seaway Complex, and Weeks Island, Cote Blanche, and Richton in the Capline Complex) and for the St. James Terminal (a distribution alternative enhancement which, although not required for the 270-day drawdown criterion, would be needed in the Capline Complex under a 180 day criterion). The purpose of this chapter is to provide environmental, natural resource, and socioeconomic information about the proposed sites, and provide baseline technical data needed for assessing potential impacts (see Chapter 7) and for making comparisons among the sites (see section 7.8).

5.1 Big Hill (Seaway Complex Site)

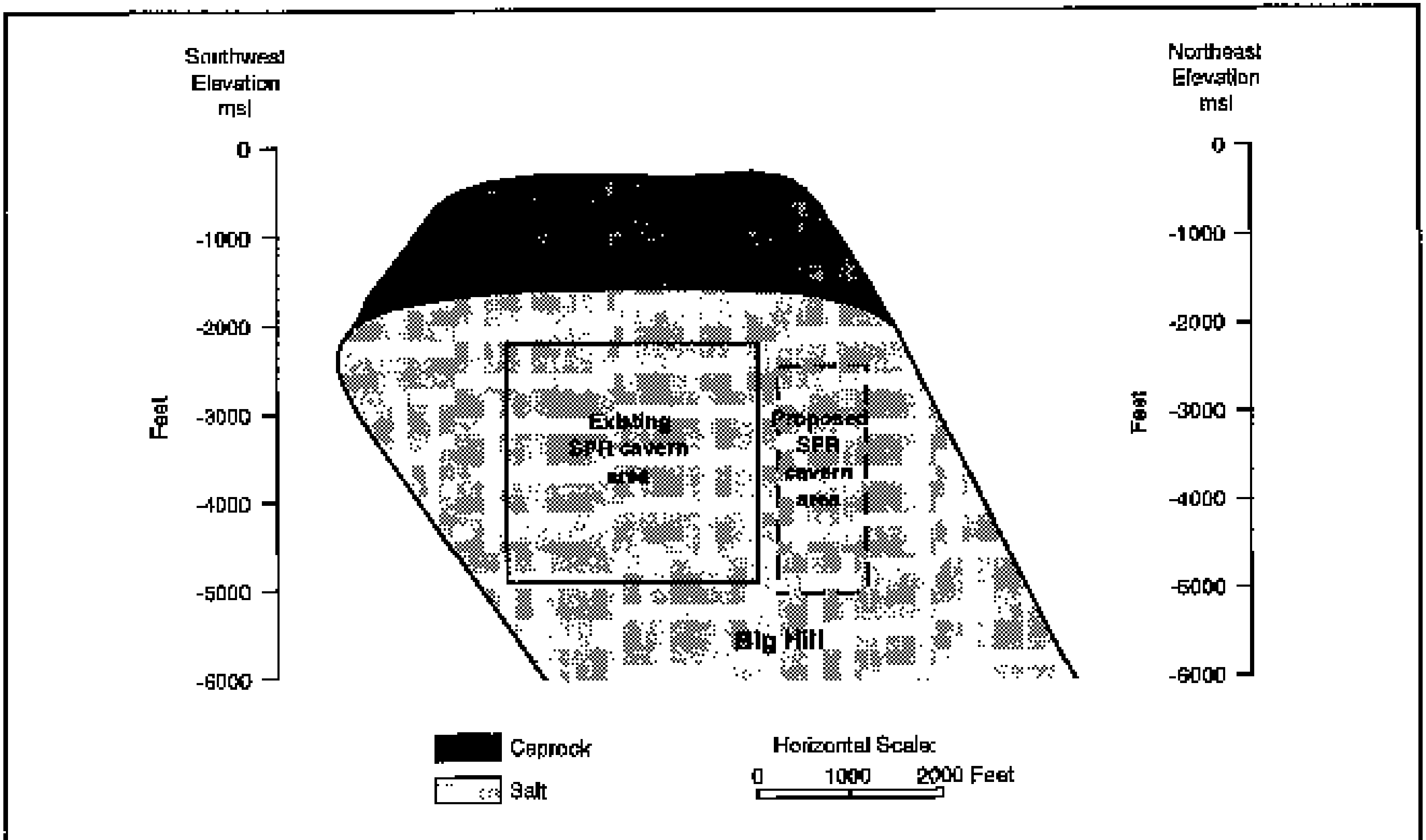
The Big Hill salt dome is one of two alternative sites proposed for expansion in the Seaway Complex. Under the 270-day drawdown criterion, DOE would increase storage capacity by constructing up to nine additional caverns in an area north of the existing facility with no distribution enhancements. To satisfy distribution requirements under a 180-day criterion, DOE would construct a pipeline from Big Hill to the East Houston Refining Complex area.

5.1.1 Geology

The proposed Big Hill expansion site is located in Jefferson County, Texas, approximately 17 miles southwest of Port Arthur, nine miles inland from the Gulf of Mexico, and 70 miles east of Houston.[1] Surrounding the Big Hill salt dome is a plain of fluvial and deltaic origin, with an average elevation of approximately three miles above msl. Within one mile of the dome on the south side is the northern boundary of a fresh to intermediate marsh that grades into brackish and saline marsh as it nears the Gulf Coast.[2]

A cross-section of the Big Hill salt dome is provided as Figure 5.1-1. Beaumont clay and Lafayette gravel in particular have been identified as major sediments overlying the dome.[3] These deposits, as well as other sands and clays, have been unevenly deposited by meandering rivers in local floodplains and deltas.[4] Sediments of Pliocene, Miocene, and Oligocene age surround the dome, extending to depths exceeding 3,000 meters.[5] More shallow sediments form Hockley, Crowley, and Morey silty loam soils at the surface. The layer of Hockley silty loam, a prime farmland soil that is rare in Jefferson County, ranges in thickness from 35 to 76 centimeters in the area overlying the dome. This soil type holds moderate amounts of moisture for plant use and readily absorbs water. Soil in the upper layer of the Crowley silty loam, the soil type found along the eastern flank of the dome, has a granular structure well suited to retaining moisture, but becomes relatively compacted further below. The Morey silty loam, which is a tight soil with a low permeability, is found on the western half of the salt dome and in much of the coast prairie portion of the surrounding county. The topography of the surface covering the Morey soils is characterized by low, sandy, circular mounds six to 15 meters in diameter and 0.3 to one meter in height. The surface soil of these mounds is a gray, fine sandy loam, and the subsoil is a heavier, blocky clay. In certain places, soils at the base of the mounds are high in soluble salt, and, in cases where the surface layer is smoothed and this salt is exposed, vegetation will not grow, creating surface features called "slick spots."[6]

Figure 5.1-1
Cross-Section of Big Hill Salt Dome



Note: Cavern locations and depths are diagrammatic and only convey approximations.

Source: U.S. Department of Energy, Preliminary Site Geological Characterization for Strategic Petroleum Reserve (SPR) Expansion Candidates, Volume II, Sandia National Laboratories, Albuquerque, NM, March 1981.

The Big Hill salt dome is a moderately elliptical piercement dome, with a nearly circular horizontal cross section, irregular top, and steep sides. It is approximately one and a quarter miles (north to south) by one mile (east to west). The salt dome is covered by a roughly circular surface mound that rises to a maximum elevation of about eleven meters above msl, and forms a significant topographic feature in the local area.[7] The dome has three prominent overhangs, including one minor overhang on the western flank and major salt overhangs on both the southern and eastern flanks.[8] The shallowest known salt is found on the west perimeter of the dome at approximately 530 meters below sea level. The deepest salt yet encountered at the site is on the south flank of the dome at 1,751 meters. It is estimated that there are 415 contiguous acres within the -600 meter contour and extending to -1,500 meters that are potentially suitable for the development of crude oil storage caverns. The existing cavern depth interval of 670 to 1,280 meters could be used for additional cavern development. The total potential storage volume is 270 MMB.[9]

The top of the caprock lies at a depth of approximately 100 meters below the surface and covers the majority of the salt mass. The thickness of the caprock varies between 260 and 410 meters, making it one of the thickest in the Gulf Coast region.[10] The caprock is composed of a porous sandstone that overlies dolomitic limestone, gypsum, and anhydrite.[11] The caprock is vugular and previous SPR drilling encountered several zones of lost circulation.[12] Hydrogen sulfide in the groundwater and sands above the caprock was also identified during the previous SPR drilling, but knowledge that these two conditions exist should circumvent any major difficulty in the future.[13] Because of the upward pressure exerted by the rising salt, the caprock is severely fractured and faulted. One major surface fault has resulted in 30 meters of displaced caprock and likely extends into the dome. Otherwise, the fault patterns encountered in the Big Hill caprock and in the areas flanking the dome are characteristic of the fault patterns of domes where extensive drilling has taken place. This pattern generally reflects radial faulting with subsidiary concentric, normal faults between the radial faults.[14] DOE is conducting seismic surveys to further delineate the salt dome.

There is a large overhang on the south flank of the salt dome which will limit cavern storage, as well as a poorly defined overhang on the west flank, near the intersection of a master fault mapped in the surrounding oil field. The overhang may limit the use of the west side of the Sabine Pass Terminal property and will be investigated further if the Big Hill site is selected.[15]

As with the creation of any subsurface cavern, some surface subsidence has occurred over the Big Hill caverns.

5.1.2 Hydrogeology

At the proposed Big Hill expansion site, the groundwater surface varies from a depth of approximately two meters bls at the center of the hill, at an altitude of eleven meters above msl, to almost ground level near the base of the hill (eight meters above msl).[16] The freshwater base of the upper unit of the Chicot aquifer, which normally sits at approximately 370 meters bls, has been uplifted to as high as 30 meters bls directly above the salt dome. Slightly saline groundwater exists in the lower unit of the Chicot at a depth of 90 meters.[17] The interface of the Upper Chicot and Lower Chicot is virtually unconfined at the site. Both the semi-confined Evangeline and the totally confined Jasper are pierced by the salt dome. Both aquifers are too deep and too saline to be used as a water supply or affected by surface operations. Thus, the remaining discussion focuses primarily upon the Chicot, where uses and impacts are of much greater interest (see Table 5.1-1).

Table 5.1-1
Characterization of Aquifers Underlying the Big Hill Site

Aquifer	Depth to Top of Aquifer (meters bls)[a]	Overlying Soils/ Permeability (cm/sec)	Karst	Degree of Salinity[b]	Major Uses
Upper Chicot	-2	Porous; west and south surface edges less porous, 1×10^{-2}	None	Mostly Freshwater	Industry/ Livestock
Lower Chicot	-90	Intermittent clay bed, 1×10^{-6} to 1×10^{-4}; sands 1×10^{-2}	None	Slightly saline	Industry/ Livestock
Evangeline	Away from dome, -460	Discontinuous thick clay bed, 1×10^{-6} to 1×10^{-4}	None	Mod. Saline to Brine	None
Jasper	Away from dome, >-600	Burkeville Aquiclude, highly impermeable	None	Mod. Saline to Brine	None

[a] Below Land Surface.
[b] Salinity determined by dissolved solids content, in parts per thousand (ppt): Freshwater, Less than 1 ppt; Slightly saline, 1-3 ppt; Moderately saline, 3-10 ppt; Very saline, 10-35 ppt; Brine, More than 35 ppt.

Sources: Bartic Memorandum, 1991; Geological Site Characterization, 1981; Groundwater Resources, Brazoria County, 1982; Groundwater Resources, Chambers and Jefferson Counties, 1973; *Engineering Aspects of Karst*, USGS Water Supply Paper 2220.

The flow of groundwater in the Lower Chicot at Big Hill is largely influenced by withdrawal at Baytown (40 miles west of Big Hill) and Beaumont-Port Arthur (22 miles northeast), creating an overall east-southeast directional flow from the original southeasterly flow.[18] There also exists a more localized cone of depression in the Upper Chicot sloping toward a focus of withdrawal at Winnie to the northwest.

Well use in the immediate area appears to be limited to industrial uses by oil companies in adjacent oil fields, livestock use at nearby ranches, and rice cultivation on the tight soils away from the dome. Neither the USGS nor the Texas Water Development Board has conducted a field inventory of wells in the Big Hill vicinity in 20 years. The last sampling data from the Board and the USGS indicate one industrial well, two livestock wells, and two unused wells within a two-mile radius of the site.[19,20,21] There is one shallow drinking water well just one mile from the site's northeast boundary, which probably is not deep enough to tap the Upper Chicot, instead probably tapping a perched water-bearing unit.[22] According to the Environmental Protection Agency's (EPA's) Federal Reporting Data System, which includes data on the locations of community water systems across the country, there are no municipal wells within five miles downgradient of the Big Hill site.[23] Considering that the land surrounding the site is swampy and contains many oil fields, extensive development of groundwater resources in the near future appears unlikely.

The regional characterization of groundwater resources presented in section 4.2.1 covers the course of the water intake and brine discharge pipelines, which run south from Big Hill to the ICW and the Gulf of Mexico, respectively.[24] This stretch overlies marshy terrain with the same hydrologic characteristics described for the Big Hill site, including an identical descending order of hydrologic units and varied soil types. The land surface elevation drops slowly toward the Gulf of Mexico, and the groundwater depths roughly follow the surface topography.[25] The pipelines pass nearby Spindletop Ditch, with an adjacent parcel of agricultural land. There is little population or established use of groundwater in the area between Big Hill and the ICW/Gulf of Mexico region. There are no towns or major withdrawal centers along the pipelines' path toward the Gulf of Mexico.

The regional characterization of groundwater resources presented in section 4.2.1 also covers the course of both of the alternate oil distribution pipeline routes (i.e., the Trinity Bay and I-10 routes from Big Hill to East Houston) considered under a 180-day drawdown criterion. The pipelines run through Jefferson and Chambers counties to Harris County, which all feature the same aquifer systems described above.[26] The pipeline routes cross close to some population centers, including the towns of Anahuac, Baytown, Deer Park, Galena Park, and Jacinto City. Many uses of groundwater resources exist within a few miles on either side of the proposed routes, as evidenced by the cone of depression in the Chicot aquifer near Baytown.[27]

5.1.3 Surface Water Environment

This section summarizes the baseline conditions of major surface waters in the vicinity of the proposed Big Hill expansion site and pipeline routes. It addresses: (1) the Gulf of Mexico in the area of Big Hill's brine disposal pipeline and diffuser; (2) the ICW around the site's raw water intake structure; and (3) inland water bodies (e.g., lakes and rivers) surrounding the proposed expansion site and crossed by pipeline routes.

5.1.3.1 Gulf of Mexico

Figure 3.1-2 shows the location of the existing brine disposal pipeline and diffuser at Big Hill. As shown, the pipeline route passes offshore in a southerly direction to the diffuser located approximately three miles offshore (29°34'N and 94°12'W). This existing pipeline and diffuser system would be used to dispose of the additional quantities of brine that would be generated if Big Hill is selected as one of the SPR expansion sites.

The Big Hill pipeline route and diffuser site were extensively studied as part of the comprehensive Texoma Complex Final Environmental Impact State (FEIS) baseline physical, geochemical, and biological monitoring effort conducted from September 1977 through October 1978. Detailed discussions of the Big Hill offshore environment are presented in section B.3.4.5.2 and Appendix Q of the Texoma Complex FEIS,[28] and section 3.2.1.5 of the Phase III EIS.[29] Based on the post-disposal monitoring studies of the Bryan Mound and West Hackberry brine diffuser sites completed between 1981 and 1985, no significant physical or chemical changes to the offshore environment are expected to have occurred since the baseline monitoring study. Appendix I provides a summary of those studies at Bryan Mound and West Hackberry, including results from environmental monitoring stations within the brine plumes and at control stations.

In general, the Gulf floor in the area of the Big Hill brine diffuser is smooth, featureless, and gently sloping. Bottom sediments are variable, ranging from fine sand and silt nearshore to soft mud farther offshore, but primarily consist of a hard sand in the immediate vicinity of the diffuser. Salinity, currents, nutrient levels and oxygen demand, and to a lesser extent, water temperatures in this area of the Texas coast are subject to wide variations, mainly due to influences from the Mississippi River system. Salinity fronts associated with freshwater outflows from the Mississippi River have been observed washing back and forth across the diffuser site with the tides. Currents in the area, including surface and bottom currents, are primarily wind-driven. The predominant current direction is toward the west and southwest, although currents can change direction rapidly and go in any direction depending on the way the wind is blowing. Extremely strong currents are associated with tropical storms and periods of stagnation occur during calm meteorological conditions. In the spring, generally low winds and high nutrient loadings from the Mississippi, Atchafalaya, and other rivers can combine to create periods of stagnation and oxygen-starved conditions (hypoxia). Strong fronts coming from the north ("winter blue northers") during the period from November to late February or early March can cause immediate and dramatic effects in water temperature. For example, temperatures have been observed to decrease by 30° to 40°F in one hour with the passing of one of these fronts. The biological community off the Texas coast in the vicinity of Big Hill has acclimated to these wide variations in environmental conditions.

With respect to new oil and gas activities since the original baseline characterization, NOAA nautical chart 11332 for Sabine Bank indicates that submerged oil and gas pipelines do not infringe on the Big Hill diffuser site. Three oil platforms are located approximately two, four, and five miles north of the diffuser site. This nautical chart, however, does not contain a complete inventory of oil and gas activities in the Gulf, and other oil pipelines and platforms may exist in the general vicinity.

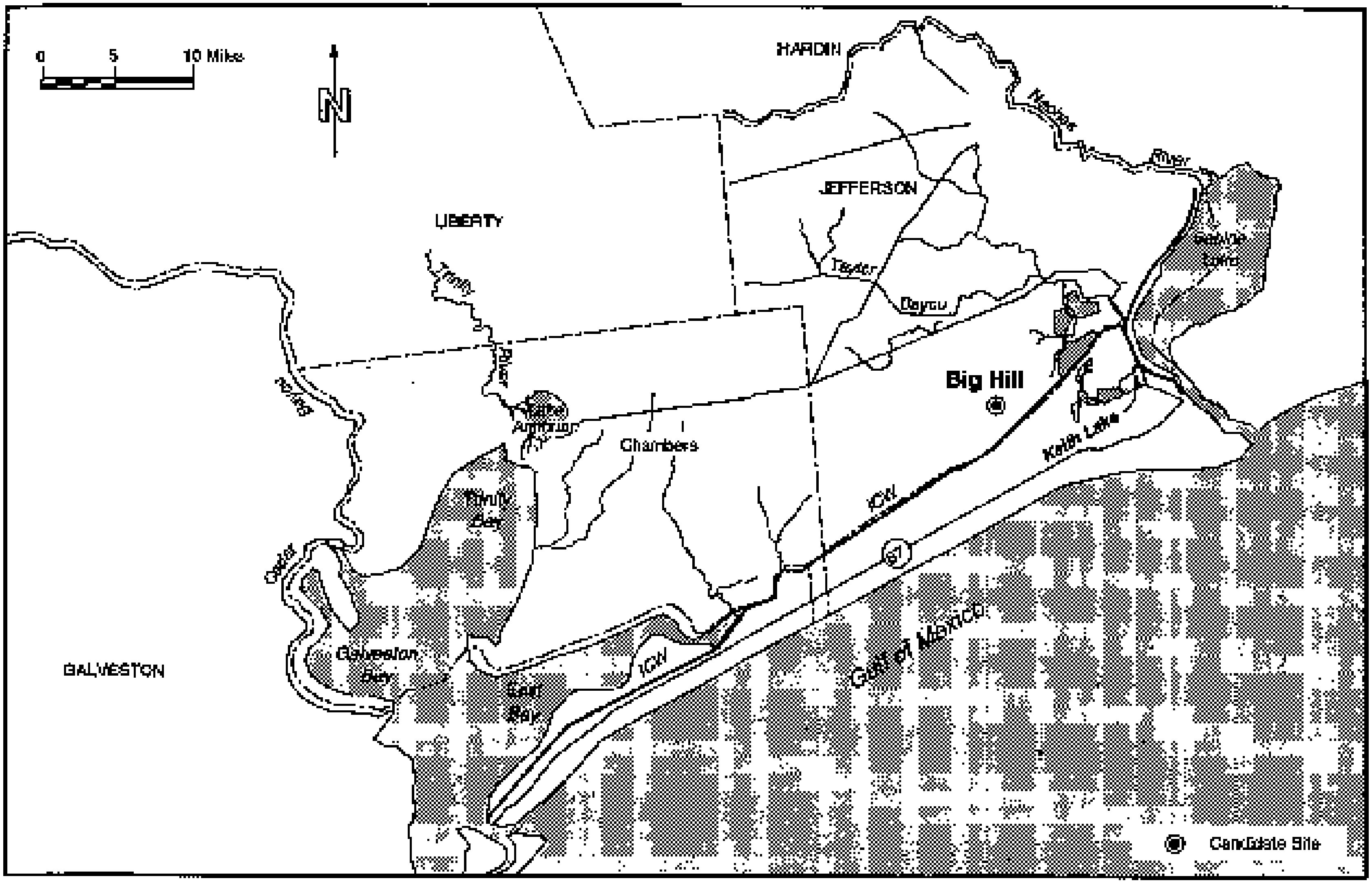
5.1.3.2 Intracoastal Waterway

Raw water required for cavern leaching and drawdown activities at the proposed Big Hill expansion site would be taken from the ICW, located about five miles south of the present SPR site. The ICW is the primary man-made water body in the region near Big Hill. The portion of the ICW in the vicinity of the Big Hill site lies less than four miles north of the Gulf of Mexico and runs parallel to the coastline. The waterway channel is approximately 250 feet wide with a controlled depth of twelve feet, limiting its use to barges and small boats. From the proposed site, the ICW extends northeastward to Sabine Lake and westward to East Galveston Bay (see Figure 5.1-2).

The existing RWI structure is located at an abandoned barge slip approximately one mile east of Spindletop ditch at 29°41'N and 94°11'W (see Figure 3.1-2). This man-made ditch joins the ICW approximately six miles southeast of the present SPR site.[30] Salt Bayou is the closest tributary to the RWI structure, located approximately 0.7 miles to the east.

Figure 5.1-2

Generalized Map of Intracoastal Waterway in the Big Hill Area



Source: Texas Water Commission. The State of Texas Water Quality Inventory. 10th Edition, 1990.

The ICW crosses through the region from Galveston Bay, through Chambers County and the southern part of Jefferson County to Sabine Lake, covering a distance of approximately 36 miles. Various water bodies, including North Prong Mud Bayou, Mud Bayou, Barnes Slough, Salt Bayou, and Star Lake, meet with the ICW to the west of the RWI. To the east, Shell Lake meets with the ICW before it converges with the Port Arthur Canal near the mouth of the Taylor Bayou. After converging with the Port Arthur Canal, the ICW runs north and south along the western shore of Sabine Lake. Running south, the ICW flows through the Sabine-Neches Canal and then converges with the Sabine Ship Channel and continues through Sabine Pass to the Gulf of Mexico. Running north, the ICW flows through the Port Arthur Canal and continues northeast along the Sabine River toward the city of Orange. This portion of the ICW is considered a part of the Sabine hydrological basin.[31]

Prevailing southwesterly winds generally cause water in the ICW to flow from the west to the east.[32] Frequently, however, large freshwater inflows into Sabine Lake from the Sabine and Neches Rivers will cause the lake's water level to rise and cause water in this stretch of the ICW to flow in the opposite direction toward Galveston Bay.[33] Flow in this section of the waterway may reverse as often as twice in one day.[34] Water generally flows at a rate of nearly 4,000 cubic feet per second (ft^3/sec) with a maximum velocity of 1.3 feet per second (ft/sec).[35] While tidal influences in the ICW are generally small (around one foot), the average tidal range in Sabine Basin is nearly four feet.

On average, an estimated 80 percent of the freshwater moving down the Sabine and Neches Rivers entering the upper Sabine Lake area bypasses Sabine Lake by travelling down the Sabine-Neches Canal toward the Gulf of Mexico as a freshwater layer on top of the denser saline waters in the bottom of the channel.[36] It appears that much of the time a portion of this freshwater flows toward East Galveston Bay through the ICW.

According to the Texas State Water Quality Standards, the waterway is intended for noncontact recreation and the propagation of fish and wildlife.[37] The ICW is considered to be brackish and of low salinity.[38] Salinity varies from one to ten ppt depending on the relative inflow from the Sabine-Neches Canal, fresh/intermediate lateral inflow from wetlands and water bodies intersecting the waterway, and saltwater inflow from East Galveston Bay.[39] Sections of the ship channel, the ICW, and the Neches and Sabine Rivers are seriously contaminated, especially with high organic loads, coliform bacteria, and organic toxins. Much of the industrial pollution from the developed areas appears to bypass Sabine Lake by flowing through the ship channel and the ICW.[40]

Tables 5.1-2 and 5.1-3 summarize key characteristics of the water bodies emptying into and flowing out of the ICW. The tables include information on the distance of each water body from the proposed site (measured from the RWI structure), as well as measurements of the width, depth, and flow rate of each water body. The flows of many of the water bodies are controlled for irrigation and one, Big Hill Bayou, is in a wildlife management area. With the exception of the brackish Salt Bayou, most of the water bodies emptying into the ICW are primarily fresh. Conversely, most of the water bodies into which the ICW discharges are brackish. The majority of the water bodies are used for rice field irrigation or commercial traffic.

Table 5.1-2
Characteristics of Surface Water Bodies Emptying Into the Intracoastal Waterway in the Vicinity of the Big Hill Raw Water Intake

Surface Water System	Distance from KWI (miles)	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses[a]
East Bay Bayou	14.3	180	5	174 (104 - 259)	No downstream public intake	None	Fresh, Brackish	Rice field irrigation water
North Prong Mud Bayou	11.5	40	4	Controlled for Irrigation	No downstream public intake	None	Fresh, Brackish	Rice field irrigation water
Barnes Slough	8.7	70	4	Controlled for Irrigation	No downstream public intake	None	Fresh, Brackish	Rice field irrigation water
Unnamed Irrig. Outflow #1	7.5	30	3	Controlled for Irrigation	No downstream public intake	None	Fresh, Brackish	Rice field irrigation water
Unnamed Irrig. Outflow #2	5.9	60	3	Controlled for Irrigation	No downstream public intake	None	Fresh, Brackish	Rice field irrigation water
Spindletop Ditch	1.1	160	6	Controlled for Irrigation	No downstream public intake	None	Fresh, Brackish	Rice field irrigation water
Salt Bayou	0.7	500	4	58.2 (34.8 - 96.6)	No downstream public intake	None	Brackish	No known uses
Unnamed Swamp Drain	--	10	3	Seasonal	No downstream public intake	None	Fresh	No known uses
Big Hill Bayou	15.5	100	6	Controlled for Wildlife Management Area	No downstream public intake	None	Fresh	Wildlife Management Area
Taylor Bayou	17.4	200	12	763 (456 - 1,270)	No downstream public intake	None	Fresh	Commercial Traffic

[a] Although not explicitly designated, many of these water bodies also may be used for recreation (e.g., boating and fishing).

Table 5.1-3
Characteristics of Surface Water Bodies Fed by the Intracoastal Waterway in the Vicinity of the Big Hill Raw Water Intake

Surface Water System	Distance from RWI (miles)	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses[a]
Sabine Lake	16.3	31,000	8	16,730 (4,520 - 29,900)	16.3	300	Brackish	Commercial Traffic; Contact Recreation
Port Arthur Canal	17.7	600	20	Tidal	7.7	300	Brackish	Commercial Traffic
Salt Bayou	0.7	75	6	58.2 (34.8 - 96.6)	No downstream public intake	None	Brackish	No known uses
Mud Bayou	11.5	80	5	Tidal	No downstream public intake	None	Brackish	No known uses
East Bay Bayou	14.3	180	5	174 (104 - 289)	No downstream public intake	None	Brackish	No known uses

[a] Although not explicitly designated, these waters also may be used for recreation (e.g., boating and fishing).

5.1.3.3 Inland Water Bodies

For the purpose of this baseline characterization, inland water bodies that would be potentially affected by the Big Hill expansion have been organized into: (1) water bodies within a five-mile radius of the proposed expansion site itself; and (2) water bodies crossed by crude oil, raw water, and brine discharge pipelines.

Water Bodies Within Five Miles of the Proposed Site

Big Hill salt dome lies in the Chenier Plain of Texas,[41] in the Neches-Trinity Coastal Basin. Because the site is located on the most elevated land in the region, approximately eleven meters above msl, it influences local stormwater runoff and surface water flow patterns. Water from the site generally drains to the south and east. Between 1951 and 1988, an average of 53 inches of rain fell annually at Port Arthur, Texas, roughly 17 miles northeast of the dome.[42] The site itself is dry, with the exception of two ponds, ten to 20 acres in size, located on the north and east edges of the dome. Within five miles of the site, however, there are a number of significant water bodies, including Little Lake, Mayhaw Bayou, Salt Bayou, Spindletop Ditch, Willie Slough Gully, and Willow Slough (see Figure 5.1-3). Key characteristics of each of these water bodies are summarized in Table 5.1-4.

In general, the water bodies in the vicinity of the proposed expansion site are freshwater systems used for irrigation of surrounding rice fields. Some of these waters, however, may become brackish for part of the year, depending on meteorological conditions and the degree of human control (e.g., irrigation use, navigational locks, etc.). Only one public intake exists downstream (on the Sabine River) from the Big Hill site, and this intake is almost 20 miles away. This intake serves a population of 300. Willow Slough is the closest water body to the proposed expansion (slightly less than two miles away).

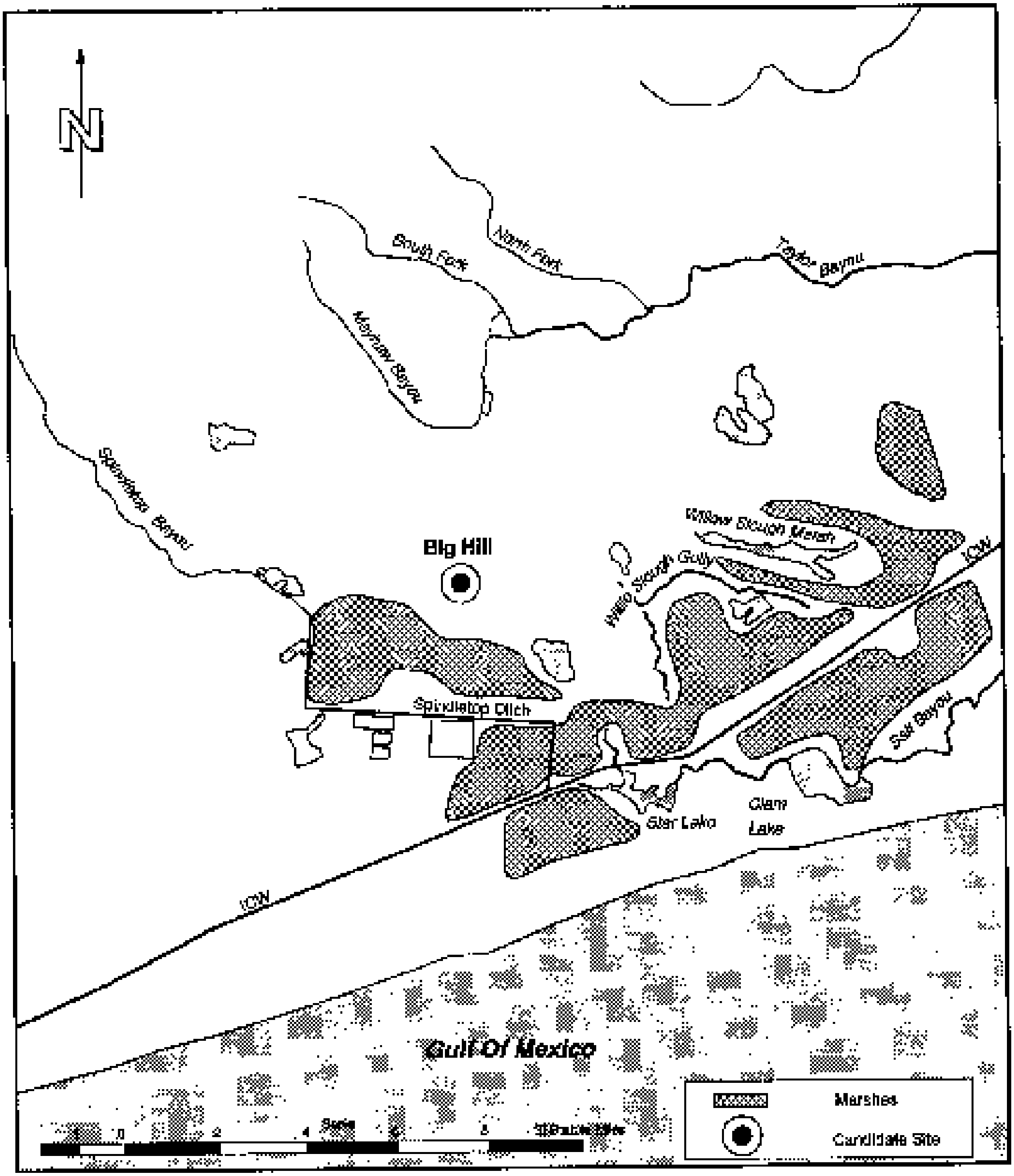
Pipeline Crossings

Because the existing Big Hill raw water and brine disposal pipelines would be used for an expansion site, the only new pipelines assessed are crude oil pipelines. Under the 270-day drawdown criterion, no new crude oil pipelines would be required; under a 180-day drawdown criterion, either the Trinity Bay or the I-10 pipeline route would be constructed.

Trinity Bay Crude Oil Pipeline. One proposed crude oil pipeline ROW would stretch roughly 58 miles from Big Hill salt dome, nearly due west, to the Houston Ship Channel near Deer Park, Texas. Along this route, the pipeline would cross 19 water bodies, each of which is characterized in Table 5.1-5. Particularly significant water bodies crossed include: Trinity Bay, San Jacinto Bay, Tabbs Bay, Spindletop Bayou, Elm Bayou, East Bay Bayou, East Fork Bayou, East Fork Double Bayou, and West Fork Double Bayou.

This crude oil pipeline route would cross the southern portion of Trinity Bay, entering the bay just south of Anahuac Channel and traveling nearly due west. The uses designated for Trinity Bay by the Texas Water Commission are contact recreation, high quality aquatic habitat, and shellfish waters. Several areas in Trinity Bay that support bottom vegetation, typically in nearshore environments, are particularly important habitats that serve as nursery areas for fish and crustaceans (see section 5.1.5.2 for further ecological characterization of the Trinity Bay system). At times, a portion of the bay has been closed to oyster harvesting due to high levels of

Figure 5.1-3
Water Bodies Within Five Miles of the Proposed Big Hill Expansion Site



Source: Department of Energy Phase III Environmental Impact Statement

Table 5.1-4
Surface Water Bodies Within Five Miles of the Proposed Big Hill Expansion Site

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Little Lake	2.6	Shell Lake, Keith Lake, Salt Bayou, ICW, Star Lake	250 x 1800	5	None	No downstream public intake	None	Fresh	No known uses
Mayhaw Bayou	3.6	South Fork Taylor Bayou, Taylor Bayou, Sabine River	30	3	56.1 (33.5-93.1)	19.5 (on Sabine River)	300	Fresh	Rice field irrigation
Salt Bayou	3.4	Little Lake, Shell Lake, Star Lake, Clam Lake, Keith Lake	120	4	58.2 (34.8-96.6)	No downstream public intake	None	Brackish	No known uses
Spindletop Ditch	3.6	ICW	150	6	Negligible Natural Flow	No downstream public intake	None	Brackish	Rice field irrigation
Willis Slough Gully	4.3	None	400 x 4,000	5	None	No downstream public intake	None	Fresh	Rice field irrigation
Willow Slough	1.7	ICW	10	9	144 (85.6-238)	No downstream public intake	None	Fresh	Rice field irrigation

fecal coliform. Dissolved oxygen also has become supersaturated and total and ortho-phosphorus levels are frequently elevated.[43]

Another important feature of Trinity Bay is the large amount of oil and gas development that it supports. Figure 5.1-4 shows the location of past and present oil and gas wells, areas leased for mineral production, and major oil and gas pipelines in the Galveston Bay system. In addition to the major pipelines shown in this figure, innumerable other pipelines are known to cross the Trinity Bay floor.

Lower San Jacinto Bay would be crossed from east to west in a relatively narrow finger. The designated uses of the bay are contact recreation and high quality aquatic habitat. This water body is part of the Houston Ship Channel system, and as such, its quality is largely influenced by point discharges into the channel. Potential water quality problems include occasionally supersaturated dissolved oxygen, persistently elevated levels of total and ortho-phosphorus, frequently elevated inorganic nitrogen, occasionally high concentrations of chlorophyll-a, and rarely, fecal coliform levels in excess of criteria.[44]

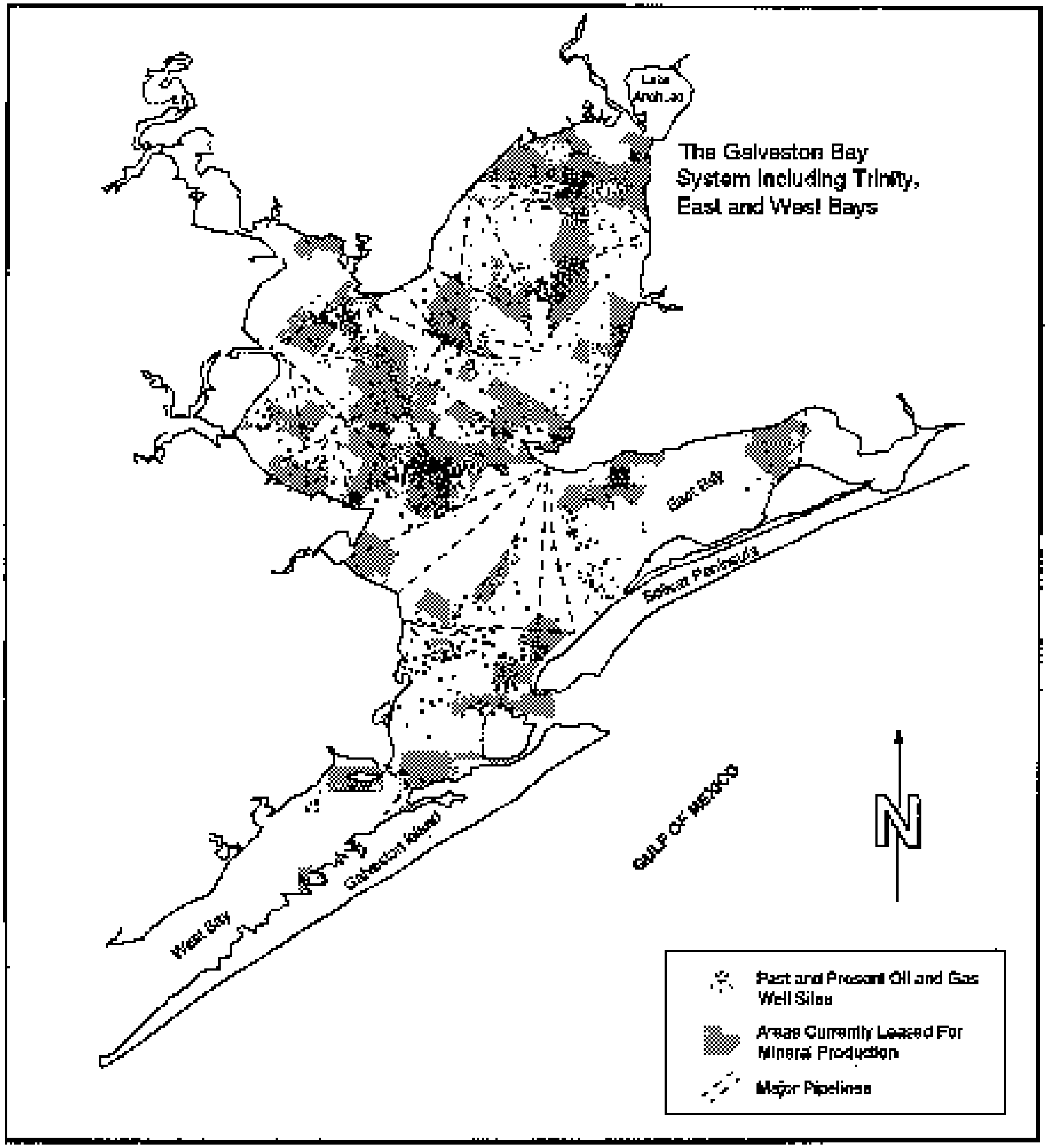
Another significant water body that would be crossed by the proposed crude oil pipeline route to Deer Park is Tabbs Bay. Like Trinity Bay and San Jacinto Bay, state-designated uses for Tabbs Bay include contact recreation and high quality aquatic habitat. The habitat in Tabbs Bay, however, is of somewhat lower quality than those in Trinity and San Jacinto Bays due to extensive dredging and water contamination associated with the considerable shipping activity in this area. The northern areas of Tabbs Bay, including where the proposed pipeline would cross and areas further north, have significantly degraded water quality and have been closed to oystering.[45]

I-10 Crude Oil Pipeline. Another crude oil pipeline option would stretch roughly 64 miles from Big Hill, nearly due west, to East Houston. For the first several miles west of Big Hill, it would follow the same route as the proposed Trinity Bay pipeline. Rather than crossing Trinity Bay, however, this pipeline would pass north of the bay and Lake Anahuac near the I-10 corridor.

The proposed I-10 route would cross 31 water bodies. Twelve of these waters would also be crossed by the proposed Trinity Bay route. Specifically, the first ten water bodies characterized in Table 5.1-5 (from Spindletop Canal through East Fork Double Bayou) also would be crossed at about the same location by the I-10 pipeline on the east side of Trinity Bay. In addition, to the west of Trinity Bay, the I-10 route would cross Barbers Hill Canal and Cedar Bayou like the Trinity Bay route, though at more northern locations. Barbers Hill Canal and Cedar Bayou are also characterized in Table 5.1-5.

The 19 water bodies that would be uniquely crossed by the I-10 route are characterized in Table 5.1-6. Most of these waters are rather small bayous and sloughs to the north of Trinity Bay. Principle exceptions are the Trinity River, just to the northwest of Lake Anahuac, and the San Jacinto River near Bear Lake and the community of Plants. In the area where it would be crossed by the I-10 pipeline route, the Trinity River is tidally influenced and is designated by the State to be used for contact recreation and high quality aquatic habitat. No significant water quality problems exist in this stretch of the Trinity River. Phosphorus levels are periodically elevated, but problems with excessive aquatic plant growths have not been observed. The San Jacinto River, in the area where it would be crossed by the I-10 pipeline route, is also designated by the State to be used for contact recreation and high quality aquatic habitat. Water quality in this segment of the San Jacinto River, however, is more limited than that in the Trinity River. A

Figure 5.1-4
Oil & Gas Development in Trinity Bay



Source: U.S. Department of Commerce, "Oil and Gas Development Figure," *Galveston Bay: Issues, Resources, Status, and Management.* Proceedings of a Seminar held March 14, 1988.

Table 5.1-5
Surface Waters Crossed by the Proposed Crude Oil Pipeline Route from Big Hill Across Trinity Bay

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Average Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Spindletop Canal	None	10	4	Pumped Water	No downstream public intake	None	Fresh	Rice field irrigation
Spindletop Bayou	ICW	75	6	Negligible Natural Flow	No downstream public intake	None	Fresh	Rice field irrigation
Devers East Canal	Barnes Slough, ICW	50	16	Pumped Water	No downstream public intake	None	Fresh	Rice field irrigation
Elm Bayou	Stanolind Res., East Bay Bayou, ICW	5	3	Intermittent	No downstream public intake	None	Fresh	Rice field irrigation
Devers Main Canal	None	50	6	Pumped Water	No downstream public intake	None	Fresh	Rice field irrigation
Onion Bayou	None	5	1	Intermittent	No downstream public intake	None	Fresh	Rice field irrigation
East Fork Oyster Bayou	Oyster Bayou	5	1	Intermittent	No downstream public intake	None	Fresh	Rice field irrigation
Lone Star Canal	Onion Bayou	40	6	Pumped Water	No downstream public intake	None	Fresh	Rice field irrigation
Oyster Bayou	None	8	3	174 (104-269)	No downstream public intake	None	Fresh	Rice field irrigation
East Fork Double Bayou	Double Bayou	40	4	80.8 (48.3-134)	No downstream public intake	None	Fresh, Brackish	Rice field irrigation, small boat traffic
Bad East Gully	East Fork Double Bayou, Double Bayou	5	1	Intermittent	No downstream public intake	None	Fresh	No known uses
West Fork Double Bayou	Double Bayou	8	3	88.8 (53-147)	No downstream public intake	None	Fresh	Rice field irrigation, small boat traffic

Table 5.1-5 (Continued)
Surface Waters Crossed by the Proposed Crude Oil Pipeline Route from Big Hill Across Trinity Bay

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Average Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Trinity Bay	Galveston Bay System	46,900	6	Tidal	No downstream public intake	None	Brackish	Commercial traffic, contact recreation, high quality aquatic habitat, and shellfish waters
Cedar Gully	None	4	0.5	Intermittent	No downstream public intake	None	Fresh	No known uses
Barbers Hill Canal	Cotton Lake Trinity Bay	10	4	Pumped Water	No downstream public intake	None	Fresh	Rice field irrigation, industrial processes
Cedar Bayou	Galveston Bay	300	8	361 (117-637)	No downstream public intake	None	Brackish	Small boat traffic, contact recreation
Tabbs Bay	Galveston Bay System	8200	40	Tidal	No downstream public intake	None	Brackish	Commercial traffic, contact recreation, high quality aquatic habitat
San Jacinto Bay	Galveston Bay System	3800	40	Tidal	No downstream public intake	None	Brackish	Commercial traffic, contact recreation, high quality aquatic habitat
Houston Ship Channel (Buffalo Bayou)	Galveston Bay System	1400	40	1100 (623-1460)	No downstream public intake	None	Brackish	Commercial traffic, industrial water supply

Table 5.1-6
Surface Waters Crossed by the Proposed Crude Oil Pipeline Route from Big Hill Along I-10[a]

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Average Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Barrow Slough (3 crossings)	Whites Bayou Turtle Bayou Lake Anahuac Trinity Bay	5	1	negligible, natural flow	8.5	3891	Fresh	No known uses
White Bayou (2 crossings)	Turtle Bayou Lake Anahuac Trinity Bay System	10	1	negligible, natural flow	8.2	3891	Fresh	Storm water drainage
Turtle Bayou	Lake Anahuac Trinity Bay	180	4	194 (39.2 - 466)	4.3	3891	Fresh	Contact recreation, small boat traffic
Trinity River	Trinity Bay	310	10	8170 (1650 - 19,700)	5.7	3891	Fresh	Rice field irrig., small boat traffic, contact recreation
Mayes Lake	Peterson Bayou Peterson Lake Old River Long Island Bayou Trinity R. and Bay	900	2	tidal	No downstream public intake	None	Brackish	Contact recreation, shellfish production
Old River Lake	Old River Long Island Bayou Trinity R. and Bay	3100	4	tidal	No downstream public intake	None	Brackish	Contact recreation, shellfish production
Cotton Bayou	Cotton Lake Old River Trinity Bay	5	1	negligible, natural flow	No downstream public intake	None	Fresh	Irrigation wasteway
Hackberry Gully	Cotton Bayou Cotton Lake Old River Trinity Bay	5	1	negligible, natural flow	No downstream public intake	None	Fresh	Irrigation wasteway
Horsepen Bayou	Cedar Bayou Galveston Bay	4	--	intermittent	No downstream public intake	None	Fresh	Irrigation wasteway

Table 5.1-6 (Continued)
Surface Waters Crossed by the Proposed Crude Oil Pipeline Route from Big Hill Along I-10[a]

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Average Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Smith Gully	Cedar Bayou Galveston Bay	4	–	intermittent	No downstream public intake	None	Fresh	Irrigation waterway
Coastal Industrial Water Authority Canal	Lynchburg Reservoir	50	6	pumped water	No downstream public intake	None	Fresh	Industrial process waters
San Jacinto River Authority Canal	Highlands Reservoir Goose Creek Galveston Bay	10	6	pumped water	No downstream public intake	None	Fresh	Rice field irrig., industrial process waters
San Jacinto River	Galveston Bay System	300	4	2570 (1450 - 3390)	No downstream public intake	None	Fresh	Contact recreation, shellfish production
Carpenter Bayou	Buffalo Bayou Galveston Bay	10	5	82.1 (46.3 - 109)	No downstream public intake	None	Fresh	Rice field irrig., industrial process waters
West Canal	None	10	6	controlled out of Sheldon Reservoir	6	9207	Fresh	Municipal water supply
Big Gulch	Greens Bayou Buffalo Bayou Galveston Bay	4	–	intermittent	No downstream public intake	None	Fresh	Storm drainage
Sulphur Gully	Greens Bayou Buffalo Bayou Galveston Bay	4	–	intermittent	No downstream public intake	None	Fresh	Storm drainage
Greens Bayou	Buffalo Bayou Galveston Bay	120	1	221 (107 - 341)	No downstream public intake	None	Fresh	Contact recreation
Hunting Bayou	Buffalo Bayou Galveston Bay	10	1	negligible, natural flow	No downstream public intake	None	Fresh	Storm drainage

[a] The I-10 route also would cross Spindletop Canal, Spindletop Bayou, [illegible] Canal, Elm Bayou, [illegible] Main Canal, [illegible] Bayou, [illegible] Fork Oyster Bayou, Lone Star Canal, Oyster Bayou, East Fork Double Bayou, [illegible] Canal, and Cedar Bayou. These water bodies are characterized in Table 5.1-5 (they also would be crossed by the proposed Trinity Bay route).

portion of the segment does not meet swimmable criteria due to elevated levels of fecal coliform bacteria, total phosphorus is frequently elevated, ortho-phosphorus is regularly elevated, and inorganic nitrogen is occasionally elevated.[46]

Raw Water and Brine Pipelines. The existing RWI and brine disposal pipelines follow the same route in a general southeasterly direction, crossing Salt Bayou roughly three miles from the site. Approximately four miles from the site, the two pipelines diverge, with the raw water pipeline continuing straight to the ICW and the brine discharge pipeline turning south toward the Gulf of Mexico. The raw water line does not cross any additional water bodies before intersecting the ICW, while the brine discharge line crosses the ICW and a tributary of Star Lake.

5.1.4 Climate and Air Quality

The proposed Big Hill expansion site would lie within a humid, subtropical region. Prevailing winds are onshore from the Gulf of Mexico, except when influenced by passing frontal systems. The average summer air temperature for the area is 84°F; the average winter air temperature is 52°F. Annual precipitation averages 52 in/yr between the Sabine and East Bay basins, with water surpluses occurring from December through April and deficits occurring from May through July.[47] Large precipitation amounts may be associated with tropical disturbances in the Gulf.

The site is located in Jefferson County, Texas, which is a nonattainment area for ozone. Jefferson County is also proposed to become a nonattainment area for sulfur dioxide.[48] The Big Hill site has no on-site air quality monitoring station; however, the Texas Air Quality Control Board maintains a monitoring station in Port Arthur, located approximately 17 miles northeast of the site. Monitored concentrations of ozone are often in excess of the NAAQS of 0.12 ppm. The NAAQS for ozone was exceeded on seven days in 1989; the highest hourly ozone measurement was recorded on May 28, 1989, registering 0.17 ppm. Background concentrations of ozone can also be approximated by using values from the Houston Southeast/Seabrook monitoring station, which is located about 50 miles southwest of the Big Hill site. These data indicate that the ozone standard was exceeded on five days during 1989, with the highest one-hour average equal to 0.19 ppm and the second highest equal to 0.16 ppm.[49]

5.1.5 Ecology

The proposed Big Hill expansion site would be located within the Chenier Plain ecosystem in an area characterized by Bailey[50] as part of the southeastern mixed forest province. The following section describes the ecology of the proposed site and along the proposed pipeline routes, including the vegetation and wildlife, and also identifies Federally-listed threatened or endangered species and any rare species identified by State agencies. The information presented here is from previous SPR documents,[51,52] information obtained from various Federal and state agencies, and a site visit conducted in June 1991.

5.1.5.1 Ecosystems at the Site and Nearby

This section characterizes the ecology at the site and in nearby areas. Discussion is provided for vegetation, terrestrial and aquatic life, threatened or endangered species, and other biological resources of potential concern.

Vegetation

The proposed site is characterized predominantly by scrub-shrub uplands with interspersed meadows (old fields) in the early stages of secondary succession. Mature trees (i.e., greater than six meters in height) are scattered throughout the proposed site area. Based on historical aerial photographs (available at the existing facility), it appears that the proposed site may have been used as a pasture area as recently as 1980. The existence of meadows at the proposed site may reflect the more recent use of these areas as pasture land. There are no large (i.e., greater than five square meters) wetland areas at the proposed site, although smaller pockets of wetland vegetation, such as various rushes and sedges, were found in some of the meadow areas. Figure 5.1-5 shows wetland and upland habitats at and nearby the expansion site.

The area surrounding the site is primarily agricultural. The proposed site is currently accessible to grazing cattle. Prairie and pastureland species characterized in earlier SPR reports include ryegrass, white clover, Bermuda grass, dallisgrass, and legumes. Natural prairie vegetation includes bluestem, Indian grass, switchgrass, prairie wildgrass, huisache, and mesquite. Although there are no large wetlands on the site, the northern boundary of an extensive freshwater to intermediate marsh, is approximately 0.6 miles south of the existing site.

The scrub-shrub areas are characterized by dense shrub and herbaceous strata with a more open canopy, consisting of Chinese tallow tree, sweet gum, and box elder. Live oaks greater than 2.5 feet in diameter at breast height are scattered throughout the site. Blackberry and greenbriar are two of the common shrub species. Common vines include poison ivy, honey suckle, and Virginia creeper. Common herbaceous species include day flower, viburnum, giant ragweed, evening primrose, rattle box, yellow partridge pea, milkweed, and a variety of grasses, with many of these species being most common in the open meadows and along the perimeter of the site near the roadway and fence line.

Terrestrial Wildlife

Bird species observed during the site visit are cardinal, boat-tailed grackle, mockingbird, mourning dove, and night hawk. Deer (most likely white-tailed deer) tracks and scat were observed at the site, as were several large burrows believed to be nine-banded armadillo burrows. Reptiles observed were one species of lizard (green anole) and one species of turtle (decomposed shell).

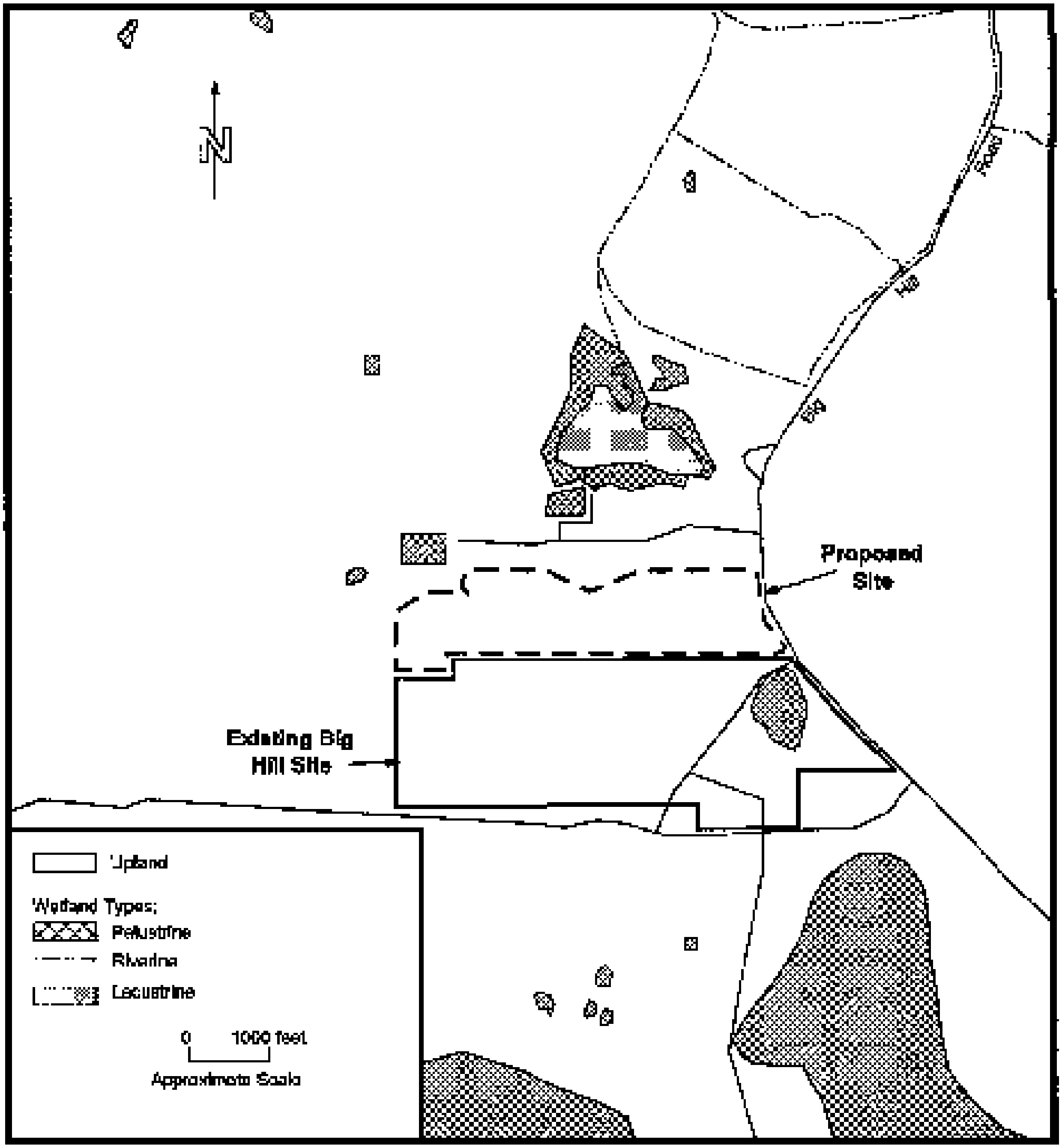
Based on previous studies, other fauna likely to inhabit the area include coyote, raccoon, upland game birds (bobwhite quail and turkey). The ponds and marshes south of the site provide excellent habitat for alligators, which are numerous in the area. In fact, the majority (over 50 percent) of the alligators taken in 1989 in Texas were in Jefferson County.[53]

Aquatic Life

There are no large surface water bodies within the proposed site boundary. One or two intermittent streams and two ponds on the site could provide habitat for aquatic invertebrates, but none are big enough to support fish populations.

The floral and faunal assemblages present in the surface waters of southeastern Texas are dependent primarily upon salinity. Three general salinity regimes are found in the affected areas:

Figure 5.1-5
Wetlands and Upland Habitats: Proposed Big Hill Expansion Site



Source: National Wetland Inventory Maps; Hamshire, Alligator Hole Marsh, Whites Ranch, and Star Lake, TX Quadrangles marine (e.g., Gulf of Mexico), moderate salinity inland waters (e.g., Sabine Lake), and fresh to brackish inland water bodies.[54] Typical benthic marine organisms include clams, blue crabs, snails, urchins, starfish, marine worms, crustaceans, and mud shrimp.[55] Saltwater sportfish are found in both the Gulf of Mexico and inshore waters. Species prevalent to Sabine Lake are speckled trout, redfish, black drum, Atlantic croaker, gaftop catfish, southern flounder, and sheepshead.[56]

The numerous brackish-to-fresh waterbodies contain varied populations of fish, benthos, phytoplankton, and zooplankton. Freshwater fish typical of this region include:[57] blue catfish, channel catfish, striped bass, white bass, largemouth bass, sunfish, gar, mosquitofish, killifish, freshwater drum, and buffalo. Although these fish can tolerate somewhat saline environments, they generally require low salinity environments (less than five ppt) for spawning. Benthos encountered in the ICW in this area include: mollusks, oligochaetes, polychaetes, amphipods, numerous larval insects (especially dipterans), and crayfish. Diatoms, bluegreen algae, green algae, and yellow-green algae were the general types of phytoplankton collected in the ICW, while zooplankton samples include copepods, cladocerans, rotifers, and ostracods.[58]

Threatened or Endangered Species

Based on information supplied by the Texas Department of Parks and Wildlife, there are no documented occurrences of endangered or threatened species at the proposed site. Several plant species or 'series' ranked as S2 or S3 (critically imperiled or rare in the State, respectively) are reported to occur in Jefferson County. Rare or imperiled species are Runyon's water willow, scarlet catchfly, and smooth blue-star. The Seacoast Bluestem/Gulfdune Paspalum Series, the Saram Chestnut Oak/Willow Oak Series, and Rush/Sedge Series are the series reported to occur in Jefferson County and ranked as rare (less than 20 occurrences) in the State. In addition, the pig frog, ranked S2 (critically imperiled) in the State, also may occur in Jefferson County. Note that these species and series are not listed in Appendix D because they are not designated by Texas or the USFWS as endangered or threatened.

Although endangered or threatened species are reported to occur in Jefferson County, none were observed during the site visit. Survey of the alternative pipeline routes has not been conducted. Representatives of USFWS identified no federally-listed species as likely to be present.

Other Biological Resources of Concern

Although not used by endangered or threatened species, several bird rookeries (breeding grounds) near the proposed site are of special concern. Several of these rookeries were active in 1990; these are listed in Table 5.1-7. At the Spindletop Reservoir, located approximately four miles south of the site, rookeries for great egrets, cattle egrets, and little blue herons are reported. At Mayhaw Bayou, located approximately eight miles north of the site, rookeries for olivaceous cormorants, little blue herons, and roseate spoonbills are reported. Willow Slough, located approximately five miles east of the site, is a rookery for a number of species: olivaceous cormorants, anhingas, great blue herons, great egrets, snowy egrets, cattle egrets, little blue herons, black-crowned night herons, white ibis, and roseate spoonbills. Two other rookeries (North Willie Slough, and Willie Slough Gully) also are located nearby but were inactive during a 1990 survey by the Texas Parks and Wildlife Department.

Table 5.1-7
Bird Rookeries Near the Proposed Big Hill Expansion Site:
Location, Activity in 1990, and Major Species

Spindletop Reservoir, 29 45'N 94 20'W (b)	Willow Slough, 29 46'N 94 08'W (a)
Great Egrets	Olivaceous Cormorants
Little Blue Herons	Anhingas
Cattle Egrets	Great Blue Herons
	Great Egrets
Mayhaw Bayou, 29 51'N 94 15'W (a)	Snowy Egrets
Olivaceous Cormorants	Little Blue Herons
Little Blue Herons	Cattle Egrets
Roseate Spoonbills	Black-crowned Night-herons
	White Ibis
North Willie Slough, 29 45'N 94 10'W (b)	Roseate Spoonbills
Species list not available	
Willie Slough Gully, 29 43'N 94 10'W (b)	
Species list not available	

(a) Active during 1990 survey.
(b) Inactive during 1990 survey.

Source: Texas Parks and Wildlife Department, 1991

5.1.5.2 Ecosystems Crossed by Pipelines

The existing raw water intake and brine pipelines at Big Hill could be used during the development phases of the additional caverns at the proposed expansion, and, therefore, the proposed pipeline routes assessed in this DEIS are crude oil pipelines to Houston (based on a 180-day drawdown criterion).

Trinity Bay Crude Oil Pipeline

The proposed Trinity Bay pipeline route would cross palustrine emergent and estuarine intertidal wetlands. Based on the Gulf Coast Ecological Inventory Map (Houston, Texas map), this pipeline route would not cross any areas identified as potential breeding grounds or nurseries for any endangered species, nor would it cross any lands designated as a wildlife refuge. It would, however, cross approximately eleven miles of the Galveston Bay system. Table 5.1-8 lists areas of habitat use within a one-half mile area along the proposed crude oil pipeline. Table 5.1-9 lists aquatic species which may occur along the proposed pipeline route.

Trinity Bay, Tabbs Bay, San Jacinto Bay, and Buffalo Bayou are all significant components of the Galveston Bay system, which would be crossed by the Trinity Bay crude oil pipeline route from Big Hill to Deer Park, Texas. Although Galveston Bay is naturally shallow (ranging in depth from four to 15 feet), dredging has created the Houston Ship Channel, which ranges from 300 to 600 feet wide and averages 50 feet deep. The portions of Tabbs Bay, Lower San Jacinto Bay, and Buffalo Bayou that lay in the path of the proposed pipeline have been dredged for ship passage, but Trinity Bay remains relatively unimpacted by channel dredging and the pollution associated

Table 5.1-8
Areas of Habitat Use Within One-Half Mile of the Proposed Crude Oil Pipelines from Big Hill to East Houston

AREA	PIPELINE TYPE	
	CRUDE OIL	
	Trinity Bay	I-10
Breeding	X	X
Nursery	X	X
Adult concentration		X
Migratory	X	X
Commercial harvesting	X	
Sport fishing/hunting	X	

Source: Gulf Coast Ecological Inventory Maps, Houston, TX. U.S. Fish and Wildlife Service. 1982.

with shipping activities.[59] There is currently a proposal to widen and deepen the Houston Ship Channel, however, which could potentially alter temperature and salinity patterns throughout the Galveston Bay system and alter the distribution of certain flora and fauna.[60]

Trinity Bay is a large, shallow, middle-to-low salinity estuarine environment that supports important stands of submerged aquatic vegetation and a wide variety of organisms. Submerged aquatic vegetation, or seagrass beds, are typically found in nearshore environments, where the water is less than six feet deep, and sunlight can penetrate to the bay floor (see Figure 5.1-6). In recent years, the total area of submerged aquatic vegetation in the Galveston Bay complex has been reduced to less than five percent of its historic area, from about 20 square kilometers (km^2) in 1960 to less than one km^2 in 1979.[61] Species of submerged aquatic vegetation found in Trinity Bay include tape grass, strap-leaf, and widgeon grass. Widgeon grass is found in the shallow coastal waters, and tape grass and strap-leaf are found in mixed stands in the upper bay and Trinity River Delta.[62] Juvenile fish and crustaceans are vulnerable to predation and depend on the seagrass beds for protective cover and their food supply (i.e., vegetation, planktonic organisms, and detritus).[63]

Most juvenile fish and crustaceans migrate into Trinity Bay as larvae or young juveniles, eventually migrating back to the Gulf as adults. Some species, however, complete their entire life cycle in the bay. Migration of juvenile fish into the bay occurs year round, but peak movements occur in late winter, spring, and early summer. The lowest concentration and diversity of organisms occur in the winter.[64] The nearshore environment of Trinity Bay is an especially important nursery area for brown shrimp (summer), white shrimp (winter, spring), drum (spring to fall), sheepshead (spring to fall), southern flounder (spring to fall), and blue crabs (year-round)

Table 5.1-9
Aquatic Species Likely to be Found Along the Proposed Trinity Bay Pipeline Route

FISH	
Atlantic croaker	Largemouth bass
Black crappie	Longear sunfish
Black drum	Pigfish
Blue catfish	Pinfish
Bluegill	Red drum
Buffalos	Redear sunfish
Carp	Sand seatrout
Channel catfish	Sea catfish
Drum	Sheepshead
Flathead catfish	Southern flounder
Freshwater drum	Southern kingfish
Gafftopsail catfish	Spotted bass
Gars	Spotted seatrout
Green sunfish	Striped mullet
Gulf kingfish	Warmouth
Gulf menhaden	White crappie
Ladyfish	
INVERTEBRATES	
Blue crab	
Brackish-water clam	
Brown shrimp	
White shrimp	

Source: Gulf Coast Ecological Inventory Map, Houston, TX. U.S. Fish and Wildlife Service. 1982.

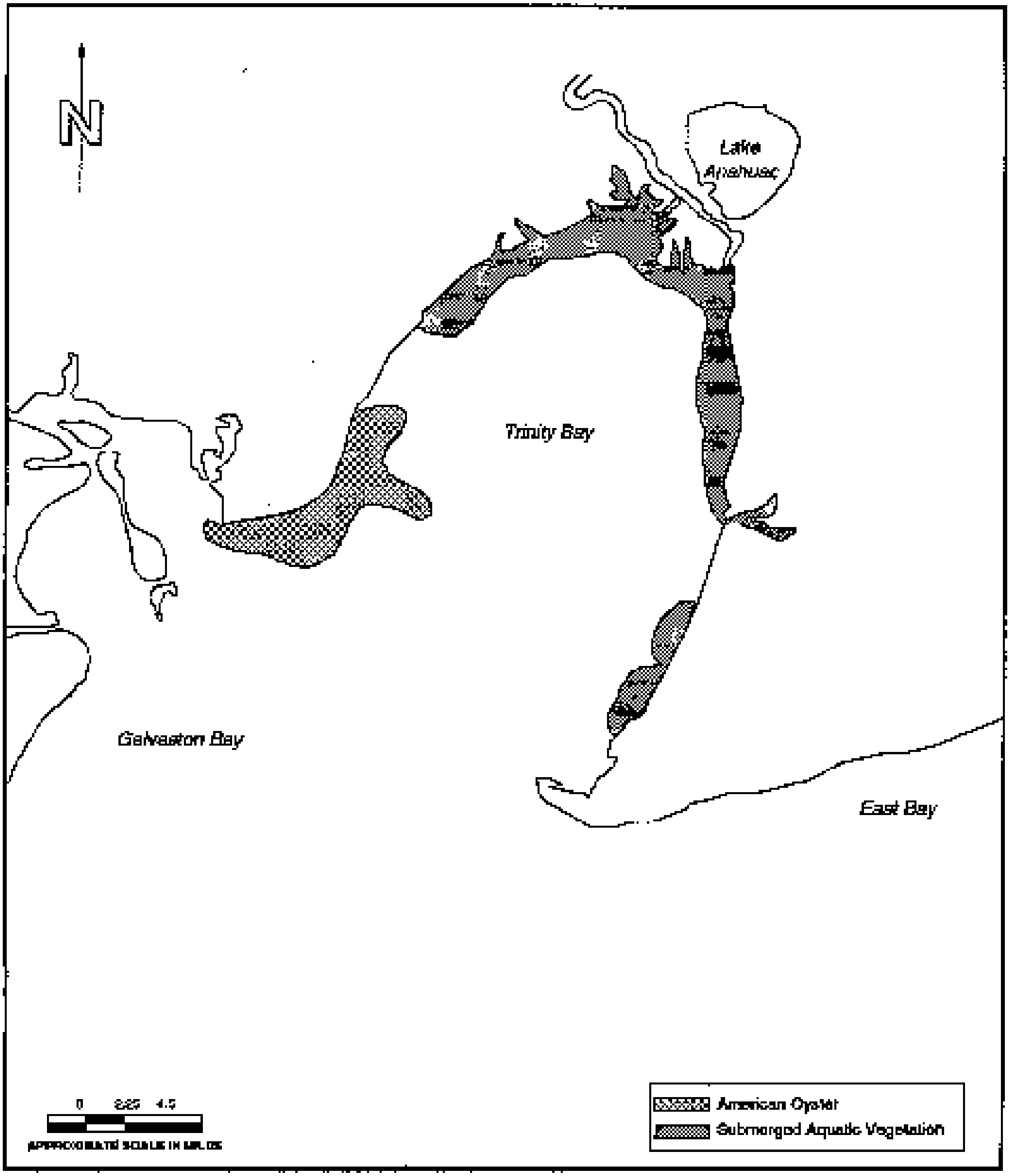
(see Figure 5.1-6).[65] One study[66] of this area found the following fish species most abundant in the bay: gulf menhaden, bay anchovy, sand seatrout, spot, Atlantic croaker, and striped mullet.

A thriving benthic community is also found throughout Trinity Bay. In a year-long study of Trinity Bay, the major benthos collected were polychaetes (74 percent of all individuals) and various species of mollusks (*Macoma* sp., *Amnicola* sp., and *Texadina sphinctostoma*).[67] Oysters are only found in the southern half of the bay along the western shore, especially in the area of Fisher Reef, but this is some distance from the proposed pipeline route[68] (see Figure 5.1-6). The oyster reef assemblage is dominated by the American oyster, and various mollusks (*Ischadium recurvum, Brachidontes exustus,* and *Mulinia lateralis*).[69] In the upper half of Trinity Bay, brackish water clams cover the bottom from shore to shore, but these have no market value.[70]

Twenty-seven endangered or threatened species are reported to occur within the three counties (Jefferson, Chambers, and Harris) in which the Trinity Bay pipeline would be located

Figure 5.1-6

Important Habitats of Trinity Bay



Source: White, W.A. and J. G. Paine, 1992. Wetland Plant Communities, Galveston Bay System and Dr. Eric Powell, Department of Oceanography, Texas A&M University

(Appendix D). Because USFWS did not identify any species as of significant concern along the pipeline ROWs, no potential impacts are assessed in Appendix F.

I-10 Crude Oil Pipeline

The proposed I-10 crude oil pipeline route would not cross any wildlife refuges. It would, however, cross several areas of palustrine forested and palustrine emergent wetlands. These wetlands, especially those associated with Trinity River, provide habitat for wading birds, shorebirds, and waterfowl, and are used as a migratory stopover for numerous species of waterfowl and songbirds. Fur-bearing mammals such as bobcat, beaver, and mink also are found in this area.

The water bodies that would be crossed by the I-10 crude oil pipeline are typically small and characterized as fresh or low salinity. The largest of the water bodies unique to this pipeline route are the Trinity River and the San Jacinto River, both of which are characterized as slightly brackish (0.5 to 5 ppt). Crustaceans and fish species found in brackish waters in this area of Texas are white and brown shrimp, blue crabs, spotted seatrout, sand seatrout, Atlantic croaker, red drum, black drum, sheepshead and southern flounder. Most of these animals use the fresh and brackish water as nursery grounds, spending the remainder of their life cycles in the Gulf of Mexico. Ichthyofauna common to both brackish and fresh water bodies include species of catfish, crappie, bass, sunfish, gars, buffalos, freshwater drum, and carp. These species spend their entire life cycles in these areas.

Information on endangered or threatened species that would be found along the I-10 pipeline route is identical to that provided for the Trinity Bay route.

5.1.5.3 Ecosystems Near the Brine Diffuser in the Gulf of Mexico

As discussed in section 5.1.3.1, the ecology of the Big Hill diffuser site was extensively studied as part of the comprehensive Texoma Complex FEIS baseline biological monitoring effort conducted from September 1977 through October 1978. Detailed discussions of the Big Hill offshore ecology are presented in section B.3.4.5.2 and Appendix Q of the Texoma Complex FEIS, and section 3.2.1.5 of the Phase III EIS. Based on post-brine disposal monitoring studies since those earlier EISs, no significant changes to the biological communities near the Big Hill brine diffuser are expected to have occurred.

Eighteen endangered or threatened vertebrate species are reported to occur in the western Gulf of Mexico, although most are unlikely to be found in the vicinity of the brine diffuser. However, Kemp's Ridley and other sea turtles may be found around oil rigs and banks (Appendix D). According to the National Marine Fisheries Service's (NMFS) endangered and threatened species list,[71] the presence of endangered and threatened species in the Gulf of Mexico has not changed since 1978. The Texas Parks and Wildlife Commission, however, moved the Loggerhead sea turtle (*Caretta caretta*) from Texas' threatened species list to the endangered species list in March 1987.[72] Appendix G of the Phase III EIS discusses other species that could potentially occur within the project area.

5.1.6 Floodplains

Executive Order 11988 (Floodplain Management), issued on May 24, 1977, requires that each Federal agency issue or amend existing regulations and procedures to avoid the use of floodplain resources as sites for Federal actions unless no practicable alternative exists. In cases where no alternative is available, the agency must minimize impacts to these resources to the greatest extent practicable. The Executive Order and subsequent implementation guidelines and regulations promulgated by the U.S. Water Resources Council and DOE (43 Federal Register (FR) 6030, February 10, 1978 and 44 FR 12594, March 7, 1979, respectively) state that an agency can include an assessment of floodplain impacts of proposed actions in an environmental assessment or environmental impact statement prepared pursuant to NEPA.

Fulfilling the requirements of Executive Order 11988, DOE consulted Flood Insurance Rate Maps (FIRMs), local authorities, and engineering contractors to determine whether proposed SPR sites and additional facilities were located in floodplain areas.

An expansion at Big Hill would cover approximately 150 acres on an elevation of 37 feet above msl.[73] The expansion storage site would be located entirely outside any floodplains (see Figure 5.1-7).[74] Thus, the Big Hill storage site will require no further floodplains assessment.

Because the proposed action at the Big Hill site is an expansion of an existing site rather than the creation of a new facility, existing structures and systems will be used. A Big Hill expansion would take advantage of the existing raw water and brine disposal pipelines and RWI structure. Only slight modifications, if any, to these systems would be necessary. As a result, no further floodplain assessment is necessary for these structures.

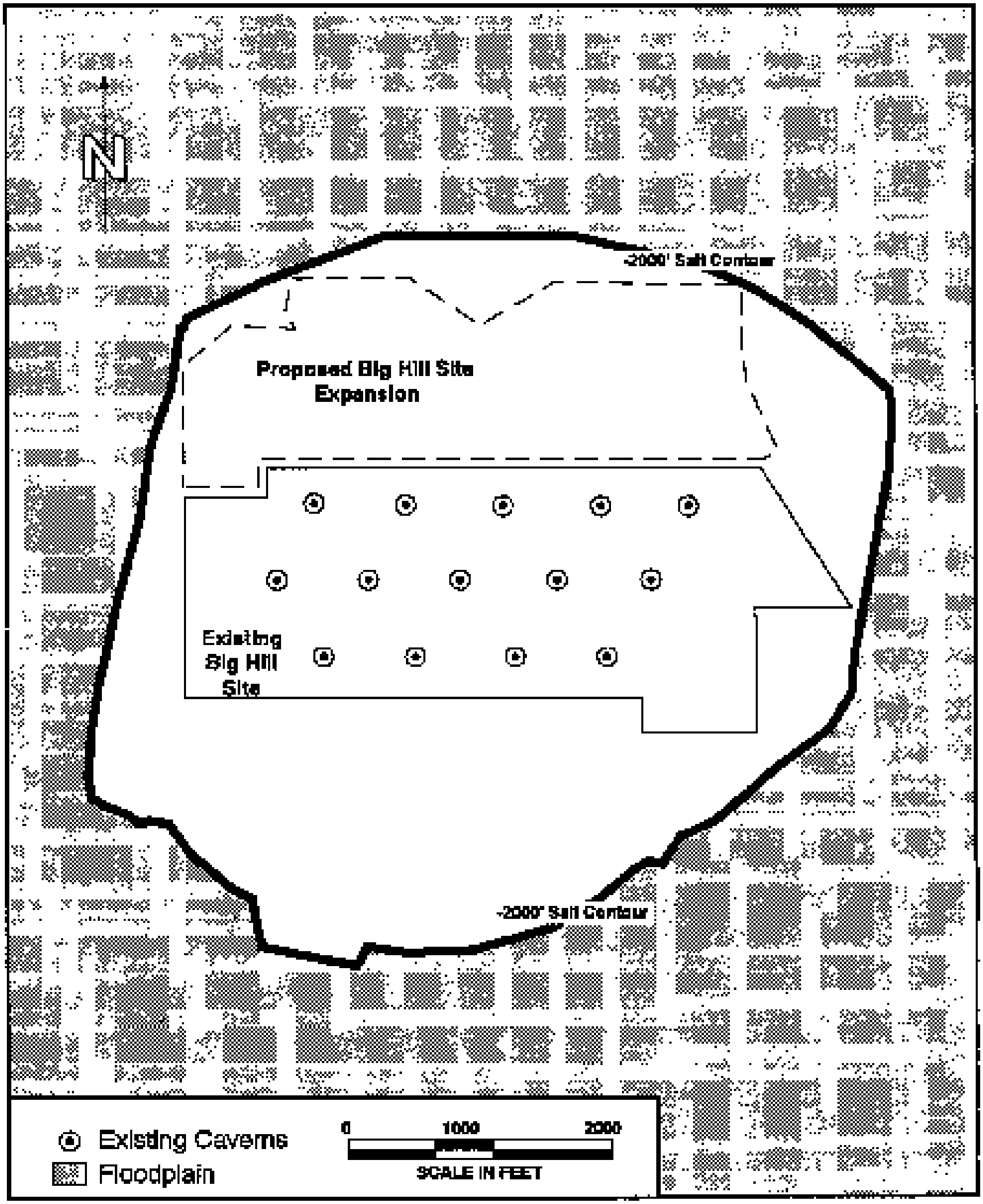
Of the total length (approximately 58 miles) of the Trinity Bay crude oil pipeline associated with the expansion of Big Hill under a 180-day drawdown criterion, about six and one-half miles are in wet land (e.g., marsh, swamp, and floodplain areas).[75] If the I-10 route to East Houston were chosen, approximately 13 of the 63 miles would be wet land. Because FIRM maps were not available for the entire pipeline route, this estimate is based on preliminary assessments from a variety of other sources.

5.1.7 Natural and Scenic Resources

The Big Hill salt dome is located in a rural agricultural area of coastal Texas. Although natural and scenic resources are less evident on the proposed site area, an extensive system of coastal wetlands, which serve as important waterfowl wintering areas, is found in areas adjacent to the site, extending from Sabine Lake to East Bay. The existing site contains no wetlands and the only water bodies in the vicinity of the site are two freshwater ponds, about ten to 20 acres in size, located on the eastern and northern edges of the salt dome, respectively. Less than one mile south of the salt dome, however, is the northern boundary of fresh to intermediate marsh. Farther south of the site are extensive wetlands.

Federal and state authorities have preserved a number of refuges and wildlife areas near the proposed site. McFaddin National Wildlife Refuge is immediately to the south and east of the Big Hill salt dome, and there are several active bird rookeries reported near the proposed site. The 54,500-acre McFaddin Refuge provides wintering habitat for migratory waterfowl. Habitats within the refuge consist of 40,800 acres of wetlands, 800 acres of open water, and

Figure 5.1-7
Big Hill Floodplains Assessment



Source: Federal Emergency Management Agency, Flood Insurance Rate Maps

12,900 acres of upland. State authorities recognize the area for its high natural productivity and importance in overall coastal ecosystem functioning. The approximately 8,400-acre J.D. Murphree Wildlife Management Area, located immediately south of the Port Arthur city limits and managed by the State of Texas, is dedicated to maintaining a high quality marsh that is desirable to wintering waterfowl. Anahuac National Wildlife Refuge contains about 9,840 acres of coastal wetlands bounded on the east by Oyster Bayou, on the south by East Bay, and is situated inland about three miles from the Gulf. Other important natural and scenic resources near the proposed site include Sea Rim State Park, which consists of 15,115 acres of beach and marshland in Jefferson County, ten miles west of Sabine Pass, Texas; the 84,500-acre Big Thicket National Preserve, an ecologically unique area covering parts of seven counties near Beaumont; Nibletts Bluff State Park about twelve miles west of Sabine Pass; and Sabine Wildlife Management Area, a 9,000-acre preserve two miles west of Nibletts Bluff.

5.1.8 Archaeological, Historical, and Cultural Resources

DOE contacted the Texas Archaeological Research Laboratory for information on culturally important resources in the area and vicinity of the proposed Big Hill expansion and proposed pipeline routes. In response, the Research Laboratory performed a file search and a search of the National Register of Historic Places 1966-1988 catalogue. There are no recorded archaeological or historic sites located within the Big Hill salt dome project area or proposed pipeline routes nor any listed sites that would be affected by the construction of expanded storage capacity at Big Hill.

5.1.9 Socioeconomics

Big Hill is located in the southern part of Jefferson County, Texas, within a few miles of the Gulf Coast. Surrounding Jefferson County are Chambers, Orange, and Galveston Counties in Texas, and Calcasieu and Cameron Parishes in Louisiana, all of which could experience socioeconomic impacts as a result of the Big Hill expansion. Beaumont, the largest city in the region, is 30 miles northeast of the site. Port Arthur (17 miles) and Galveston (35 miles) are also within this six-county region. Oil fill for an expansion at Big Hill would be accomplished via the existing pipeline from the site to terminals in Nederland, Texas. Drawdown under the 270-day drawdown criterion would be accomplished with no new pipelines; however, under a 180-day drawdown criterion, a new pipeline would be constructed to East Houston. This section discusses the socioeconomic conditions in these four counties and two parishes (hereafter referred to as "the Big Hill region"). Although the proposed pipeline routes run to East Houston, this area was not assessed with the other six counties and parishes because of its distance from Big Hill.

5.1.9.1 History and Cultural Patterns

The Big Hill region, located along the Gulf Coast, has retained many of the unique cultural aspects of the region's original settlers. These early inhabitants, French and Spanish settlers and trappers, arrived in the region during the early 1800's. The French and Spanish heritages of these early settlers, as well as the culture of the local native Indians, are reflected in the names of streets and towns, place names, family names, the local cuisine, and local dialects. Although this low-lying coastal region was sparsely populated throughout much of the nineteenth century, rapid industrialization after the turn of the century led to a major increase in the region's population. Important discoveries of oil at Calcasieu Parish in 1886, and the drilling of the first major oil well in the world (the Anthony F. Lucas Gusher) in 1901 at Spindletop, near present-day Beaumont, prompted the rapid development of petroleum refineries and petrochemical production facilities near the major Gulf Coast port cities.

The Alabama-Coushatta Native American Reservation is located in Livingston, TX, east of the Trinity River. This land is 45 miles northwest of the Big Hill expansion site. Because of the distance, the Native Americans are not expected to have any concerns regarding site development or expansion.

5.1.9.2 Population

Population in the Big Hill region grew very slowly over the period 1980 to 1990, increasing from 727,000 in 1980 to 734,468 in 1990, a 1.0 percent increase. In fact, during the period from 1983 to 1989, the region's population actually decreased from a high of 760,300 to a low of 725,200 in 1989. Jefferson County, the largest of the six jurisdictions in the Big Hill region, experienced a net population loss for the entire decade, declining from 250,938 in 1980 to 239,397 in 1990, a decrease of 4.6 percent. Population also fell in Orange County, but increased in Chambers and Galveston Counties.

Most of Jefferson County's population reside in urban areas; 96 percent of the population live in cities and towns with a population greater than 10,000 (Figure 5.1-8). Furthermore, the population is concentrated in two areas, Beaumont and Port Arthur, which constitute 72 percent of the total population in the county. These two cities are approximately 30 and 17 miles from the Big Hill site, respectively. Port Arthur, with a population of 58,724, is the closest incorporated town.

In general, the regional population is also concentrated in towns and cities with populations over 10,000. The three smaller jurisdictions, Chambers and Orange Counties and Cameron parish, however, are predominantly rural. The overall decline in the Region's population between 1986 and 1989 was largely concentrated in the incorporated cities and towns.

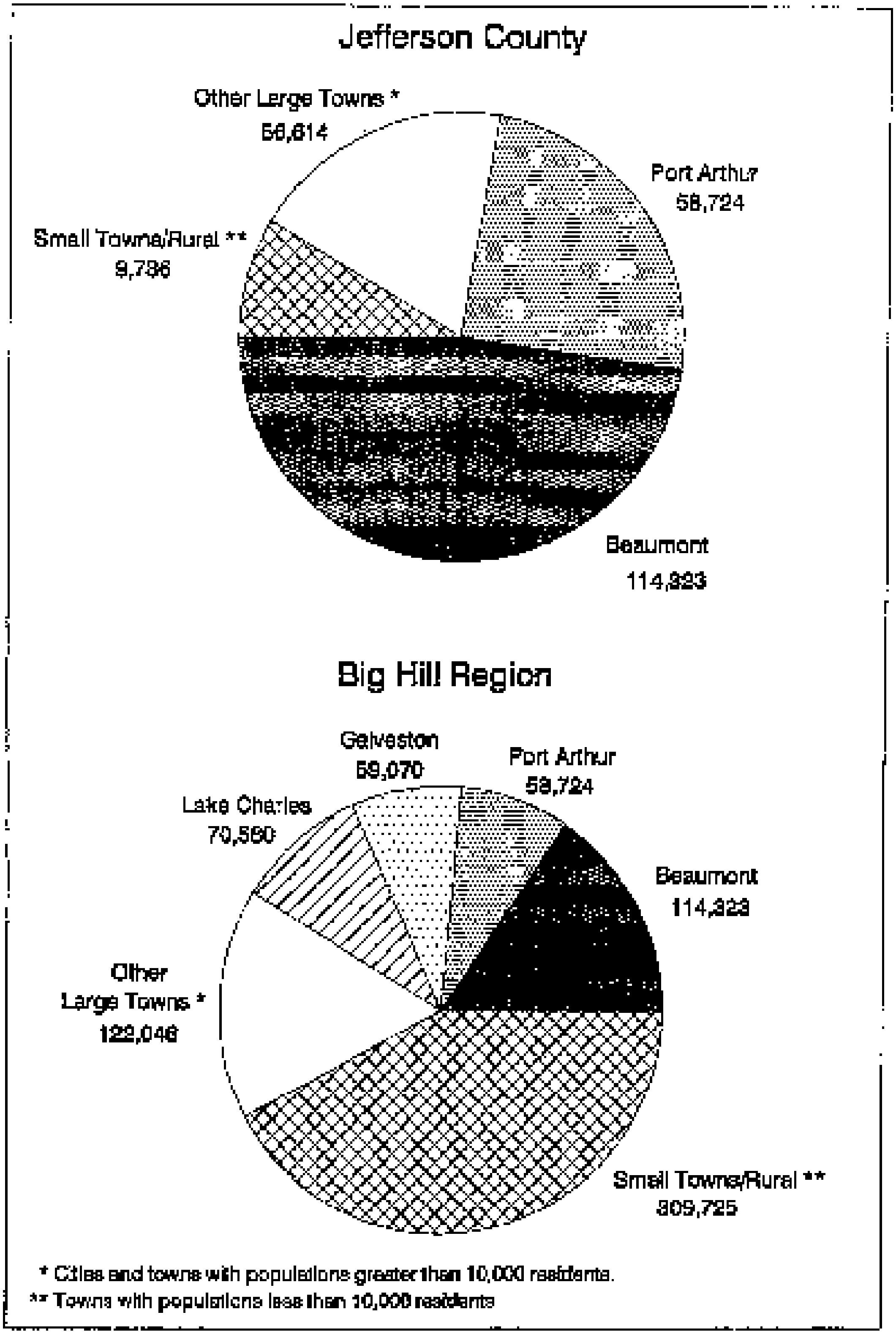
5.1.9.3 Economic Activities

The size of the regional workforce peaked at 360,000 in 1983, declined to a low of 342,000 in 1986, and has remained stagnant in the ensuing years. Regional unemployment peaked in 1986 at 13 percent but gradually fell to 6.5 percent in 1990 (Figure 5.1-9). The unemployment rate for Jefferson County closely paralleled that of the region. In fact, high unemployment rates were prevalent in Texas during the 1980s. The overall poor economic performance of the region was largely the result of decreasing energy prices in the early to mid-1980s.

The service, manufacturing (e.g., petroleum refining), and retail trade sectors which generate the majority of economic activity in Jefferson County, employ 61 percent of the workforce and account for 62 percent of the total earnings. Also important to the county's economy are the government and construction sectors which together employ 21 percent of the workforce. Total annual industry earnings in Jefferson County were $3.04 billion or $24,729 per worker in 1989 (Figure 5.1-10).

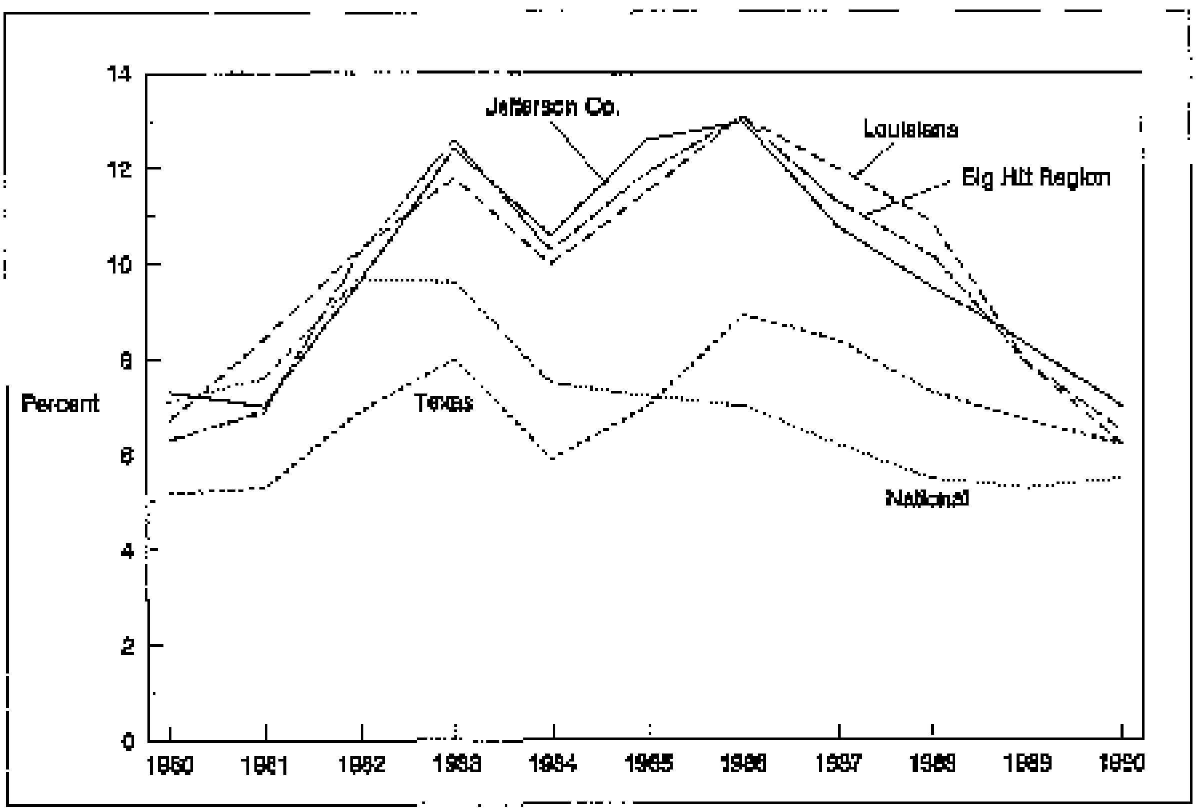
As seen in Figure 5.1-11, the pattern of economic activity in the Region as a whole is similar to that in Jefferson County. Services, manufacturing, and retail trade are the dominant

Figure 5.1-8
Population Distribution in Jefferson County and the Big Hill Region, 1990



Source: STF-1A. Selected Highlights from the 1990 Census. Table 1.
U.S. Department of Commerce, Bureau of the Census.

Figure 5.1-9
Unemployment Rate in the Big Hill Region, 1980-1990



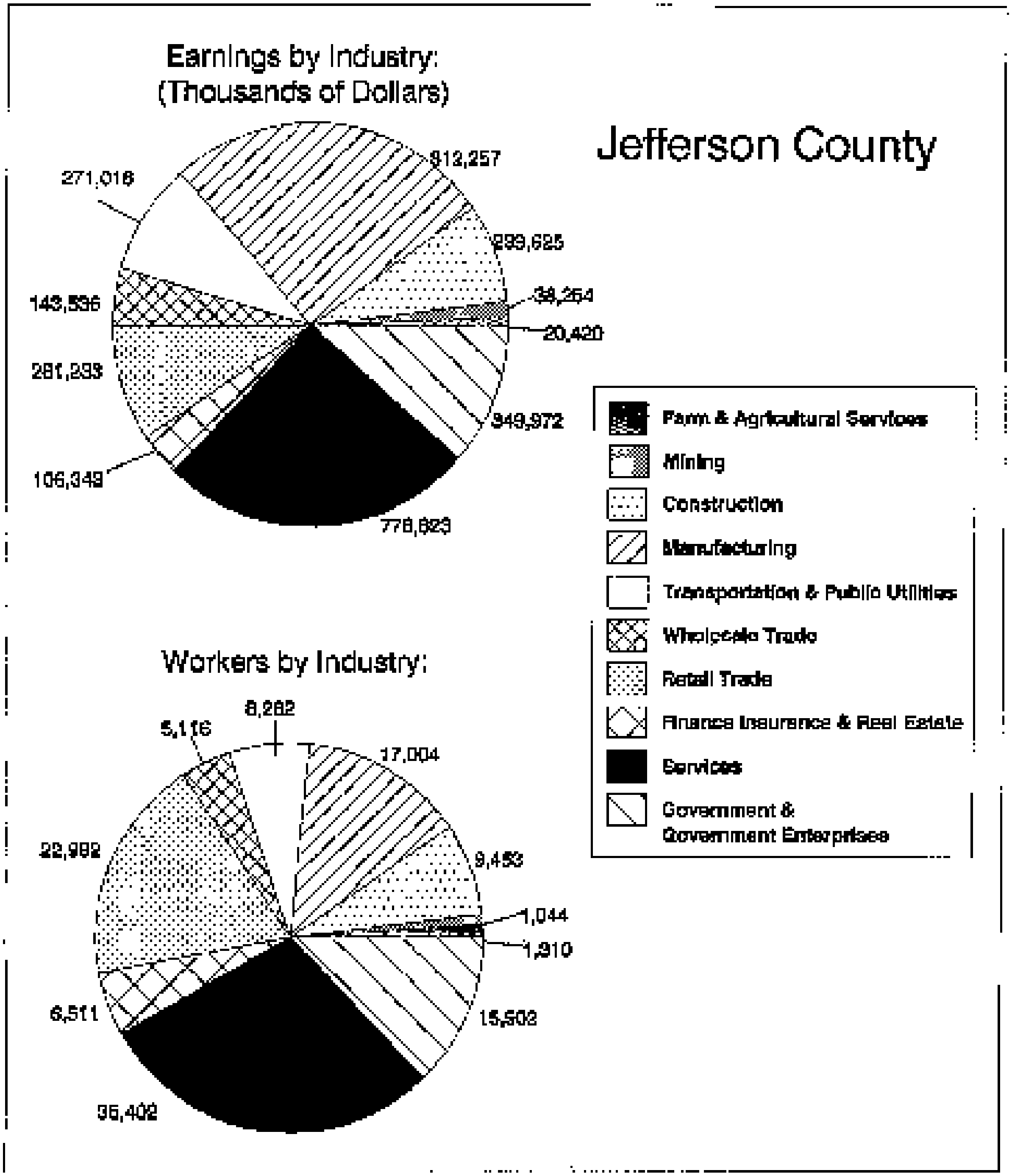
Source: U.S. Department of Labor, Bureau of Labor Statistics, 1990.

sectors and together employ the majority of the workforce and account for the majority of earnings. The Region's total earnings amounted to about $7.77 billion or $22,366 per worker in 1989. Jefferson and Galveston Counties had the highest per worker earnings in the region, while Orange County and Cameron parish have the lowest per worker earnings.

5.1.9.4 Transportation Systems

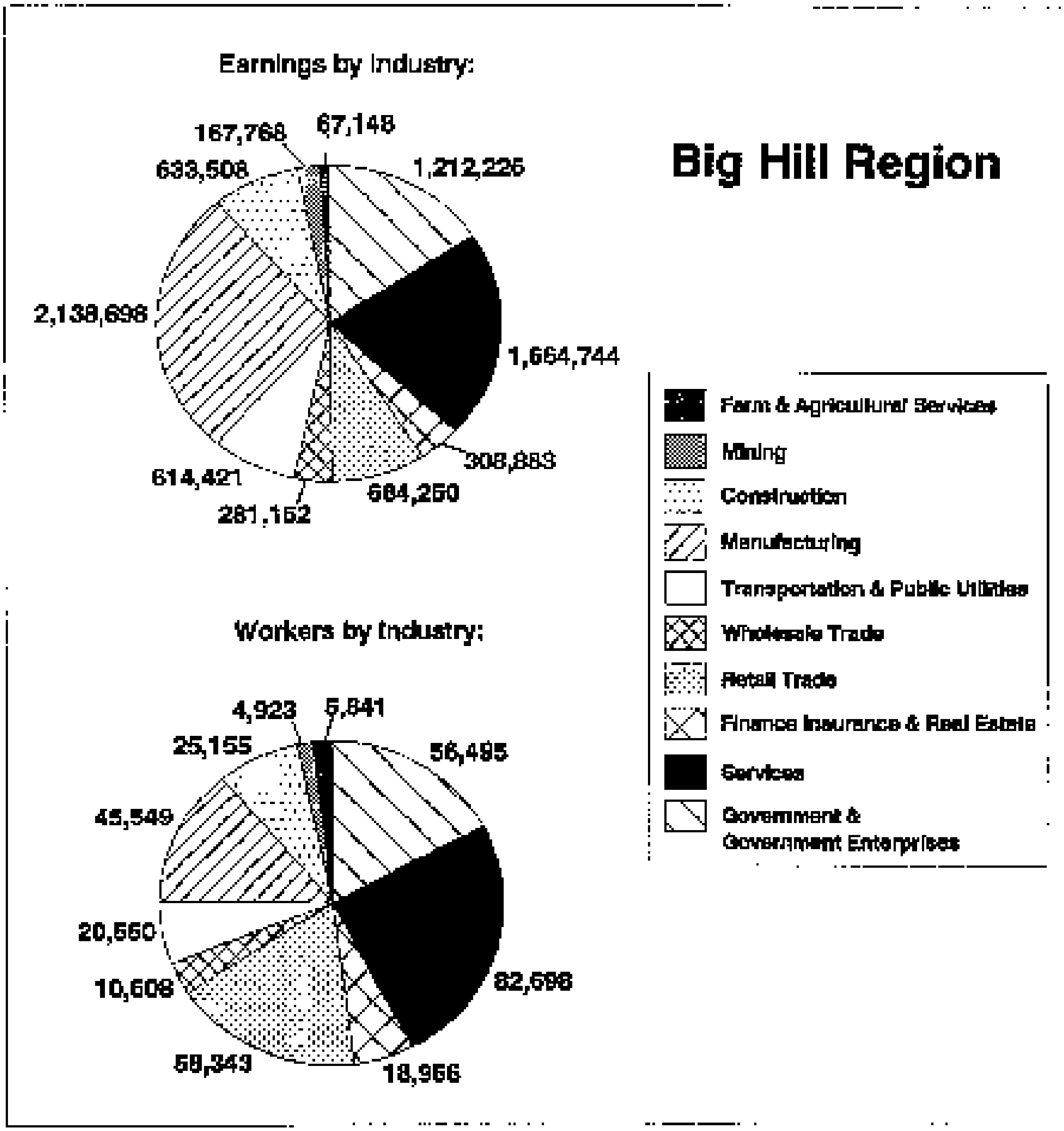
The Big Hill region is served by numerous well-developed transportation systems. These include a Federal interstate highway, State and county roads, railroads, bus service, open water ports, barge traffic along the ICW, and general aviation airports. Approximately 32,500 vessels travelled on the ICW between Galveston and the Sabine River in 1989, of which more than half were tankers.[76] Figure 5.1-12 illustrates the Big Hill Region's transportation network, highlighting the primary and secondary highways, railroads, ports on the Gulf of Mexico, and airports.

Figure 5.1-10
Jefferson County Industry Earnings and Workforce, 1989



Source: Personal Income by Major Source and Earnings by Industry, Table CA5.2, Full-time and Part-time Employees by Major Industry. Table CA2.5 U.S. Department of Commerce, Bureau of Economic Analysis, 1989.

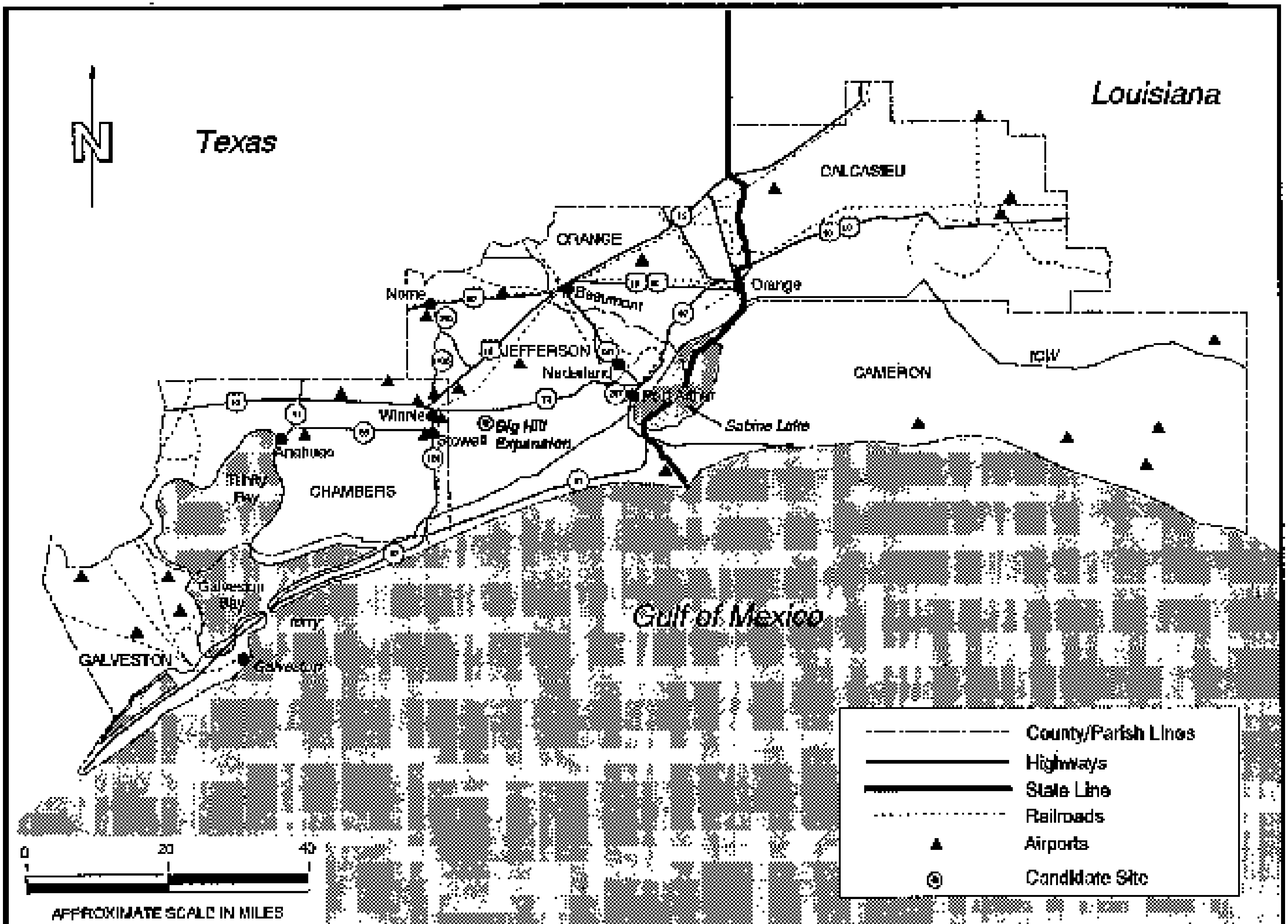
Figure 5.1-11
Big Hill Region Industry Earnings and Workforce in 1989



Source: Personal Income by Major Source and Earnings by Industry, Table CA5.2.
Full-time and Part-time Employees by Major Industry, Table CA2.5
U.S. Department of Commerce, Bureau of Economic Analysis, 1989.

Figure 5.1-12

Transportation Systems in the Big Hill Region



Source: U.S. Geological Survey

Interstate Highway 10 (I-10), a major national east-west highway, passes ten miles to the northwest of the Big Hill site. Highway I-10 merges with U.S. 90 near Beaumont, and continues to the east before crossing into the State of Louisiana. The segment of I-10 directly northwest of the site is rather heavily used, carrying averaging approximately 260,000 vehicles per day.

Table 5.1-10 summarizes road characteristics and traffic statistics (1990) for potential commuting routes to and from the Big Hill site. Cities and towns of origin in the table reflect areas of heaviest density within a 30 mile radius of the Big Hill site. Commuter routes in the table were chosen based on minimizing the distance between the town of origin and the site. Texas State Highway 73, which passes six miles north of the site, is the closest highway to the site. Most of Highway 73's road surface is bituminous concrete, and its condition is rated "good" by the Texas Department of Transportation (DOT). Currently, entry into the site is made via a six-mile, two-lane county road. The road is maintained by Jefferson County and its surface varies from partial pavement to gravel. All on site roads have two lanes and are paved.

All roads specified as possible commuting routes, including bridges located along these segments, are designed to carry the standard highway maximum legal load of 80,000 pounds. Of the 124 bridges located along specified commuting routes to Big Hill, 27 have been identified by the Texas Department of Transportation as being in fair condition or below. In particular, seven bridges on State Highway 73 have been classified as fair to poor, including one structure, just south of U.S. Highway 287, described as being in serious condition. Construction has been underway on 16 bridges along U.S. Highway 10 for the past five years, and is expected to continue for another three or four years.

5.1.9.5 Housing and Public Services

The following sections discuss housing, health care, education facilities, and public utility services available in the Big Hill area.

Housing

There are approximately 312,000 housing units in the Big Hill region. Of this total, about 271,400 or about 87 percent were occupied during 1990. The remaining units were vacant because they were being offered for rent or sale, sold or rented, but not occupied, used seasonally for vacation or second homes, or used for migratory workers. Of the occupied units, approximately 67 percent were owner-occupied and 35 percent were renter-occupied.

The number of units available for either rent or sale in the Big Hill region numbered 17,043 during 1990. Of this total, 12,168 were rental units and 4,875 were units for sale (Figure 5.1-13). Together, Jefferson and Galveston Counties accounted for over 69 percent of the total available housing in the region. In Jefferson County, there were total of 101,289 housing units in 1990. Of this total, 3,729 were available for rent and 1,482 were up for sale. Of those housing units occupied during 1990, 66 percent were owner-occupied. Currently, about 30 percent of the present workforce at Big Hill lives in Beaumont, and about 25 percent residues in the town of Winnie and Stowell. The rest of the workforce is spread out among a larger area.

Table 5.1-10
Road Characteristics and Traffic Statistics for Likely Commuting Routes to Big Hill

City/Town of Origin	Route(s)	Distance[1] (miles)	No. of Lanes, Road Width	Daily Vehicle Counts[2] (1990)	Vehicle Capacity	% of Trucks	Number of Accidents (1990)
Beaumont	US 10 to 73 73E to Big Hill	17.6 7.7	4-6 lanes, 48-72 feet 2-4 lanes, 24-48 feet	27,500 4,800 - 6,800	NA	13.5 - 28.9 10.9 - 13	90 28
Nederland/Port Neches	347 SE to 73 73W to Big Hill	3.4 22.6	4-6 lanes, 48-84 feet 2-4 lanes, 24-50 feet	17,800 - 22,000 4,800 - 30,000	NA	2 - 2.7 8.8 - 10.9	76 145
Port Arthur	287 NW to 73 73W to Big Hill	2 20.8	4-6 lanes, 56-94 feet 2-4 lanes, 24-50 feet	29,000 4,800 - 24,000	NA	9.7 8.8 - 10.4	93 89
Winnie/Stowell	124N to 73 73E to Big Hill	2.4 7.1	4 lanes, 46-50 feet 2-4 lanes, 24-48 feet	6,800 - 10,700 4,800	NA	6.2 - 6.7 10.9 - 13	17 20
Anahuac	61E to 65 65E to 124 124N to 73 73E to Big Hill	2 15.5 2.4 7.1	2 lanes, 20-43 feet 2 lanes, 20 feet 4 lanes, 46-50 feet 2-4 lanes, 24-48 feet	2,100 790 - 1,150 6,800 - 10,700 4,800 - 6,800	NA	7.6 - 14.7 13.9 - 14.9 6.2 - 6.7 10.9 - 13	4 5 17 28
Nome	365S to 1406 1406 to 73 73E to Big Hill	4.3 12.4 5.8	2 lanes, 20 feet 2 lanes, 18 feet 2-4 lanes, 24-48 feet	1,450 - 1,700 830 - 1,700 4,800 - 6,800	NA	5.6 5.8 - 6.4 10.9 - 13	4 22 14

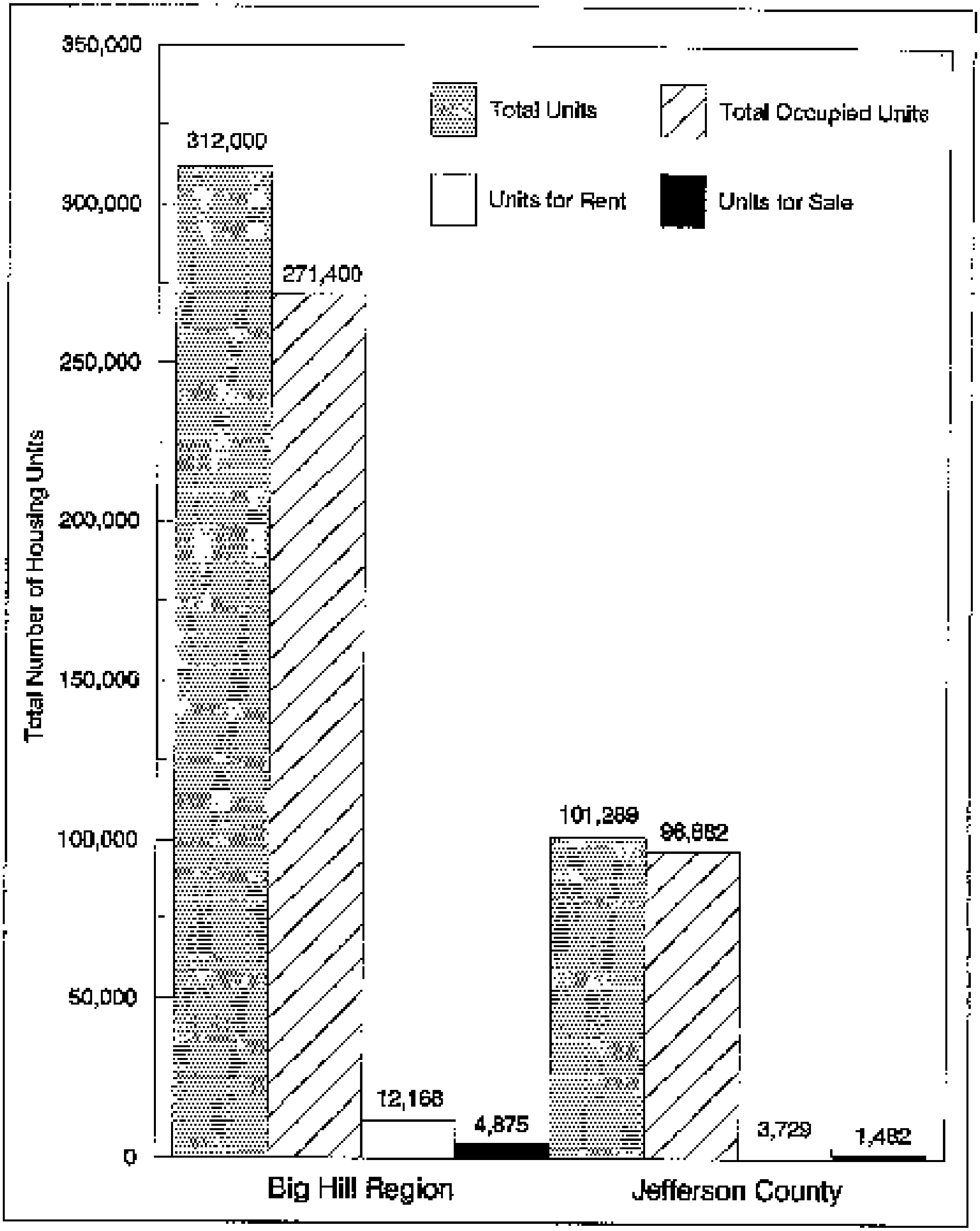
NA = Data were not available from the Texas Department of Highways.

[1] Distance and accident data reflect estimates from mile marker information by the Texas Department of Public Safety.

[2] Average number of vehicles traveling on road during 1990. Range is indicated where data for more than one point of the segement were available.

Source: Texas Department of Highways, Average Daily Traffic maps, 1990. Texas Department of Highways, Highway Planning Division, Roadway Information, 1990. Texas Department of Public Safety, Statistical Services Unit, Traffic Accident Statistics, 1990.

Figure 5.1-13
Housing in the Big Hill Region in 1990



Source: U.S. Department of Commerce, Bureau of the Census, 1990.

Health Care

In the Big Hill region, health care facilities vary widely from county to county. In 1990, there were 257 physicians practicing medicine (one for every 1,618 residents), and there were 4,231 hospital beds (one for every 174 residents). Jefferson County has 503 physicians or one for every 476 residents (Table 5.1-11). In its eight hospitals, Jefferson County has 1,928 beds or one for every 124 residents. The nearest hospitals to the site are Winnie Baptist Hospital, 25 minutes away, and Mid-Jefferson County Hospital in Nederland and St. Mary-Port Arthur Hospital, both 45 minutes away. A major trauma and burn center in close proximity to the Big Hill site is located at St. Elizabeth's Hospital in Beaumont, 55 minutes away. The rural counties (Cameron, Chambers, and Orange) have fewer physicians and hospital beds per resident than do the more urban counties. The State average for Texas is one physician for every 598 people and one hospital bed for every 239 people.

Education

Jefferson County encompasses six public school districts. There are 44,646 students in 63 public schools (Table 5.1-12). An additional 3,000 students attend ten private schools. The twelve public secondary schools are located in Sabine Pass, Hamshire-Fannett, Port Arthur, and Beaumont. Impacts on schools from an influx of worker's children are discussed in section 7.1.9.8.

Utilities

Gulf State Utilities (GSU), an investor-owned electric utility company headquartered in Beaumont, Texas, currently supplies electrical power to the Big Hill facility. GSU serves more than 550,000 customers within a 28,000 square mile area of Southeast Texas and South Central Louisiana. Near Big Hill, GSU has a 138 kilovolt (kV) transmission line that runs east to west from Port Arthur to Stowell, parallel to and just south of State Route 73. To service the current Big Hill facility, GSU tapped into this transmission line. From the tap point on the transmission line, one line runs south through the DOE electrical power substation at Big Hill, and a second line reverses direction north to the transmission line to create a loop. Creation of a loop allows power to be supplied from two possible directions in case a problem occurs with one of the lines. The transformer located in the DOE substation steps down the voltage from the transmission line to about 13.8 kV for distribution at the facility.

5.1.9.6 Government Revenues and Expenditures

The Federal government spent almost $2.3 billion in the Big Hill region in 1990 (Table 5.1-13) or about $3,000 per capita. More than one-third of that spending, $875 million or more than $3,500 per capita, was in Jefferson County. Local government expenditures in 1987 were $1.2 billion; $385 million was spent by governments within Jefferson County (see Table 5.1-14).

The proposed Big Hill expansion site has an assessed value of about $400 per acre according to the Jefferson County tax assessor office. In 1990, property taxes of 1.9 percent included a county tax, a school district tax, a water navigation district tax, and a Trinity Bay district tax. Property tax paid on the proposed 200-acre site in 1990 totalled approximately $1,500.00.

Table 5.1-11
Health Care Facilities and Personnel, 1990

Parish or County	Hospitals	Hospital Beds	Residents per Bed	Physicians	Residents per Physician
Jefferson	8	1,928	124	503	476
Cameron	1	33	281	2	4,630
Calcasieu	7	1,177	143	259	649
Chambers	2	106	190	9	2,232
Galveston	4	782	287	135	1,160
Orange	1	205	393	49	1,643
Region	23	4,231	174	957	1,618

Source: Texas Health Department, Health Facility Licensure and Certification Division, Health Data and Policy Analysis Division, 1990.

Table 5.1-12
Jefferson County Education Data, 1990

Jefferson County	Number of Schools	Number of Students	Average $/Student	Average Number of Students/Teacher
Public Primary (K-8)	51	35,909	3,660	19
Secondary (9-12)	12	8,737	N/A	15
Private (K-12)	10	3,000	N/A	N/A

Source: Texas Education Agency, Department of Research and Development, 1990.

5.1.9.7 Emergency Response Capabilities

In the event of a major emergency at the Big Hill facility, assistance would be provided by the available services in Jefferson and Chambers counties, including police, fire, and emergency medical services from the Beaumont/Port Arthur metropolitan area and surrounding towns. In Jefferson County, there are five municipal police departments, one County Sheriff's department, and one Texas State police branch. Chambers County has one municipal police department at Mont Belvieu, and a County Sheriff's office at Winnie/Stowell. The nearest municipal police department to the Big Hill site is the Port Arthur police department; the first response to an emergency at the Big Hill site, however, would likely come from the Chambers County Sheriff's

Table 5.1-13
Federal Government Expenditures in the Big Hill Region, 1990
(Thousand Dollars)

County	Expenditures
Jefferson	874,803
Chambers	60,698
Orange	188,801
Galveston	611,655
Calcasieu	525,319
Cameron	17,574
Total	2,278,850

Source:
Bureau of Economic Analysis, U.S. Department of Commerce

Table 5.1-14
Local Government Expenditures in the Big Hill Region, 1987
(Thousand Dollars)

County	Expenditures
Jefferson	385,920
Chambers	99,499
Orange	42,578
Galveston	221,202
Calcasieu	28,310
Cameron	458,937
Total	1,236,455

Source:
Bureau of Economic Analysis, U.S. Department of Commerce

department in Winnie/Stowell, located 15 miles west. Other municipal police departments are located in Beaumont, Groves, Nederland, and Port Neches.

A total of twelve fire departments are located in Jefferson County, five of which are full-time and seven of which are volunteer. All Jefferson County firefighting personnel have received basic fire suppression training. Firefighters also received hazardous materials training, first aid and medical treatment, and training to respond to natural disasters and radiological incidents. The Sabine Neches Chief Association, a mutual emergency aid agreement between industries and municipalities, provides an additional response service to members in the area. Two of Jefferson County's fire departments, the volunteer departments at Hampshire and Labelle/Fannett, have associated ambulance and rescue units. Chambers County has a volunteer fire department in Winnie/Stowell about 15 miles from Big Hill. It is estimated that fire departments to the Big Hill site, including Beaumont, Port Arthur, and Hampshire, would take approximately 30 minutes to respond to an incident after notification.

Three ambulance and rescue units are available to the Big Hill site: Hampshire, Labelle/Fannett, and Beaumont. Each offers advanced (or paramedic) life support capabilities, and can respond to the Big Hill site within 30 to 45 minutes, depending upon the location. For additional information about health care and hospitals, see section 5.1.9.5.

In addition to these public services, Jefferson County has both an Emergency Management Plan and a Hazardous Materials Response Plan. The main purpose of these plans is to facilitate a coordinated and rapid response to any major emergency contingency. The county's Local Emergency Planning Committee (LEPC) participates in local drills planned by local industries and city governments, and the county's Emergency Management Office works along with local governments to respond to all emergencies.

5.1.9.8 Land Use

The Big Hill site is located in southwestern Jefferson County, Texas, and is positioned nine miles northwest of the Gulf of Mexico, about five miles north of the ICW, and some three miles north of the Spindletop Ditch (which is a barge canal connecting to the ICW). The closest residential areas are some five miles away near the unincorporated communities of Winnie and Stowell. These communities are centers for social and commercial activity for the surrounding rural areas. No land use analysis has been conducted in the area since that of the U.S. Geological Survey in 1973.

The existing Big Hill SPR site encompasses approximately 250 acres of land. Approximately 507 acres of surface area of Big Hill are enclosed within the 2,000-foot depth to salt contour and about 613 acres of dome's surface area are within the 3,000-foot depth contour. The present SPR site is developed in an upland area with elevation exceeding 35 feet above msl at the highest point. The site is situated within a small area of industrial-use land with large areas of croplands and pastures to the north and west, and extensive marsh lands to the south and southeast that stretch to the coast.[77]

Agricultural production is the primary land use in Jefferson County; over half of the acreage in the county is dedicated to farming. Farmers from the Big Hill region make their living primarily from growing rice and raising beef cattle. In 1987, rice was harvested in Jefferson County on approximately 28,300 acres yielding about 43 hundred weight (cwt) per acre.[78] In all, about one million cwt of rice were produced in Jefferson County during the same year. Cattle numbered about 28,200 with nearly 19,250 beef cows. In 1987, crop receipts totaled over thirteen million dollars, and livestock and related products totaled $4.5 million. Soybeans and sorghum are two other common crops in the area. Oil and gas production constitutes the other major land use activity in Jefferson County.

The proposed Big Hill expansion site contains no prime and unique farmland. The proposed Trinity Bay pipeline right-of-way contains a total of 380.8 acres of prime and unique farmland, as identified by the U.S. Soil Conservation Service. Of this, 116.9 acres are in Jefferson County, 192.1 acres are in Chambers County, and 71.8 acres are in Harris County. The proposed Interstate 10 pipeline right-of-way contains a total of 494.1 acres of prime and unique farmland, as identified by the U.S. Soil Conservation Service. Of this, 116.9 acres are in Jefferson County, 224.5 acres are in Chambers County, and 152.7 acres are in Harris County.[79]

Forestry statistics are only available for Jefferson and Chambers counties together, because the Forestry Service does not distinguish between these adjacent counties in its statistical reports. Of the one million acres in the two counties, about 72,000 acres are timberlands (i.e., forest land capable of producing at least 20 cubic feet of industrial wood per acre per year). Oak-gum cypress and natural loblolly-shortleaf pine trees constitute almost 75 percent of the forested sections in the two counties. Of the total forested acreage in the two counties, about 59,000 acres are considered sawtimber in sufficiently stocked areas. Sawtimber trees are those of commercial use that contain at least one twelve-foot saw log and meet regional specifications for freedom from defect.[80] This acreage sees a net annual growth of about 23 million boardfeet of sawtimber, and an annual removal of about eleven and a half million boardfeet.

There are no National Forest lands within Jefferson County. The McFadden National Wildlife Refuge, an important waterfowl habitat, however, occupies about 55,000 acres in Jefferson County, in an area south of Big Hill and north of the Gulf Coast.

5.1.10 Ambient Noise

The primary noise source near the proposed Big Hill expansion site is the existing 160-million-barrel SPR facility. Industrial hygiene inspections performed at the Big Hill facility provided the sound level survey data for operations at the site. These readings are a general guide to the sound levels produced by various SPR activities. According to the survey data, the major sound sources at the existing site consist primarily of raw water injection and brine disposal pumps.

The average sound level measured near the brine disposal pad was 106 dBA. The sound level measured near the well pad was 98 dBA. At the raw water intake structure, the sound level, measured 30 feet from the structure, was 79 dBA. Based on these data, which provide the worst case sound levels for the most problematic sound sources, it can be estimated that day-night (L_{dn}) sound levels 500 feet from the existing site would be comparable to a noisy urban area (i.e., 63 to 68 dBA). Following completion of cavern leaching, noise levels will fall off dramatically at the site as pumps will then be used only for oil transfer or in the event of an SPR drawdown.

The proposed expansion site at Big Hill is approximately a quarter mile from the raw water and brine disposal pumping stations at the current site. The proposed area is an extension of the existing cavern field and currently experiences very little noise disturbance. Because the major noise sources at the existing SPR site are some distance (i.e., over 1,000 feet) from the proposed expansion area, the proposed expansion area is assumed to have baseline L_{dn} sound levels comparable to a suburban area (i.e., 53 to 58 dBA). The nearest residence is over one mile from the expansion site and would, therefore, be outside the noise impact zone.[81] (See Appendix H for information on the methods used for estimating noise levels.)

5.2 Stratton Ridge (Seaway Complex Site)

The Stratton Ridge salt dome is also under consideration for SPR expansion in the Seaway Complex. DOE would accomplish this expansion by modeling development of this site after the existing Big Hill site. This would include site development; leaching of ten storage caverns, each with a capacity of ten MMB; construction of a raw water intake system; a brine disposal system; and a crude oil distribution system. The crude oil distribution system to be constructed would be identical under either the 270-day or 180-day drawdown criterion: an approximately one-mile spur to the existing DOE pipeline that connects Bryan Mound with Texas City.

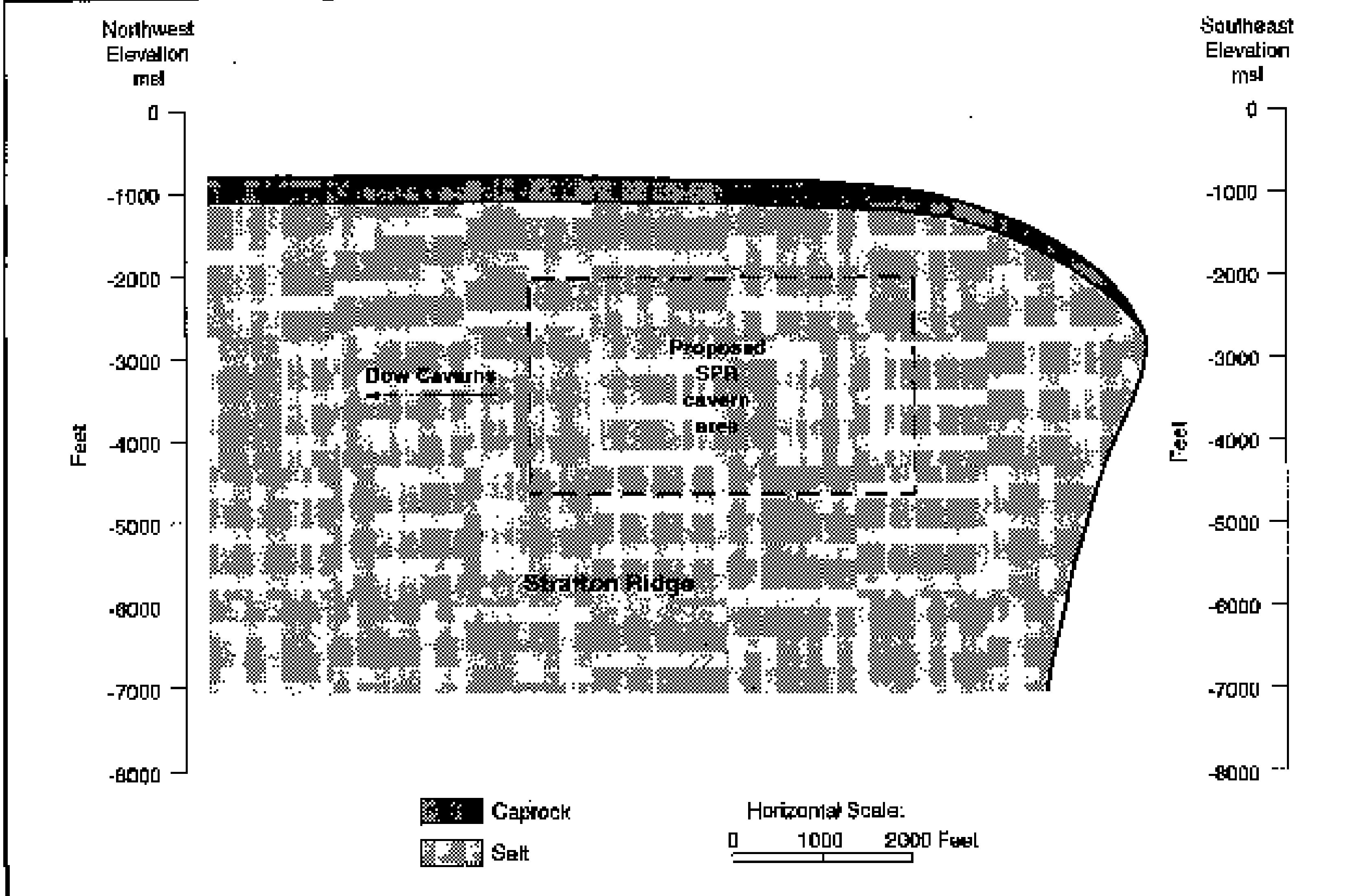
5.2.1 Geology

The Stratton Ridge salt dome lies six miles north of Freeport in Brazoria County, Texas. The site ranges from three to four meters above msl with a local topography characterized by the surrounding marshes, bayous, lakes, and creeks. Stubblefield Lake, Club Lake, Big Slough, and Oyster Creek are all adjacent to the site.[82]

A cross-section of the Stratton Ridge salt dome is presented as Figure 5.2-1. The Stratton Ridge salt dome is irregular in shape with a trough-like depression that extends generally in a north-south direction on the east-central part of the dome. This depression is apparently the result of an active slump fault at the site. Additionally, caprock shifting and associated casing failures are known to have occurred in the area of this suspected fault, causing the release of ethane into the caprock in at least one instance. Seismic work performed in December 1990 by Cockrell Oil Company demonstrates that this fault completely cuts off the east side of the dome with a 60 degree dip. There is a definite topographic rise on the upthrown side of the surface projection of this fault, supporting this interpretation. There is, however, ample room for SPR caverns on the high side of the fault, far enough back so that continuing fault movement would not damage well casings.[83] Further geophysical studies would be necessary to determine the best location for the caverns.

The salt dome is relatively large with approximate dimensions of three miles (north-south) by four miles (east-west). The top of the caprock is at a depth of 265 meters, and the top of the salt is at a depth of 390 meters. There is a salt overhang on the southeastern corner of the dome, but it would not affect the proposed SPR site because of the distance that would exist between the overhang and the proposed site.[84] Radial faulting, typically found around the perimeters of salt domes, exists on the southern edge of the dome. This faulting probably would not affect cavern development as it does not likely extend into the salt mass. Other faulting, which may not extend to the salt dome, has been identified in the caprock. These caprock faults are of a much smaller displacement, and the seismic reflection surveys conducted by both Dow and Amoco show that they are identifiable, and presumably avoidable.[85] Additionally, structural lows in the salt may be related to differential growth or rise in the salt mass, causing possible anomalous zones. Although such features are to be expected in domes the size of Stratton Ridge, they may manifest

Figure 5.2-1
Cross-Section of Stratton Ridge Salt Dome



Note: Cavern locations and depths are diagrammatic and only convey approximations.

Source: U.S. Department of Energy, Preliminary Site Geological Characterization for Strategic Petroleum Reserve (SPR) Expansion Candidates, Volume II, Sandia National Laboratories, Albuquerque, NM, March 1991.

themselves in the form of caprock faulting.[86] Despite these anomalies, it is estimated that there are 325 contiguous acres within the -640 to -1,250 meter depth range that are potentially suitable for the development of crude oil storage caverns with a potential storage volume of over 160 MMB.[87]

Fairly tight Beaumont clays extend throughout Brazoria County as the dominant surface or slightly subsurface soil.[88] The surface soils immediately overlying Stratton Ridge are the Edna fine sandy loam and the Edna-Aris complex. They feature a subsurface clay layer up to 1.5 meters thick, and are both poorly drained, have low permeabilities, and slow surface runoff. These soils would not readily permit water to pass into the water table. Other soil types surrounding the site, including the Bernard-Edna, the Narta, and the Sumpf clay, exhibit characteristics similar to the Edna series.[89]

Approximately 57 brine and petroleum product storage caverns with a wide range of sizes are currently in use at Stratton Ridge.[90] Subsidence is occurring over the extensive cavern field operated by a number of chemical and petroleum interests (i.e., Dow, Amoco, Conoco, and Occidental) at rates comparable to those experienced at existing SPR sites (i.e., likely between 9 and 35 millimeters (mm) per year).[91] Precise subsidence data for these privately-owned caverns are not available.

5.2.2 Hydrogeology

The site-specific groundwater characteristics of Stratton Ridge have not been studied to the same degree as those at Big Hill. Nonetheless, because Stratton Ridge overlies the same hydrologic units as Big Hill and is less than ten miles from Bryan Mound, which has been studied in detail, some inferences may be made about Stratton Ridge's site-specific groundwater characteristics.[92]

Bryan Mound's proximity to Stratton Ridge and their common strong influence from Freeport, the nearest large center of withdrawal from the aquifers underlying both sites, makes the two sites comparable. The surface elevation over each salt dome is approximately 15 feet above msl[93,94] (Stratton Ridge 17 feet, Bryan Mound, 15 feet). In addition, groundwater wells in both areas tap the same aquifers at similar depths.[95]

Table 5.2-1 characterizes the aquifer system underlying Stratton Ridge (permeabilities are based on Bryan Mound data). The Upper Chicot is the most widespread source of freshwater in Brazoria County, and the only one in the Stratton Ridge area.[96] In the region, the top of the freshwater zone in the Upper Chicot starts just above sea level, at about three meters bls, but has been recorded as high as one meter bls. This three to six meter thick zone is underlain by a four to six meter thick intervening discontinuous clay layer. Under this clay layer, another freshwater zone (still in the Upper Chicot) extends for another four to six meters. This second water-bearing zone generally occurs at depths of approximately nine to 19 meters bls, but in localized areas can be found at depths to 25 meters bls.[97] The virtually unconfined Lower Chicot begins at around 90 meters bls. A small amount of freshwater occurs in localized pools at approximately 90 to 120 feet bls near Stratton Ridge. The semiconfined Evangeline aquifer, beginning at approximately 340 feet bls near Stratton Ridge, is pierced by the salt dome. Near Stratton Ridge, the Evangeline contains saline water that generally is unsuitable for use. Again, the confined Jasper is too saline and too deep for local use. In the immediate vicinity of any salt dome, the groundwater becomes substantially more saline.[98] The Evangeline and deeper aquifers at Stratton Ridge are more saline at greater distances from the dome than at Bryan Mound.

Table 5.2-1
Characterization of Aquifers Underlying the Stratton Ridge Site

Aquifer	Depth to Top of Aquifer (meters bls)[a]	Overlying Soils/ Permeability (cm/sec)	Karst	Water Quality; Degree of Salinity[b]	Major Uses
Upper Chicot	-3	Beaumont clays at surface; 5×10^{-5} at surface to 9×10^{-4} in sands	None	Freshwater to Slightly Saline	Public, Irrig./ Agric.; Some industry
Lower Chicot	-90	Discontinuous clay beds; sands, 1×10^{-2}	None	Slightly Saline to Saline	Public, Irrig./ Agric.; Some industry
Evangeline	Away from dome, -340	Clay beds, join intermittently; 1×10^{-2} average in sands	None	Saline to Brine	None
Jasper	Away from dome, >-600	Burkeville Aquiclude; highly impermeable	None	Saline to Brine	None

a Below Land Surface.
b Salinity determined by dissolved solids content, in ppt: Freshwater, Less than 1 ppt; Slightly saline, 1-3 ppt; Moderately saline, 3-10 ppt; Very saline, 10-35 ppt; Brine, More than 35 ppt.
Sources: Groundwater Resources, Brazoria County; Gheraghty and Miller; *Engineering Aspects of Karst*, 1990 Annual Site Environmental Report; USGS Water Supply Paper 2220.

Development of groundwater resources in the Stratton Ridge vicinity appears more widespread than near Big Hill, although the types of uses are similar.[99] As mentioned previously, nearby Freeport, six miles from the site, is a major center of development requiring heavy pumpage from the Upper Chicot.[100] Movement of the local groundwater remains fairly constant as Freeport pumpage pulls the water in the same direction as the natural flow. The Lower Chicot and Evangeline are pumped more heavily by Houston wells, causing a northerly flow from the site in these aquifers.[101]

Because the area surrounding Stratton Ridge is less marshy than that around Big Hill, some public use and a significant number of industrial and irrigation/agricultural uses are represented in the immediate area. Most public and private drinking water wells tap the Upper Chicot, while agricultural and industrial wells tend to tap the more saline aquifers below.[102]

Municipal groundwater use is the principal source of groundwater discharge. Rainfall is the principal mode of recharge for all aquifers in Brazoria County.[103] This recharge occurs through Goliad sand outcrops, mostly in northern Brazoria County. The other aquifers are recharged by similar means in areas north of Brazoria County.[104]

With respect to the hydrogeology along proposed pipeline routes, the raw water intake and brine discharge pipelines run southeast toward the ICW and the Gulf of Mexico from the Stratton Ridge site. For most of its length, the proposed pipeline route is at least one mile from population centers. The one exception is the town of Surfside, which lies to the south of the ICW, where the brine discharge pipeline would pass within one mile of the community before entering the Gulf of Mexico. The aquifers in this limited area are the same units described in the regional characterization for Texas (section 4.2.1), but are more saline due to their proximity to the coast. While there are apparently few agricultural or industrial users of groundwater in this area, the public drinking supplies at Surfside are heavily dependent upon aquifers.[105]

Oil distribution at Stratton Ridge would be achieved via the existing Bryan Mound DOE pipeline that passes within one mile of the proposed Stratton Ridge site. DOE would construct a less than one-mile spur connecting the site to the existing 42-inch pipeline. Because of the close proximity to the site of the entire spur pipeline, the hydrogeological description of Stratton Ridge is applicable to this pipeline ROW as well.

5.2.3 Surface Water Environment

This section summarizes the baseline conditions of surface waters potentially affected by the proposed activities at Stratton Ridge. In particular, it briefly characterizes: (1) the Gulf of Mexico in the area of Stratton Ridge's proposed brine disposal pipeline and diffuser; (2) the ICW in the vicinity of the site's proposed raw water intake structure; and (3) inland water bodies surrounding the proposed site and crossed by pipelines.

5.2.3.1 Gulf of Mexico

Figure 3.2 2 shows the proposed diffuser location for the Stratton Ridge site. Because Stratton Ridge would be a newly developed site, DOE would have to construct a new brine discharge pipeline and diffuser. The proposed pipeline route would pass southeast from Stratton Ridge and extend to a diffuser approximately four miles from the Texas coastline near Freeport, Texas (at latitude 28°56'N and longitude 95°13'W).

The following sections briefly describe the baseline physical and chemical conditions for the proposed Stratton Ridge pipeline route and diffuser location in the Gulf. Oil and gas activities in the area are also briefly described. These conditions are discussed here because unlike Big Hill, which has an existing brine disposal system that has been characterized in detail in a previous SPR EIS, the Stratton Ridge system would be new. Climatology and biological conditions are described in sections 5.2.4 and 5.2.5, respectively, and a more detailed discussion of the baseline environmental characteristics associated with the proposed diffuser location in the Gulf is given in Appendix J. The information in this section was derived from existing data sources describing the northern Gulf of Mexico in general and from site-specific investigations for the Bryan Mound diffuser system located just 14 miles to the south.

Physical Conditions

The shallow nearshore Gulf region in which the Stratton Ridge proposed diffuser site is located is characterized by a highly variable environmental regime. Not only do temperatures show a wide seasonal range, but also the sediment system is continually disturbed, by both weather-related phenomena and shrimp trawling. In addition, the nearshore northwest Gulf is characterized by a highly variable salinity regime not often found in coastal areas. Continental runoff from rivers including the nearby Brazos River influences the surface salinity concentrations of estuarine and inner shelf waters. In fact, freshwater discharges from the Mississippi and Atchafalaya Rivers dominate much of the structure and function of the near coast ecosystem.[106] As observed at the Big Hill diffuser, salinity fronts associated with freshwater discharges from the Mississippi River system are expected to wash back and forth across the proposed Stratton Ridge diffuser site with the tides.

The most prominent nearshore features of the Stratton Ridge area include shallow bays, barrier islands, sand dunes, and relatively flat marshland that is dissected by man-made flood control structures. Oyster Creek and Drum Bay are environmentally sensitive areas lying inland near the diffuser area (see Figure 3.2-2). In addition, the Freeport Harbor Shipping Channel lies approximately three miles southwest of the proposed diffuser site.

Current patterns are the most significant factor in determining dispersal of brine. Wind stress, local runoff, and density stratification combine to shape the behavior of nearshore waters. Wind-driven currents predominate in controlling nearshore circulation and beach drift, while density gradients and vertical mixing of brackish and freshwaters have a major effect on tidal passes and estuaries. Data indicate that the prevailing current direction varies seasonally, and that currents can flow in any direction depending on which way the wind is blowing. One year-long study northeast of the proposed diffuser site, however, suggests that local currents are dominantly longshore to the west. Current speeds are also variable, with measured values ranging from 0.1 feet per second to 1.7 feet per second. Extremely strong currents can be caused by tropical storms and periods of stagnation can occur during calm meteorological conditions.

The continental shelf along the Texas coast is a smooth, featureless, gently sloping plain.[107] The Gulf floor in the diffuser area is generally smooth with a hard sandy bottom surface. The proposed 3,300-foot diffuser would be located in water ranging from 36 to 42 feet deep. Tides near the diffuser site have a vertical range of about three feet and a velocity of approximately half a knot.[108]

Chemical Conditions

The characteristics of the chemical factors in the nearshore Gulf of Mexico waters have been found to be highly dependent on the seasonal discharges of the Mississippi and Atchafalaya Rivers and the intrusion of deep marine waters. The upper water layers are generally highly influenced by the less saline, less dense riverine waters, while the bottom water layers are affected by the more saline, denser Gulf water. The seasonal changes in climatological conditions markedly affect the mixing and diffusion characteristics of these two water layers.[109]

Near-surface nutrient concentrations are low in open Gulf waters and generally increase toward shore, especially in the regions influenced by river runoff.[110] Trace metal and hydrocarbon concentrations tend to be high off the Texas coast, especially around oil rigs and platforms. While the major source of trace metals is the sediment brought in by rivers, this is supplemented by outflow from several highly polluted estuaries and by drilling muds and other waste associated with oil exploration and production activities. Hydrocarbons enter the northern Gulf waters from river outflow, the atmosphere, natural seepage, oil and gas production, local transportation, and ship traffic. High levels of synthetic organic chemicals, such as pesticides and polychlorinated biphenyls, which are also brought to coastal waters by rivers and streams, have been observed off the Mississippi River and in coastal bays and estuaries.

Oil and Gas Activities

NOAA's nautical charts, which identify only a selection of the extensive submerged pipelines and oil platforms in the Gulf, indicate that one offshore oil platform exists approximately one mile southwest of the proposed Stratton Ridge diffuser site. The next closest platform is located six miles southwest of the diffuser. In addition, a large submerged pipeline lies two miles north of the proposed diffuser site. This pipeline enters the Gulf of Mexico from the Swan Lake area, apparently close to the proposed brine pipeline route.

5.2.3.2 Intracoastal Waterway

The raw water required for cavern leaching and drawdown activities at the proposed Stratton Ridge site will be taken from the ICW, a major navigation channel maintained by the U.S. Army Corps of Engineers. The portion of the ICW in the vicinity of Stratton Ridge is less than one mile north of the Gulf of Mexico and runs parallel to the coastline (Figure 3.2-2). The waterway channel is approximately 250 feet wide with a controlled depth of twelve feet.

From the proposed site, the ICW extends northeastward to West Galveston Bay and southwestward to Matagorda Bay, covering a distance of just over 42 miles. This portion of the coast is unlike most of the Texas Gulf Coast where barrier islands are separated from the mainland by broad, shallow bays.[111] Land along the ICW is predominantly brackish marsh. Levees have been constructed along portions of the ICW; near the Brazos River, for example, ICW levees are 17 feet above msl.[112] Major water bodies intersecting this segment of the ICW include Cedar Lake, the San Bernard River, the Brazos River, Freeport Harbor, Oyster Creek, and Bastrop Bayou. The ICW is connected to the Gulf of Mexico by the Brazos River, Freeport Harbor, and a number of smaller channels.

The proposed RWI structure is located on the north bank of the ICW about 5,000 feet north of Oyster Creek, and across the ICW from the north end of Swan Lake (at 28°59'N and 95°16'W). The Brazoria National Wildlife Refuge borders both banks of the ICW beginning just northeast of the proposed RWI structure and continuing to Bastrop Bay. Freeport Harbor, the busiest commercial port near Stratton Ridge, intersects the ICW about three miles southwest of the proposed RWI structure. At a distance of about 2,200 feet to the northwest of the proposed RWI structure, the ICW bifurcates into the old ICW which enters Drum Bay, and the ICW main channel which passes north of Drum Bay. The old ICW is not maintained and no longer appears on some maps. Key features of the water bodies that intersect the ICW within five miles upstream and downstream of the proposed RWI structure are presented in Table 5.2-2.

The Brazos River is the most important freshwater tributary to the ICW near Stratton Ridge. The lower 25 miles of the river are brackish and tidally influenced. Tidal range at the mouth of the river is two feet.[113] Like the Brazos River, the ICW is tidally influenced and

Table 5.2-2
Characteristics of Surface Water Bodies Intersecting the Intracoastal Waterway Within Five Miles of the Proposed Raw Water Intake at Stratton Ridge

Surface Water System	Distance from RWI (miles)	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses[a]
Freeport Harbor	3.2	500	10	Tidal	No downstream public intake	None	Salt	Barge traffic
Dow Barge Canal	3.2	300	10	–	No downstream public intake	None	Salt	Barge traffic
Oyster Creek	0.9	150	5	329 (200-554)	No downstream public intake	None	Brackish	Contact recreation, high quality aquatic habitat
Swan Lake	0.6	3,600	2	Lake	No downstream public intake	None	Salt	No designated uses
Old ICW	0.4	100	8	--	No downstream public intake	None	Brackish	Barge traffic
Nicks Cut/Nicks Lake	3.5	3,000	3	--	No downstream public intake	None	Brackish	No designated uses
Drum Bay	3.5	5,000	2	Tidal	No downstream public intake	None	Brackish	Barge traffic

[a] Although not explicitly established as a use for these waters, they all may be used for recreation (e.g., fishing).

brackish. Influence of the Brazos River on the ICW, however, is limited by locks on each side of the intersection of the river. These locks are operated by the U.S. Army Corps of Engineers to keep detritus and silt from entering the ICW during periods of elevated flow.[114]

At the intersection of the ICW and Freeport Harbor, the reported salinity range is eight to 40 ppt. Surface water quality data collected from the ICW near its intersection with the Brazos River show an average surface dissolved oxygen concentration of 3.5 milligrams per liter (mg/l), and an average temperature of 80°F.[115] At Oyster Creek, an average dissolved oxygen level of 6.4 mg/l and an average temperature of 73°F were reported by the Texas Water Commission.[116] Water quality of lakes and tributaries intersecting the ICW in the Stratton Ridge region generally meet established surface water criteria. Violations of dissolved oxygen and fecal coliform criteria, however, have been observed by the Texas Water Commission. Additionally, low pH and elevated metal concentrations have been reported in the Freeport Harbor.[117]

5.2.3.3 Inland Water Bodies

For the purpose of this characterization, inland water bodies potentially affected by the Stratton Ridge expansion have been organized into: (1) waters within a five-mile radius of the proposed site itself; and (2) waters crossed by proposed pipelines.

Water Bodies Within Five Miles of the Proposed Site

The candidate SPR expansion site at Stratton Ridge lies on the Strand Plain of Texas in the San Jacinto-Brazos Coastal Basin.[118] Significant bodies of water in this area include the Brazos River, the San Bernard River, Chocolate Bayou, and Austin Bayou. Most of the basin's streams are tidal and drain into Galveston Bay. The candidate site is relatively flat with elevations ranging from five to 15 feet above msl, with stormwater and surface runoff generally draining to the south and east. Between 1951 and 1988, an average of 44 inches of rain fell annually at Bay City Waterworks, Texas, roughly 36 miles west of the dome.[119] Four unnamed ponds and one stream exist on the candidate site, and within five miles there are 28 named water bodies. Key features of all of these water bodies are characterized in Table 5.2-5. Water bodies closest to the site and/or of regional significance include Oyster Creek, Chubb Lake, Round Lake, Shank Lake, Dutch Lake, Freshwater Lake, Horseshoe Lake, Ridge Slough, Big Slough, Stubblefield Lake, Salt Bayou, and Salt Lake. Oyster Creek is of particular significance because it has been designated by the State as high quality aquatic habitat. It runs along the southern border of the candidate site and flows to the ICW. Square Island Lake and the Brazos River, both about four miles from the proposed Stratton Ridge site, as well as Bastrop Bayou located about five miles from the proposed site, also have been designated by the State as high quality aquatic habitat.

Of the four ponds located within the candidate site boundaries, three are in the northern corner and the fourth is in the southcentral portion. These ponds have no significant tributaries or outflows, and are all less than four acres in size. The stream originates on the site and drains to the south.

Pipeline Crossings

Crude oil from Stratton Ridge would be distributed in the existing DOE pipeline from the SPR facility at Bryan Mound to Texas City. Utilization of this pipeline would require the

Table 5.2-3
Characteristics of Surface Water Bodies in the Area of the Proposed Stratton Ridge Site

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses[a]
Oyster Creek	30 feet	ICW	100	3	329 (200-554)	No downstream public intake	None	Brackish	Contact recreation, high quality aquatic habitat
Cheth Lake	0.6	None	1,300	2	Lake	No downstream public intake	None	Fresh	No designated uses
Big Slough	1.4	None	100	1	Negligible	No downstream public intake	None	Fresh	Drainage, irrigation
Little Slough	2.7	Bastrop Bayou	10	1	Negligible	No downstream public intake	None	Fresh	No designated uses
Bastrop Bayou	4.6	Cox Lake, Lost Lake, Bastrop Bay	120	2	39.2 (27-66)	No downstream public intake	None	Brackish	Contact recreation, high quality aquatic habitat
Square Island Lake	4.0	Bastrop Bayou	1,100	2	Lake	No downstream public intake	None	Fresh, Brackish	Contact recreation, high quality aquatic habitat
Salt Bayou	1.0	Salt Lake	10	1	Negligible	No downstream public intake	None	Brackish	No designated uses
Salt Lake	4.8	Slop Bowl, Nicks Lake	5,000	2	Lake	No downstream public intake	None	Salt	Boat traffic
Stubblefield Lake	1.5	Salt Bayou	500	2	Lake	No downstream public intake	None	Fresh	No designated uses
Ridge Slough	2.2	Slop Bowl	10	1	Intermittent	No downstream public intake	None	Fresh	Drainage
Shanks Lake	1.5	None	200	1	Lake	No downstream public intake	None	Fresh, Brackish	No designated uses

Table 5.2-3 (Continued)
Characteristics of Surface Water Bodies in the Area of the Proposed Stratton Ridge Site

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses[a]
Freshwater Lake	4.4	None	500	1	Lake	No downstream public intake	None	Fresh	No designated uses
Horseshoe Lake	2.8	None	400	1	Lake	No downstream public intake	None	Fresh	No designated uses
Dutch Lake	1.6	None	400	1	Lake	No downstream public intake	None	Fresh	No dsignated uses
East Union Bayou	2.7	ICW, Flag Lake Drainage Canal	50	2	32.7	No downstream public intake	None	Brackish	No designated uses
Essex Bayou	4.1	ICW	20	1	Negligible	No downstream public intake	None	Brackish	No designated uses
Round Lake	4.6	None	1,100	1	Lake	No downstream public intake	None	Fresh	No designated uses
Old Brazos River	4.6	ICW	500	10	–	5,380	22,244	Brackish	Navigation
Brazos River	3.7	ICW, Gulf of Mexico, Dow Canal	450	7	8,050	8,000	22,244	Brackish	Contact recreation, high quality aquatic habitat
Follet Lake	2.2	None	1,600	2	Lake	No downstream public intake	None	Fresh	No designated uses
Ash Lake	1.2	None	1,600	1	Lake	No downstream public intake	None	Fresh	No designated uses
Lake Barbara	3.3	None	650	2	Lake	No downstream public intake	None	Fresh	No designated uses
Clute Lake	2.4	None	700	2	Lake	No downstream public intake	None	Fresh	No designated uses

Table 5.2-3 (Continued)
Characteristics of Surface Water Bodies in the Area of the Proposed Stratton Ridge Site

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses[a]
Flag Lake	4.0	Flag Lake Drainage Canal	200	2	Lake	No downstream public intake	None	Fresh	No designated uses
Eagle Lake	3.2	None	400	2	Lake	No downstream public intake	None	Fresh	Drainage
Lake Bend	2.9	Oyster Creek	400	3	Lake	No downstream public intake	None	Fresh	No designated uses
Dow Barge Canal	2.7	ICW, Old Brazos River, Gulf of Mexico	300	10	Tidal	No downstream public intake	None	Brackish	Barge traffic
Flag Lake Drainage Canal	2.5	East Union Bayou	100	2	Negligible	No downstream public intake	None	Fresh	Drainage

[a] Although not always designated explicitly by the State as a use, many of these water bodies also appear to be used for recreational fishing and boating.

construction of an approximately one mile spur connecting Stratton Ridge to the existing pipeline. The spur would cross no water bodies.[120] The existing pipeline from Bryan Mound to Texas City, however, crosses numerous bayous and other water bodies, of which Chocolate Bay and Bastrop Bayou are the most substantial.

The raw water and brine pipelines follow the same ROW from the expansion site to the ICW, eight miles away. The raw water line ends at this point, but the brine pipeline continues on, nine miles in a southeasterly direction, to the diffuser in the Gulf of Mexico.[121] The predominant water bodies crossed by this pipeline route include Ridge Slough, Essex Bayou, and the ICW. Ridge Slough and Essex Bayou are characterized in Table 5.2-3, and the ICW is characterized in section 5.2.3.2.

5.2.4 Climate and Air Quality

The Stratton Ridge site lies in a generally humid area that is strongly influenced by offshore meteorological conditions. Generally, the characteristics of the coastal area where the site is located include high wind speeds, frequent east to southeasterly winds, small daily temperature ranges, slightly high humidity, and regular storm activity.[122] Wind and storm conditions off the Gulf Coast have a pronounced influence on variations in water height in this area. The average summer air temperature for the area is 83°F; the average winter air temperature is 54°F. Annual precipitation averages 44 in/yr.[123]

Stratton Ridge is located in Brazoria County, Texas, which is a nonattainment area for ozone. The Stratton Ridge site does not have an air quality monitoring station; however, the Texas Air Control Board maintains a monitoring station nearby in Clute/Freeport, located three miles southwest of the Stratton Ridge site. In 1988, the one-hour ozone standard was exceeded on three days. Additionally, the Texas Air Control Board maintains a monitoring station in Texas City, approximately 35 miles northwest of the site. At this monitoring station, the NAAQS for ozone was exceeded on five days in 1989; the highest ozone measurement was recorded on April 21, 1989, registering 0.16 ppm.[124] In addition to petroleum refineries and petrochemical industries, significant local pollution sources include transportation vehicle emissions and combustion of industrial fuels.

5.2.5 Ecology

The following section describes the ecology of the Stratton Ridge area, including vegetation, wildlife, and rare, threatened, and endangered species at the proposed site, the biological communities offshore in the Gulf of Mexico, and those that are expected to be encountered along proposed pipeline routes. The information presented here is from a site visit conducted in June 1991, information obtained from various Federal and state agencies, and previous SPR documents.

5.2.5.1 Ecosystems at the Site and Nearby

This section characterizes the ecology at the site and in nearby areas. Discussion is provided for vegetation, terrestrial and aquatic life, rare, threatened, or endangered species, and other biological resources of potential concern.

Vegetation

The proposed Stratton Ridge site is located within the Prairie Parkland province, in an area classified as Oak and Bluestem Parkland.[125] The proposed site is characterized by emergent wetlands, open parkland forests with extensive stands of mature live oak, and abandoned farmland and orchards. Dominant canopy species are live oak and water oak. Figure 5.2-2 shows wetland and upland habitats at and near the proposed site.

Several wetland areas (as shown on National Wetland Inventory maps) occur within the proposed site boundaries. The majority of these are palustrine forested wetlands dominated by sedges and rushes. Plants that occur in these wetlands include mud plantain, duckweed, frogbit, white water lily, water lettuce, soft rush, a sedge, pennywort, Eleocharis sp., and smartweed. Texas water locust saplings occur along the edge of the large emergent wetland located near the central portion of the eastern boundary.

A large palustrine forested wetland complex dominated by deciduous trees occupies the northwest corner of the proposed site. Numerous very large live oaks and water oak (greater than six feet in diameter at breast height) are located in or near this wetland complex. Passion flower vine and trumpet creeper vine are prevalent on these trees.

Along an old roadbed extending east to west through the south-central portion of the site numerous small pocketed wetlands occur. Species observed include palmetto, wild petunia, smartweed and various sedges. A stream that was not on the topographic maps of the area was identified along this roadbed, as was a fairly extensive wetland complex associated with this stream, which consists of water oak in the canopy, and water elm, Chinese tallow tree, and yaupon as understory species..

Much of the site is open parkland-type forest dominated by live oaks and water oaks. Water elm and water tupelo also are present in the canopy. Common understory species are American holly, water elm, dahoon, yaupon, and sweet bay. Devil's walkingstick and shining sumac are very prevalent. Vines observed include butterfly pea, trumpet creeper, and wild grape. Very little herbaceous layer exists; sparsely distributed grasses and forbs occur in several areas.

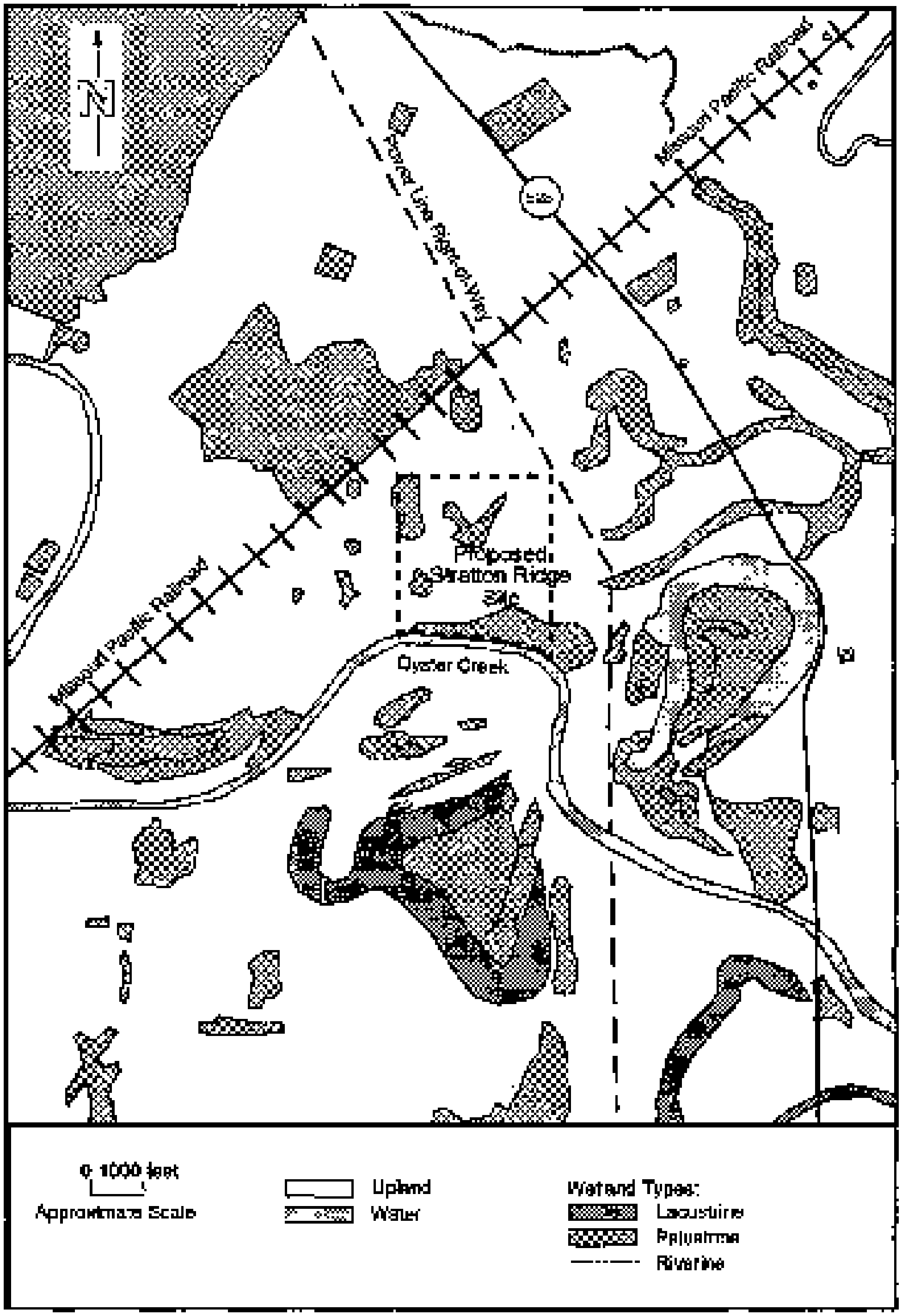
Along the old roadbed through the south-central portion of the site are osage orange, honey locust, pecan, white ash, and dogwood. Yaupon, Chinese tallow tree, water oak, and live oak also are common species. Understory vegetation consists of milkweed (in the open areas of the roadbed), blackberry, and palmetto.

Terrestrial Wildlife

Bird species observed during the site visit are Carolina chickadee, pileated woodpecker, black duck, black vulture, northern cardinal, buteo hawk, ibis (overhead), and crows. Large groups of black vultures were observed along the power lines east of the site. Mammals observed during the site visit are nine-banded armadillo, raccoon, and an abundance of swamp rabbits. Much of the area is used for or accessible to grazing cattle. Feral pigs also inhabit the area.

Figure 5.2-2

Wetlands and Upland Habitats: Proposed Stratton Ridge Site



Source: National Wetland Inventory Map; Oyster Creek, TX Quadrangle

Aquatic Life

As described in section 5.2.3.3, there are four unnamed ponds (each less than four acres) on the site, and an intermittent stream in the northern portion of the site. Based on observations made during the site visit, however, it is likely that several of the wetlands on the site also contain sufficient water to support a variety of aquatic species. The dominant flora found in these waters are typically green algae, diatoms, and bluegreen algae. Common zooplankton include rotifers, copepods, cladocerans, and nematodes, while amphipods, corixids, larval dipterans and beetles are the dominant benthic macroinvertebrates. Oyster Creek flows along the southern boundary of the proposed site. Other inland water bodies of primary significance near Stratton Ridge include Bastrop Bayou, Nicks Lake, and Salt Lake. Fish typically found in inland water bodies in the area include gizzard shad, carp, gar, and sport fishes such as largemouth bass, channel catfish, and several species of sunfish and crappie.[126]

Threatened or Endangered Species

Based on information supplied by the Texas Department of Parks and Wildlife, there are no reported occurrences of endangered or threatened species at the proposed site. One species listed as rare in Texas, the three flower broomweed, and two rare natural communities, the Water Oak-Coastal live oak series, and the Coastal live oak-loam series, are reported to occur within the Oyster Creek quadrangle which encompasses Stratton Ridge. Note that the species and series are not listed in Appendix D because they are not designated as endangered or threatened by Texas or USFWS. Twenty-one endangered or threatened species are reported to occur within Brazoria County.

Other Biological Resources of Concern

Breeding habitats for both endangered and non-endangered bird species near the site are of special concern. Two bird rookeries which were active in 1990 occur near the proposed site (Table 5.2-4). The Freeport Dow rookery, located approximately six miles south-southeast of the site, is a breeding ground for least terns and black skimmers. The Dow Gate rookery, located approximately five miles south-southeast of the site, is another breeding ground for least terns. A third rookery for least terns, located approximately three miles south of the site, was inactive in 1990 but active in 1989.

Table 5.2-4
Bird Rookeries Near the Proposed Stratton Ridge Site: Location, Activity in 1989 and 1990, and Major Species

Bird Rookeries	
Freeport Dow, 28 57'N 95 18'W (a)	Dow Gate A-40, 28 57'N 95 19'W (a)
Least Terns	Least Terns
Black Skimmers	
	Dow Tern, 28 59'N 95 21'W (b)
	Least Terns

(a) Active during 1990 survey.
(b) Active during 1989 survey.
Source: Texas Parks and Wildlife Department, 1991

5.2.5.2 Ecosystems Crossed by Pipelines

Table 5.2-5 lists ecological areas of interest that are crossed by the pipelines for Stratton Ridge based on a Gulf Coast Ecological Inventory map (USFWS 1982). The proposed pipeline spur to Bryan Mound does not cross any areas of ecological interest. Two state endangered or threatened species, the Florida Sandhill crane and the wood stork, could use areas along the proposed water intake and brine pipelines as breeding or nesting areas. In addition, 21 endangered or threatened species are reported to occur within Brazoria County, the county in which the crude oil spur route, RWI route, and brine pipeline route are located. See Appendix D for a detailed listing and references. Tables 5.2-6 and 5.2-7 list other species which may occur along the proposed pipeline routes. In Appendix E, a biological assessment is presented for federally listed species that USFWS reported as possibly present along the pipeline routes.

A previous EIS for SPR construction in Brazoria County, where Stratton Ridge is located, discussed the aquatic environment of coastal Texas as two general groups: coastal waters and inland waters.[127] Coastal waters in this area are excellent nursery habitats for juvenile shrimp and fish. Circulation within the enclosed lakes and bays is typically poor, with low species diversity but high population densities. In areas where circulation is better (i.e., areas with a strong tidal influence), the conditions are reversed, with high species diversity but low densities. Fish species characteristics of the nearshore environment include Atlantic threadfin, Atlantic croaker, sand seatrout, and silver seatrout. Phytoplankton, especially diatoms, are responsible for the majority of the production in these areas, and zooplankton are seasonally abundant, with densities peaking in late spring and early fall following phytoplankton abundance. Nematodes, amphipods, copepods, ostracods, mollusks, and polychaetes are the predominant benthic animals in the region.[128]

Oysters occur in all Texas bays in variable numbers.[129] Texas oyster reefs are most successful in shallow bays and mudflats (most occur at depths from three to six feet), but they can be found as deep as 40 feet in intertidal areas and channels. The coastwide abundance of oysters in Texas is generally declining, primarily due to overharvesting and dredging activities. The Galveston Bay system is the State's major oyster producing area — the West Bay of this system is the nearest one to Stratton Ridge. West Bay is connected to the northeastern edges of Christmas and Bastrop Bays, more than eleven miles from Stratton Ridge. Pollution due to oil and gas production, pesticide runoff, and sewage disposal are all recognized as detrimental to oyster populations. Some reefs in Galveston Bay are closed to fishing due to high levels of fecal coliform bacteria.

Drum Bay is connected to the ICW approximately four miles from the proposed RWI structure, while Christmas Bay is connected to the northeastern portion of Drum Bay more than five miles from the proposed RWI structure.

The Christmas Bay complex, which is part of the larger Galveston Bay system, consists of Christmas Bay, Bastrop Bay to the north, and Drum Bay to the south. Christmas Bay is a highly productive estuarine environment that supports 96 species of fish, 68 species of crustaceans, 140 species of mollusks, and 41 species of polychaetes. One of the Bay's most unique features is the relative abundance of submerged aquatic vegetation (seagrass beds). Once common estuarine flora, submerged aquatic vegetation has been decreased by approximately 90 percent in recent years.[130] In Christmas and Drum Bays, however, 191 acres of seagrasses remain, representing 56 percent of the remaining submerged aquatic vegetation in the Galveston Bay system. Sea

Table 5.2-5
Areas of Habitat Use Within One-Half Mile of the Proposed Pipelines from Stratton Ridge

Area	Pipeline Type	
	Water (E)	Brine (E)
Breeding	X	X
Nursery		
Adult concentration	X	X
Migratory	X	X
Commercial harvesting		
Sport fishing/hunting		
Wildlife refuge/Management area	X	X

E = Pipeline crosses an area of the following endangered species: Florida Sandhill Crane, Wood Stork.
Source: Gulf Coast Ecological Inventory Maps, Houston, TX and Bay City, TX. U.S. Fish and Wildlife Service, 1982.

grasses found in Christmas Bay include: turtle grass (several tiny patches), clover grass (more common), shoalgrass (dominant species), and widgeon grass (common, especially in spring).[131] These beds provide important habitat for many juvenile marine organisms, and are the most productive vegetation in the Galveston Bay system; however, they are also the least abundant habitat and are vanishing at a rapid rate.

Other important species found in the Christmas Bay complex include: eastern oysters (breeding; nursery; commercial harvesting), white shrimp (nursery; summer), brown shrimp (nursery; winter/spring), blue crabs (nursery), drum (nursery; spring-fall), sheepshead (nursery; spring-fall), and southern flounder (nursery; spring-fall).[132]

Because Drum Bay is a dead end flushed only by tidal action and winds, its circulation is poor. The Bay does have two small outlets, Nicks Cut and the western end of the original ICW; the latter outlet feeds into the current ICW. Drum Bay generally supports the same flora and fauna as Christmas Bay, but not in the same abundance. This is primarily because Drum Bay is subject to wide temperature fluctuations and receives very little fresh water.[133]

Bastrop Bayou, which is the major source of fresh water for the Christmas Bay complex, supports essentially the same important species as the Bay does for some distance upstream. Additionally, coral heads and rock outcroppings have been observed off the mouth of Brazos

Table 5.2-6
Species Likely to be Found Along the
Proposed Stratton Ridge Brine and Raw Water Pipeline Routes

BIRDS AND DUCKS
Egrets
Florida sandhill crane [S]
Geese
Herons
Mottled duck
Roseate spoonbill
Shorebirds
Scissortailed flycatcher
Snowgeese
Songbirds and others
Warblers
Waterfowl
Woodstork [S]
MAMMALS
Coyote
Nutria
Raccoon
River otter

[S] indicates species protected by State legislation.

Source: Gulf Coast Ecological Inventory Map, Bay City, TX. U.S. Fish and Wildlife Service. 1982.

River Diversion Channel. These are unique habitats for this area, as most substrate is sand or mud, and may produce regionally unique floral and faunal assemblages.[134]

5.2.5.3 Ecosystems Near the Brine Diffuser Location in the Gulf of Mexico

Characterization of the baseline biological conditions near the proposed Stratton Ridge diffuser site is limited by a lack of specific data for that location. Therefore, this summary draws on both general information for the Gulf and specific studies done for Bryan Mound. The generalized information for the Gulf is relevant because the biological community along the inner continental shelf off the Louisiana and Texas coastlines is fairly constant. Similarly, the site-specific data for Bryan Mound are relevant because of the proximity of Bryan Mound and Stratton Ridge (the diffusers from these two sites would be separated by 14 miles) and the baseline biological communities at the two diffuser sites are believed to be similar to each other.

The Texas coastline is generally irregular and characterized by a series of estuaries, bays, and rivers. These highly productive areas support a broad diversity of species. In addition, coastal areas serve as important spawning and nursery grounds for many marine species. The Texas offshore region, including the proposed Stratton Ridge diffuser site, contains a wide variety of habitats for marine biota, both in the water column and on the seafloor. The biological

Table 5.2-7
Species Likely to be Found Along the Proposed Stratton Ridge Crude Oil Spur Route

BIRDS AND DUCKS	
Black skimmer	Shorebirds
Dabbling ducks	Snow goose
Egrets	Songbirds and others
Gulls and terns	Wading birds
Herons	Waterfowl
Seabirds	
FISH	
Atlantic croaker	Largemouth bass
Black crappie	Longear sunfish
Black drum	Pigfish
Blue catfish	Pinfish
Bluegill	Red drum
Buffalos	Redear sunfish
Carp	Sand seatrout
Channel catfish	Sea catfish
Drum	Sheepshead
Flathead catfish	Southern flounder
Freshwater drum	Southern kingfish
Gafftopsail catfish	Spotted bass
Gars	Spotted seatrout
Green sunfish	Stripped mullet
Gulf kingfish	Warmouth
Gulf menhaden	White crappie
Ladyfish	
INVERTEBRATES	**REPTILES AND AMPHIBIANS**
Blue crab	Diamondback terrapin
Brown shrimp	
White shrimp	

Source: Gulf Coast Ecological Inventory Map, Houston, TX. U.S. Fish and Wildlife Service. 1982.

communities that exist in this region have acclimated to the wide variations in environmental conditions (salinity, temperature, currents, nutrient levels, etc.) summarized in section 5.2.3.1 and described in more detail in Appendix J.

Studies suggest that plankton in the Stratton Ridge area are relatively abundant and diverse. Diatoms and, to a lesser extent, dinoflagellates dominate the phytoplankton community by varying amounts in different seasons. A study done off the Texas coastline found copepods to be the most abundant type of zooplankton.[135] Like phytoplankton, zooplankton abundance varies in number and species and with respect to time and space.

Benthos constitute the portion of the offshore biota that is most likely to be affected by pipeline construction and brine discharge. The benthic communities of the Texas coast are distributed largely by sediment type and water depth. Factors that also control the occurrence of benthic organisms are salinity, temperature, currents, and food availability. The benthic communities that comprise the nearshore northwest Gulf of Mexico are characterized by numerical domination by a few species, especially polychaetes and crustaceans. Over 290 species of benthic macroinvertebrate infauna have been identified in the vicinity of Bryan Mound and Stratton Ridge.[136]

The ichthyofauna in the Bryan Mound studies has been dominated by a very few species whose year to year abundance continues to fluctuate widely. Species that are consistently abundant in the northern Gulf include longspined porgy, silver sea trout, Atlantic bumper, shoal flounder, striped anchovy, and Gulf butterfish.[137]

Eighteen endangered or threatened vertebrate species are reported to occur in the western Gulf (Appendix D). However, only a few of these species are considered common to the area. Kemp's Ridley sea turtles, for example, may be found around oil rigs and banks. None of these species, however, has been noted in studies done in the general vicinity of the proposed Stratton Ridge diffuser site. A biological assessment of potentially impacted marine species is presented in Appendix E.

The Gulf of Mexico off Texas supports major commercial and recreational fisheries. Estuary-dependent species dominate the commercial fishery resources, and approximately 1.5 million acres of estuaries play a dominant role in Texas' commercial fishery. Texas ranked third among the central and Western Gulf states in total commercial fishery landings for 1989 with nearly 96.4 million pounds landed. Both white and brown shrimp are fished commercially in the waters surrounding the proposed Stratton Ridge diffuser site, and sport fishing near the site is popular, especially during summer months.[138]

5.2.6 Floodplains

The Stratton Ridge storage site would cover approximately 200 acres at an elevation of approximately ten to 15 feet above msl.[139] The site itself lies in a floodplain region (see Figure 5.2-3).[140]

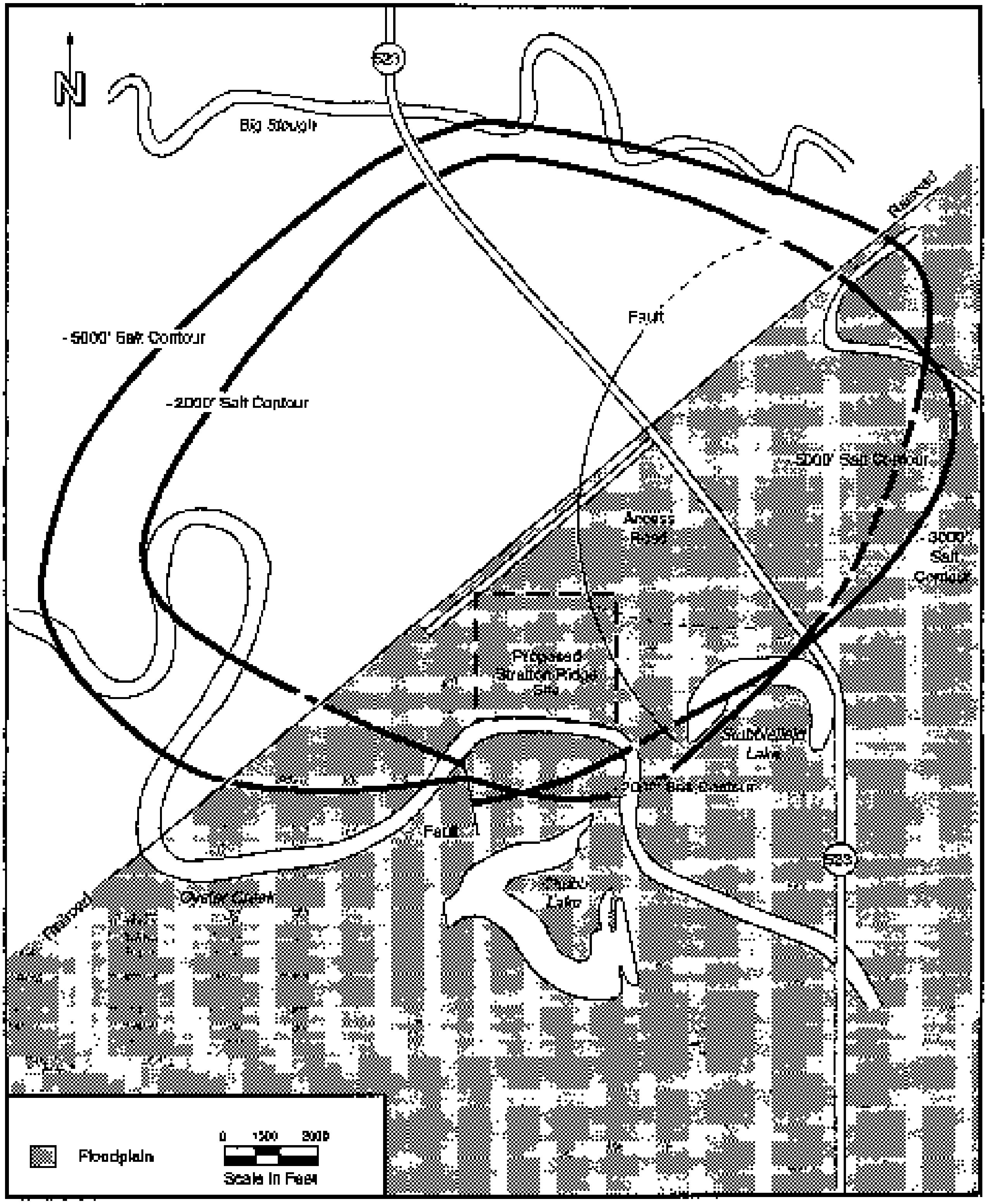
The crude oil pipeline, approximately a one-mile tie-in to the existing Bryan Mound to Texas City line, would pass through floodplain; approximately three miles of the brine disposal and raw water pipelines, which will share the same ROW, would be constructed through wetlands.[141] In addition, a RWI structure would be constructed at the ICW in floodplains.

5.2.7 Natural and Scenic Resources

The area around the proposed Stratton Ridge storage site includes several wetland areas, old-growth forests, and cattle grazing fields. Approximately 46 acres of wetlands exist within the proposed site that could sustain populations of aquatic life.

The Brazoria National Wildlife Refuge in Angleton, Texas, is located approximately three miles east and south of Stratton Ridge. Slop Bowl Marsh, a State-managed area, is located approximately four miles east-southeast, within the boundary of Brazoria National Wildlife Refuge. Bryan Beach State Park and San Bernard National Wildlife Refuge are also located near the proposed site.

Figure 5.2-3
Floodplains at Stratton Ridge Salt Dome



Source: Brazoria County Engineering Department, August 1991.

5.2.8 Archaeological, Historical, and Cultural Resources

DOE contacted the Texas Archeological Research Laboratory for information on culturally important resources in the area and vicinity of the proposed Stratton Ridge site. In response, the Research Laboratory performed a file search and a search of the National Register of Historic Places 1966-1988 catalogue. There are no recorded archaeological or historical sites located within the Stratton Ridge project area nor any sites that would be affected by the construction of an SPR facility at Stratton Ridge. Nearby sites, however, at Stubblefield Lake and along the bank of Oyster Creek, indicate the possibility of encountering unrecorded sites within the project boundaries of Stratton Ridge.

There are no identified archaeological, historical, or cultural sites in the immediate path of the pipelines or at the site of the proposed RWI structure. There are four identified sites in the general area of the pipelines; each of the sites (HR47, HR408, HR682, and HR74) are historic or prehistoric shell middens. None of these sites are currently listed or proposed for listing on the National Register.[142]

5.2.9 Socioeconomics

Stratton Ridge is located in the southern part of Brazoria County, Texas, within a few miles of the Gulf Coast. Surrounding Brazoria County on the Texas Gulf Coast are Galveston County to the north and Matagorda County to the south. Galveston, the largest city in the region, is about 35 miles northeast of the site. Bay City (37 miles) and Lake Jackson (five miles) are also within this three-county region.

5.2.9.1 History and Cultural Patterns

Brazoria County was at one time inhabited by Native American tribes, primarily the Karankawa. European settlement did not begin until after the War of 1812 when Moses Austin secured a land grant from Mexico to establish a settlement in Spanish Texas. In 1821, Austin's son, Stephen F. Austin, began the process of settlement on land between the Colorado River and the Brazos River, calling the region, Brazoria. Southern Brazoria County is where modern Texas began. A conflict developed between Mexico and the Texans when the Mexicans realized the extent of Texan influence in the Brazoria settlement, and that Anglo-Americans outnumbered Mexicans ten to one. In December 1831, shots were fired in the "Brazoria Incident," which was to become the first show of force in the Texas Revolution. Brazoria was among the earliest counties established by the Republic of Texas in 1836.

The Alabama-Coushatta Native American Reservation, located in Livingston, TX, is 110 miles north of the Stratton Ridge site. Because of the distance, the Native Americans are not expected to have any concerns with site development or expansion.

5.2.9.2 Population

The three Texas counties (Brazoria, Galveston, and Matagorda) comprising the Stratton Ridge region grew in population from 405,800 in 1980 to 445,218 in 1990, about a ten percent increase. During this ten-year period, however, there was considerable fluctuation in the area's population. For example, after increasing almost eight percent in the first half of the decade, the population actually decreased between 1985 and 1989. Population growth was sufficiently robust in the last two years to surpass the peak reached in 1985. Brazoria County contributed most to the area's growth, increasing from 169,587 in 1980 to 190,891 in 1990, an increase of 12.6 percent. The population of Galveston County also increased during this period, from 195,940 in 1980 to 217,400 in 1990, an increase of 11.0 percent. Matagorda County, the most rural and least populous county in the region, experienced a slight decline in population from 37,828 in 1980 to 36,928 in 1990, a drop of 2.4 percent.

Brazoria County is a mostly rural county with more than half of the population residing in rural and unincorporated areas. Most of the county's other population is concentrated in several cities and towns with population greater than 10,000 (Figure 5.2-4). Together, the towns of Lake Jackson (22,720) and Alvin (19,222) account for about 22 percent of Brazoria's population. These two cities are approximately five and 22 miles from the Stratton Ridge site, respectively. Clute, with a population of 9,577, is the closest incorporated town to the Stratton Ridge site. Overall, significant growth is projected for the entire three-county region during the next decade, particularly in Brazoria County. According to estimates by the U.S Bureau of Census and the Texas Water Board, Brazoria County will reach a population of 268,000 by the year 2000.

5.2.9.3 Economic Activities

The size of the workforce in the Stratton Ridge region fluctuated during the early 1980s, but has remained relatively constant during the latter half of the decade, reaching a high of 215,085 in 1989. In the period between 1980 and 1989 the regional unemployment rate reached highs of 10.7 percent in 1983 and 11.3 percent in 1986 during economic downturns, but fell to 7.7 percent in 1990 (Figure 5.2-5). Brazoria County's high unemployment rate paralleled that of the region during the 1980s and to a large extent resulted from the depressed state of the energy industry.

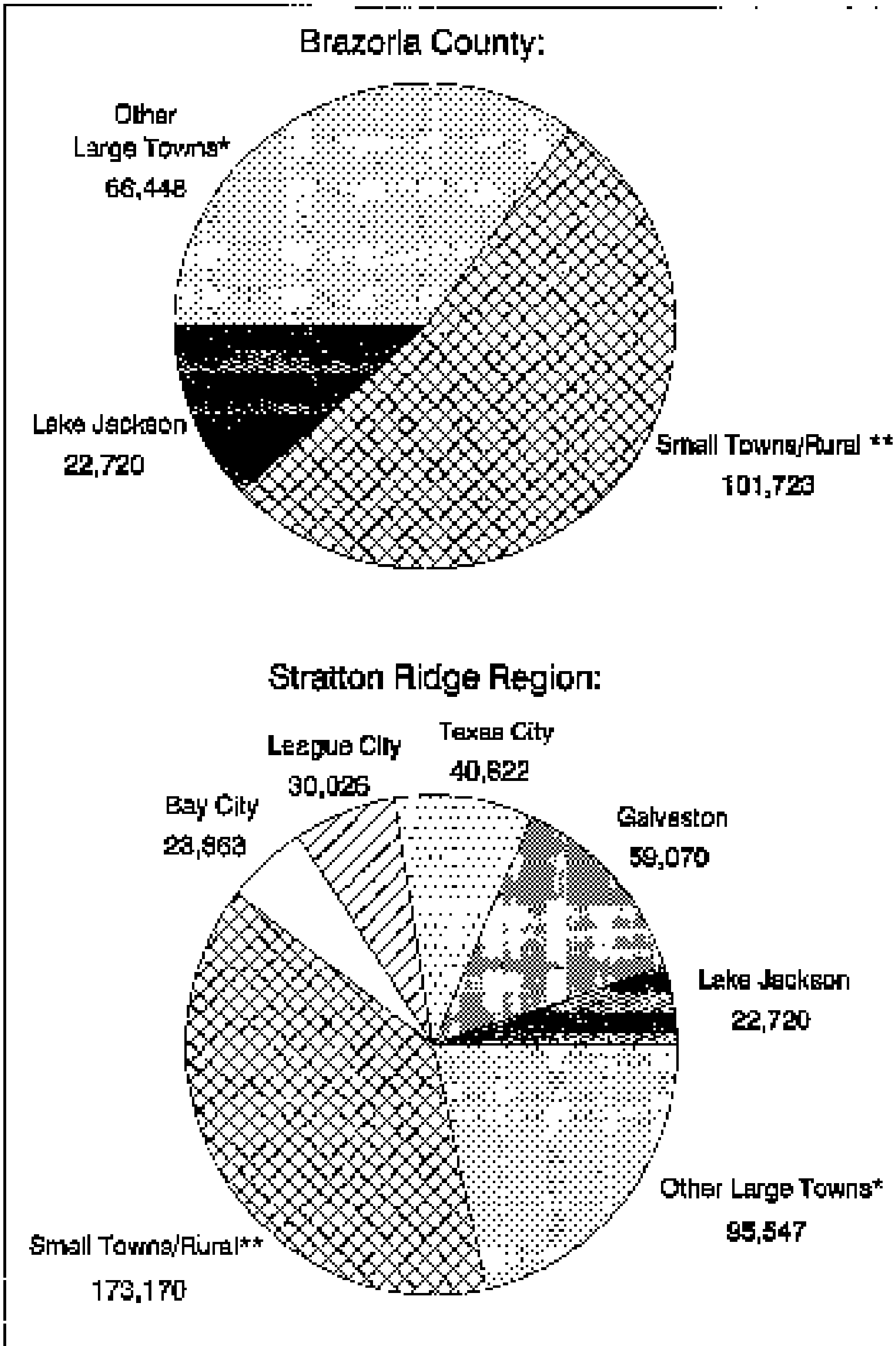
The dominant industrial sectors in Brazoria County in terms of employment and earnings are manufacturing, services, retail trade, and government services (Figure 5.2-6). Together these four sectors employ about 71 percent of the total workforce and account for 61 percent of the industry earnings. These same sectors also account for the majority of economic activity in the region as a whole (Figure 5.2-7).

Total annual industry earnings in Brazoria County were approximately $2.02 billion or $23,440 per worker in 1989. For the Stratton Ridge region, industry earnings totaled over $4.55 billion or $21,178 per worker. Brazoria County had the highest per-worker earnings of the three-county region, and Matagorda had the lowest.

5.2.9.4 Transportation Systems

The area surrounding the Stratton Ridge site is interconnected by a number of Texas State highways and county roads. There are no Federal Interstate or U.S numbered highways in the immediate vicinity of the site. Texas State farm-road 523, which links Angleton to the north and Freeport to the South, is the closest road to Stratton Ridge. The road surface of farm-road 523 is made of bituminous concrete and sheet asphalt and is classified as in "good" condition. Entry into the site would be made via an access road from 523. Currently, no paved access road exists. Figure 5.2-8 depicts the transportation network for Brazoria, Matagorda, and Galveston Counties.

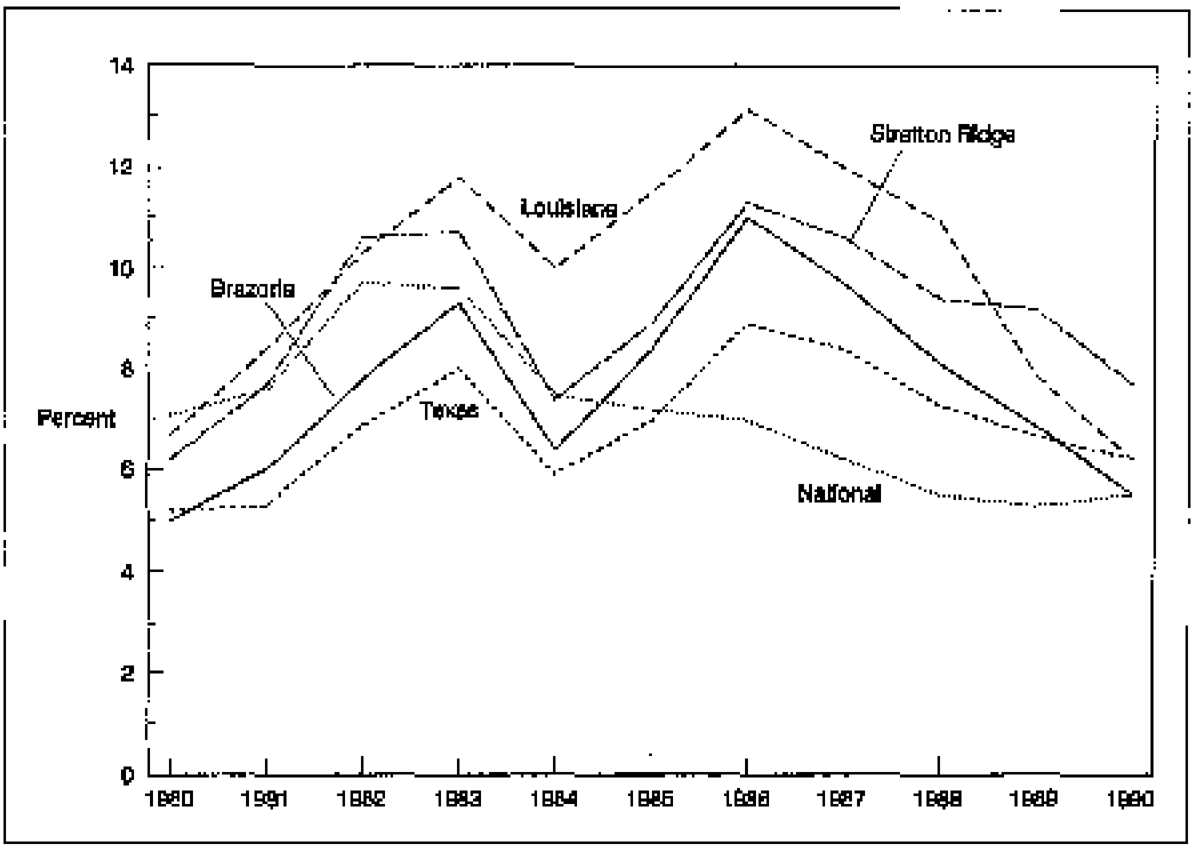
Figure 5.2-4
Population Distribution in Brazoria County
and the Stratton Ridge Region in 1990



* Cities and towns with population greater than 10,000 residents
** Towns and rural areas with population less than 10,000 residents.

Source: STF-1A. Selected Highlights of the 1990 Census. Table 1.
U.S. Department of Commerce, Bureau of Census.

Figure 5.2-6
Unemployment Rate in the Stratton Ridge Region, 1980-1990

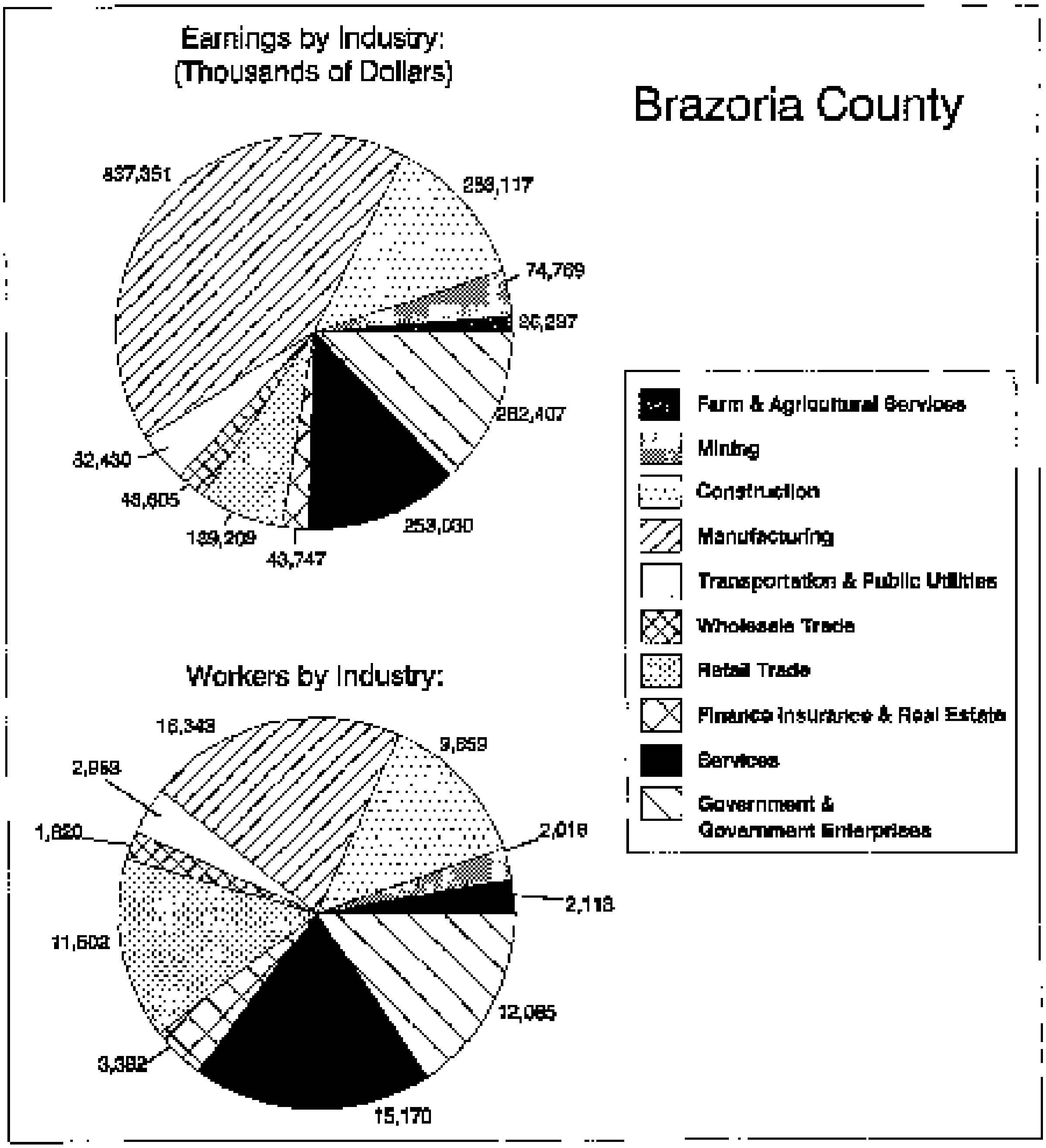


Source: U.S. Department of Labor, Bureau of Labor Statistics, 1990.

Other major roads in the vicinity of Stratton Ridge include Texas State Highway 288 that connects Angleton with Lake Jackson. Table 5.2-8 summarizes road characteristics and traffic statistics (1990) for road segments likely to be used by a prospective work force at Stratton Ridge. Cities and towns of origin reflect population centers within a 30-mile radius of Stratton Ridge. Commuter routes were chosen based on existing transportation networks and minimal distance between town of origin and Stratton Ridge.

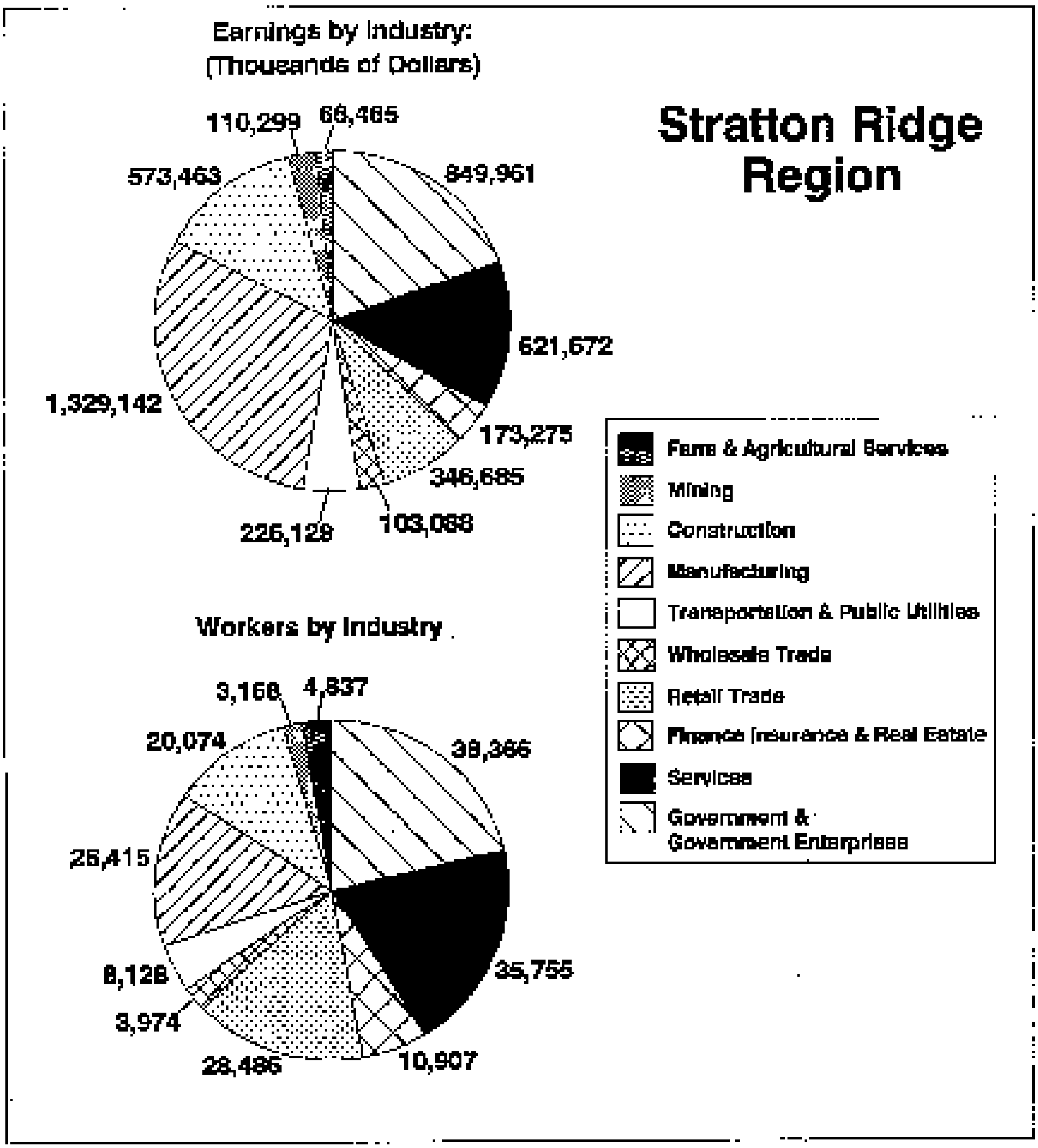
All highways specified as likely commuting routes to Stratton Ridge, and nearly all of the 84 bridges along these routes, are designed to carry a maximum legal load of 80,000 pounds. The only structure that is not capable of carrying this weight is located three miles south of Freeport, Texas on Route 1495 over the Intracoastal Canal. The bridge consists of timber spans with a swing barge main span and has a posted maximum weight limit of 28,000 pounds. Six bridges along specified commuting segments have been identified as being in fair to poor condition. Currently, no bridges are under construction or rehabilitation in this area.

Figure 5.2-6
Brazoria County Industry Earnings and Workforce, 1989



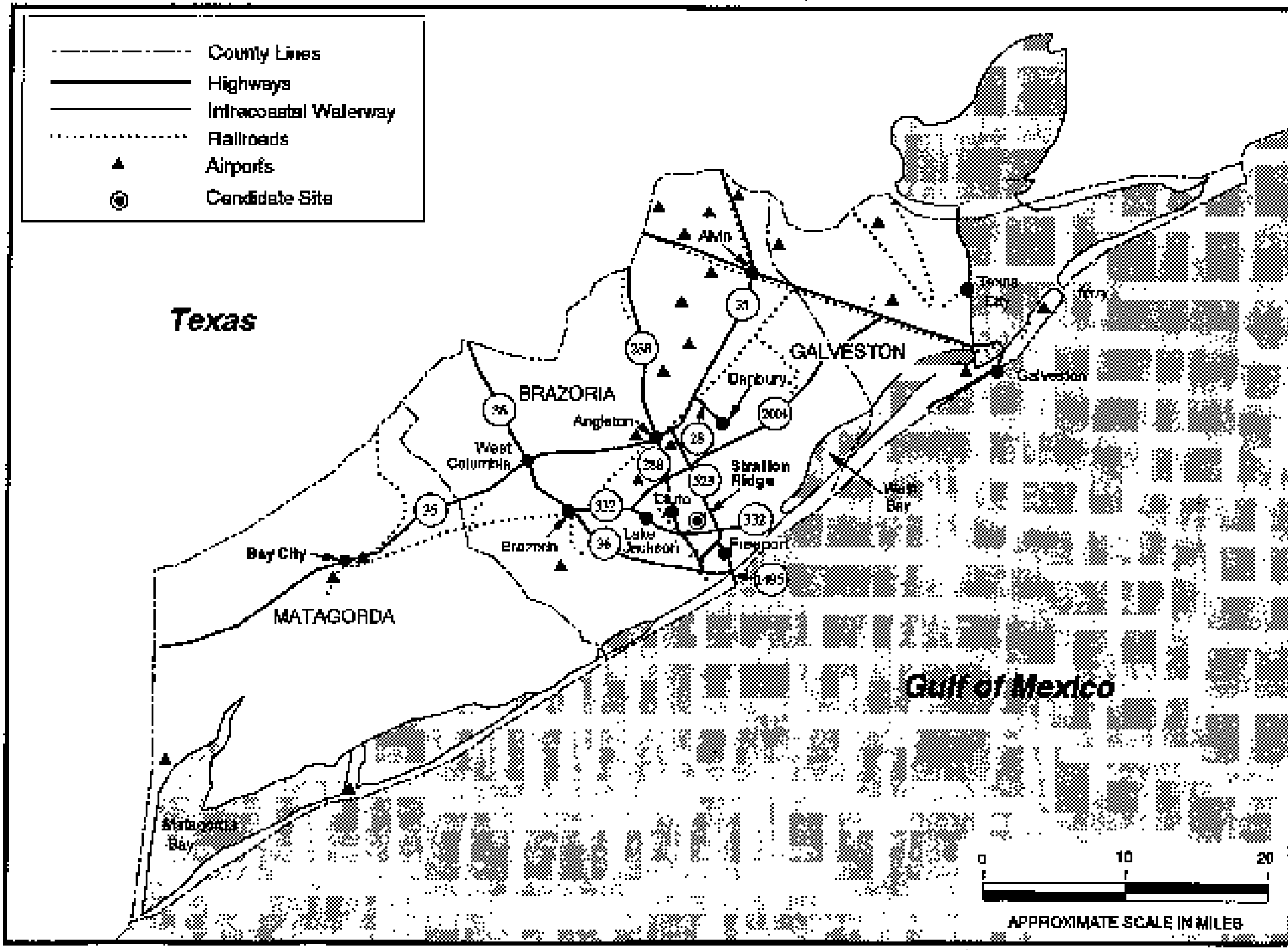
Source: Personal Income by Major Source and Earnings by Industry, Table CA5.2.
Full-time and Part-time Employees by Major Industry, Table CA2.5
U.S. Department of Commerce, Bureau of Economic Analysis, 1989.

Figure 5.2-7
Stratton Ridge Region Industry Earnings and Workforce in 1989



Source: U.S. Department of Commerce, Bureau of Economic Analysis, 1989.

Figure 5.2-8
Transportation Systems in the Stratton Ridge Region



Source: U.S. Geological Survey

Table 5.2-8
Road Characteristics and Traffic Statistics for Likely Commuting Routes to Stratton Ridge

City/Town of Origin	Route(s)	Distance[1] (miles)	No. of Lanes, Road Width	Daily Vehicle Counts[2] (1990)	Vehicle Capacity	% of Trucks	Number of Accidents (1990)
Angleton	35E to 523 523S to Stratton Ridge	3.8 9.2	2-4 lanes, 23-51 feet 2 lanes, 22-24 feet	10,400 - 10,800 4,800 - 7,100	NA	9.4 - 10.7 3.1 - 3.9	25 67
Lake Jackson	332E to 523 523N to Stratton Ridge	3.5 5.8	4 lanes, 48 feet 2 lanes, 22-24 feet	10,400 - 16,300 4,800 - 7,900	NA	8.1 3 - 3.6	37 14
Clute	288S to 332 332E to 523 523N to Stratton Ridge	4.4 NA 5.8	4 lanes, 46-48 feet 4 lanes, 48 feet 2 lanes, 22-24 feet	16,700 16,300 4,800 - 7,900	NA	12.9 - 14.9 8.1 3 - 3.6	NA NA 14
Freeport	1495N to 523 523N to Stratton Ridge	NA 5.8	2-4 lanes, 24-48 feet 2 lanes, 22-24 feet	5,900 - 6,300 4,800 - 7,900	NA	3.2 - 5.6 3 - 3.6	NA 14
Brazoria	332E to 523 523N to Stratton Ridge	15.8 5.8	4 lanes, 48 feet 2 lanes, 22-24 feet	10,400 - 16,300 4,800 - 7,900	NA	8.1 3 - 3.6	209 14
West Columbia	35E to 523 523S to Stratton Ridge	13.6 9.2	2-4 lanes, 23-51 feet 2 lanes, 22-24 feet	10,400 - 10,800 4,800 - 7,100	NA	9.4 - 10.7 3.1 - 3.9	101 67
Danbury	28N to 35 35W to 523 523S to Stratton Ridge	1.2 6.6 9.2	2 lanes, 20 feet 2-4 lanes, 24-60 feet 2 lanes, 22-24 feet	1,400 - 2,100 5,900 - 10,400 4,800 - 7,100	NA	5.4 - 5.7 9.6 - 12.9 3.1 - 3.9	0 29 67

NA = Data were not available from Texas Department of Highways.

[1] Distance and accident data reflect estimates from mile marker information by the Texas Department of Public Safety.

[2] Average number of vehicles travelling on road during 1990. Range is indicated where data for more than one point of the segment were available.

Source: Texas Department of Highways, Average Daily Traffic maps, 1990. Texas Department of Highways, Highway Planning Division, Roadway Information, 1990. Texas Department of Public Safety, Statistical Services Unit, Traffic Accident Statistics, 1990.

There are several airports in the Stratton Ridge region. There are two airports in Matagorda County, one of which is located in Bay City. Brazoria County have five general aviation airports, the largest one outside of Brazoria. The county also has seven airports designated as "other than hard-surfaced." Galveston County has the largest airport in the region, Scholes Field, on Galveston Island. There are also two smaller airports in the county, south of Houston. There are several private airports and heliports in the three counties which are not included on this map. Greyhound and Texas Charter provide bus transportation service to the three-county region. The Atcheson, Topeka & Santa Fe, Burlington Northern, Union Pacific, and Missouri Pacific railroads all provide intrastate and interstate commercial railroad service.

Brazoria County has its main commercial barge access to the Gulf of Mexico and the ICW through the port of Freeport, located near the Stratton Ridge site. Vessel traffic on the ICW numbered about 32,500 between the Sabine River and Galveston in 1989. More than half of these vessels were tankers.[143] Tres Palacios Bay opens into Matagorda Bay, which provides barges access to the Colorado River and points inland, and to East Matagorda Bay. The Matagorda Ship Channel in Matagorda County also provides commercial barge access to the Gulf of Mexico.

5.2.9.5 Housing and Public Services

The following sections describe the housing availability in the Stratton Ridge area and summarizes the education, health care, and public utility service.

Housing

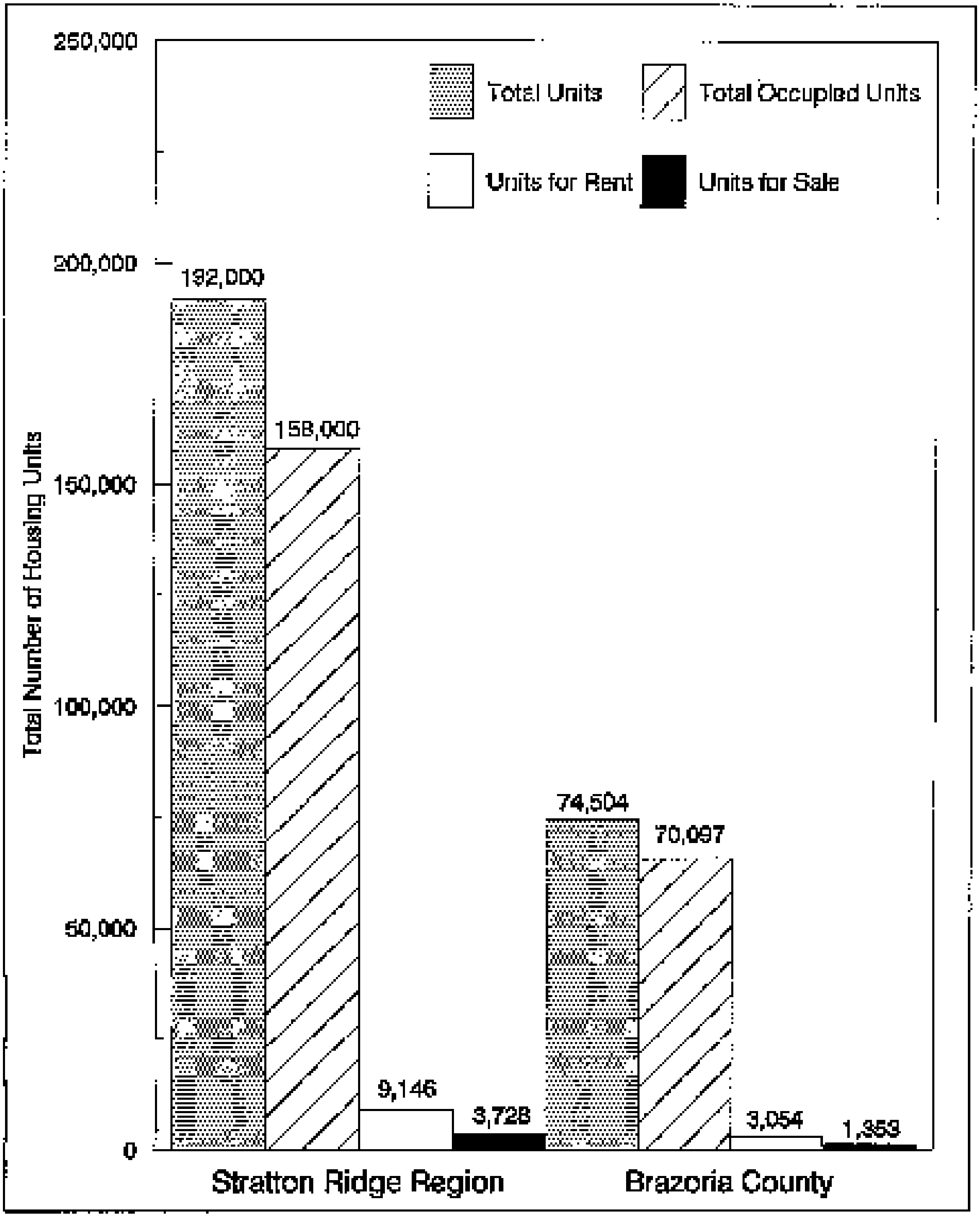
There are approximately 192,000 housing units in the Stratton Ridge region. Of this total, about 158,000 or about 82 percent were occupied during 1990. The remaining units were vacant because they were being offered for rent or sale, unoccupied, used seasonally for vacation or second homes, or used for migratory workers. Of the occupied units, approximately 65 percent were owner-occupied and 35 percent were renter-occupied

The number of units available for either rent or sale in the Stratton Ridge region numbered 12,874 during 1990. Of this total, 9,146 were rental units and 3,728 were units for sale (Figure 5.2-9). Galveston County accounted for over 52 percent of the total available housing in the region. In Brazoria County, there were total of 74,504 housing units in 1990. Of this total, 3,054 were available for rent and 1,353 were up for sale. Of those units occupied during 1990, 69 percent were owner-occupied.

Health Care

The accessibility of health care facilities and personnel varies widely throughout the Stratton Ridge region. Approximately 300 physicians were practicing medicine in the region during 1990, a ratio of one physician for every 1,484 residents. There are a total of 1,296 hospital beds in the region, or one bed for every 344 residents. Brazoria County has 130 physicians or one physician for every 1,468 residents (Table 5.2-9). In its four hospitals, Brazoria County has 364 beds, a ratio of one for every 524 residents. The closest hospital to Stratton Ridge is located about ten miles from the site in Lake Jackson and has 164 beds. The Texas State-wide averages for physicians and hospital beds are one physician for every 598 people and one hospital bed for every 239 people.

Figure 5.2-9
Housing in the Stratton Ridge Region in 1990



Source: U.S. Department of Commerce, Bureau of the Census, 1990.

Table 5.2-9
Health Care Facilities and Personnel, 1990

Parish or County	Hospitals	Hospital Beds	Residents per Bed	Physicians	Residents per Physician
Brazoria	4	364	524	130	1,468
Galveston	4	782	278	135	1,610
Matagorda	2	150	246	35	1,055
Region	10	1,296	344	300	1,484

Source: Texas Department of Health; Health Data and Policy Analysis Division and Health Facility Licensure and Certification Division, 1990.

Education

Brazoria County encompasses eight public school districts. There are a total of 48,197 students attending 58 primary, secondary, and vocational public schools (Table 5.2-10). An additional 526 students attend three private schools in the county. Any impacts associated with the influx of worker's children is discussed in section 7.2.9.8.

Utilities

HL&P, an investor-owned utility that services an area east of State Route 288 and south of State Route 2004, would supply electric power to Stratton Ridge. HL&P has one 138 kilovolt (kV) transmission line that cuts across Stratton Ridge Road and is tied to a loop system with the Houston area. As described in section 5.1.9.5, a loop system allows power to be supplied from two possible directions in case a problem occurs in a line. HL&P also has a 12 kV distribution circuit from the nearest substation, located at Lake Jackson, that runs parallel to the Stratton Ridge right-of-way.

5.2.9.6 Government Revenues and Expenditures

The Federal government spent almost $1.1 billion in the Stratton Ridge region in 1990 (Table 5.2-11) or about $2,411 per capita. More than one-third of that spending, $366 million (more than $1,917 per capita), was in Brazoria County. Local government expenditures in 1987 were $814 million; $280 million was spent by governments within Brazoria County (Table 5.2-12).

The Stratton Ridge site has an assessed value of about $90 per acre. In 1990, property taxes of 0.56 percent included a county tax, a Brazos River & Harbor tax, and a Valasco Drainage District tax. Property tax paid on the 200-acre site in 1990 totalled approximately $100.

Table 5.2-10
Brazoria County Education Data, 1990

Brazoria County	Number of Schools	Number of Students	Average $/Student	Average Number of Students/Teacher
Public Primary (K-8)	48	30,097	NA	NA
Secondary (9-12)	8	10,348	NA	NA
Private (K-12)	5	526	NA	11

Source: Texas Education Agency, Department of Research and Development, 1990.

5.2.9.7 Emergency Response Capabilities

Emergency response capabilities for the Stratton Ridge site are the existing emergency police, fire or medical services in Brazoria County, including Freeport, Lake Jackson, Clute, and surrounding rural towns.

There are six municipal police departments in Brazoria County that are within 30 miles of the Stratton Ridge site: Angleton, Clute, Freeport, Lake Jackson, Oyster Creek, and Richwood. The nearest police department to the Stratton Ridge site is the Clute police department, 10 to 15 minutes from first notification. The initial response to an emergency at the Stratton Ridge site, however, would come from the County Sheriff's department, located about 10 miles away in Angleton.

There are seven volunteer fire departments located near the Stratton Ridge site. In the event of an emergency at the site, the Clute fire department, located about ten miles from the site, would be the first to respond, with additional support from the Lake Jackson and Richwood fire departments in the event of a major incident. All volunteer fire personnel in Brazoria County have completed basic fire suppression training and include personnel familiar with hazardous materials response and emergency medical services.

A total of nine ambulance and rescue units are available to the Stratton Ridge site. Seven of these, including Danbury/Clute, the closest to the site, are volunteer services and are associated with the local volunteer fire department. The Freeport and Lake Jackson ambulance services are full-time. Each offers advanced (or paramedic) life support capabilities, and the closest can respond to the Stratton Ridge site within 15 to 20 minutes. Two of the hospitals located in Brazoria County are near the Stratton Ridge site: Brazosport Memorial Hospital in Lake Jackson and Angleton/Danbury Medical Center in Angleton. A helicopter medivac service is located in Galveston approximately 40 miles from the site for transport of injured personnel to the nearest major trauma and burn centers, located 60 miles from the site in metropolitan Houston.

To facilitate emergency response, Brazoria County has both an Emergency Management Plan and a Hazardous Materials Response Plan. The county's LEPC participates in local drills

Table 5.2-11
Federal Government Expenditures in the Stratton Ridge Region, 1990
(Thousand Dollars)

County	Expenditure
Brazoria	365,918
Galveston	611,655
Matagorda	95,735
Total	1,073,308

Source: Bureau of Economic Analysis, U.S. Department of Commerce

Table 5.2-12
Local Government Expenditures in the Stratton Ridge Region, 1987
(Thousand Dollars)

County	Expenditure
Brazoria	279,597
Galveston	458,937
Matagorda	75,205
Total	813,739

Source: Bureau of Economic Analysis, U.S. Department of Commerce

planned by local industries and city governments, and the county's Emergency Management office, located in Angleton at the Brazoria County Courthouse, works along with local governments to respond to all emergencies.

5.2.9.8 Land Use

The Stratton Ridge dome is in south-central Brazoria County, Texas, about three miles east of Clute and Lake Jackson and six miles north of Freeport. The proposed site would be located on approximately 200 acres on the south-central portion of the salt dome. Because of the large local petrochemical industry, the population concentration in the towns surrounding Stratton Ridge is the highest of the proposed expansion sites. Although the local economy is driven by the petrochemical industry, the area also has some cattle ranching and farming.

The immediate site location is forested with evergreens and is bordered on the south by Oyster Creek. The Missouri Pacific railroad runs along the site's northwest border, and several wetland areas, old-growth forests, and cattle grazing fields are adjacent to the site. A large wetland constitutes the southwest edge of the site, a small wetland area lies adjacent to the Missouri Pacific roadbed, and a forested wetland can be found along a small stream that passes near the site. In general, residential and small industrial areas can be found to the west and south of Stratton Ridge, croplands and pasture lie to the north, and nonforested wetlands to the east.[144] No land use analysis has been conducted in the area since that of the U.S. Geological Survey in 1973, and the soil survey of the Soil Conservation Service in 1978.

About 60 percent of the acreage in Brazoria County is in agricultural use. As in Jefferson County, rice is the major crop with a total of over 1.5 million hundred weight (cwt) of rice harvested on approximately 29,000 acres in 1987.[145] Rice is usually grown for two years at which point the land is rotated for a year to pasture, soybeans, or grain sorghum crops. Corn, grain sorghum, soybeans, and cotton constitute the other major regional crops. Between 400,000 and 450,000 bushels each of corn and sorghum were produced during 1987. In all, crop receipts for the same year totaled nearly $25.5 million.

Cattle ranching is also a major agricultural use in Brazoria County. In 1987, for example, three times as many farms in Brazoria had cattle, and twice as many beef cows (39,500) were bred than in Jefferson County. Livestock, poultry, and related products totaled $11.7 million of market value in 1987.

The proposed Stratton Ridge site contains no prime and unique farmland. The proposed Stratton Ridge pipeline right-of-way contains a total of 43.2 acres of prime and unique farmland, as identified by the U.S. Soil Conservation Service.[146]

Brazoria County lies outside the area in East Texas identified by the Forest Service as the timber region. The majority of wooded areas in Brazoria lie in the western portion of the county, and are often used for pasture or livestock grazing rather than commercial forestry. Although no forestry statistics were available for Brazoria County, the Forest Service indicated that very little commercial forest land exists in the county for which there is little (or no) forest management. The yield and quality of the timber from the area is relatively poor, partly due to poor forest management, and the land has thus far been more productive if cleared for urban development, pasture, or cropland.[147] Additionally, there are no National Forest Lands within Brazoria County.

5.2.10 Ambient Noise

Land use near the proposed Stratton Ridge site is characterized by the operation of existing brine and storage caverns owned by Dow, Amoco, Conoco, and Occidental. Although sound monitoring data are not available for these operations, they are assumed to be of approximately the same magnitude as those discussed above at Big Hill because of the similarity of the operations. The existing industrial operations on the salt dome, which are approximately one-half mile from the proposed site, and the presence of a Missouri Pacific train track that lies adjacent to the proposed site are estimated to produce an L_{dn} comparable to an urban area (i.e., 58 to 63 dBA) within the 5,000-foot radius impact zone. In addition to the industrial operations near the site, there were two residences within the impact zone as of 1974.[148] The nearer of these residences was approximately one-half mile from the proposed site. (See Appendix H for information on methods used for estimating noise levels.)

5.3 Weeks Island (Capline Complex Site)

DOE is proposing to create up to 16 additional storage caverns near the existing Weeks Island salt dome facility. Crude oil storage capacity at this facility would be increased by up to 160 MMB to a total of 233 MMB by this expansion. To satisfy a 270-day drawdown criterion, DOE would upgrade the existing pipeline to St. James Terminal by adding one booster pump. Under a 180-day drawdown criterion, DOE would also make the following distribution enhancements: construct a tie-in to a reversed Texas 22" pipeline to Clovelly; expand the St. James Terminal by adding up to two docks and up to two tanks; and construct a second pump station on the existing pipeline to St. James. The St. James Terminal expansion is discussed in section 5.4. At the Weeks Island site, DOE is also considering two options for brine disposal: a brine pipeline with a diffuser into the Gulf of Mexico, or deep well injection into appropriate substrata.

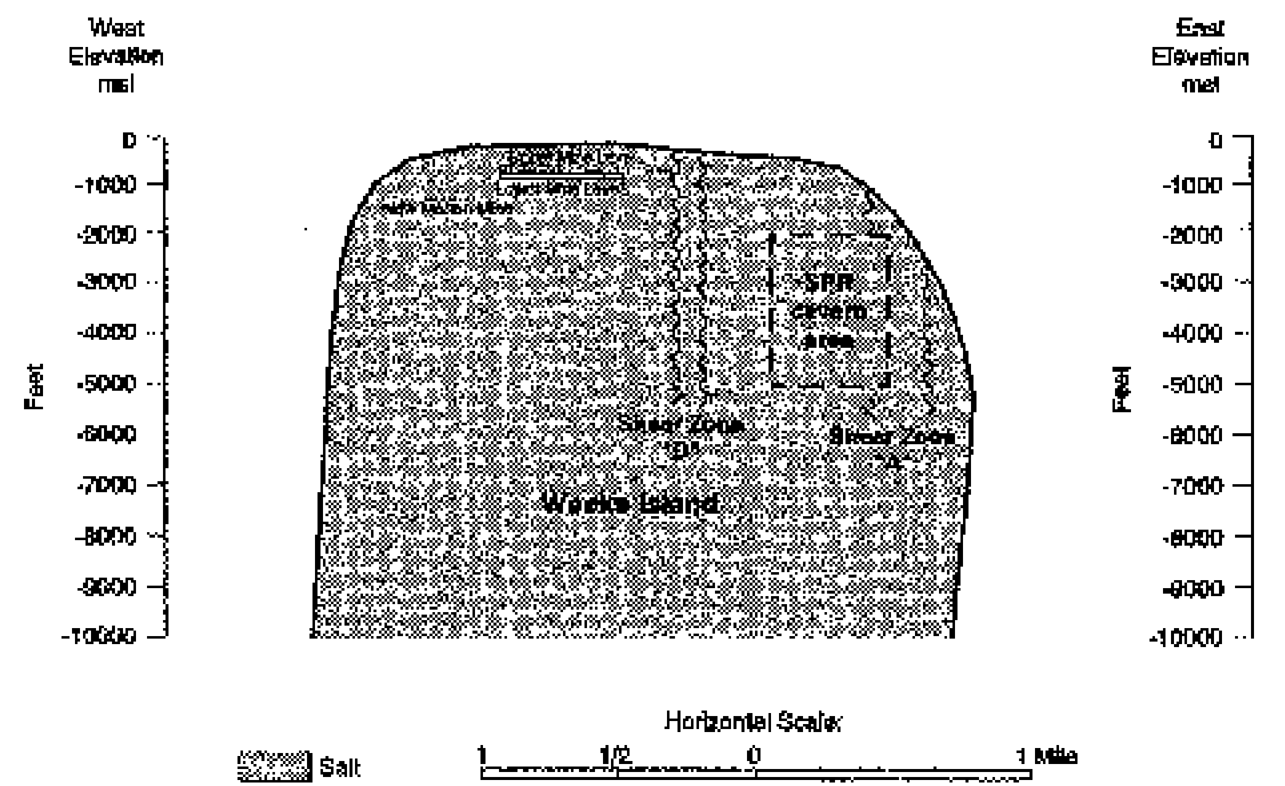
5.3.1 Geology

The Weeks Island salt dome borders Vermilion Bay, which is contiguous to the Gulf of Mexico. The "island" is one of the five salt domes aligned in a northwest-southeast direction along the Gulf Coast in southern Louisiana. The other four "islands" are Jefferson, Avery, Cote Blanche, and Belle Isle. These five salt domes collectively form topographic high points in the surrounding bayous of the region.[149] Weeks Island is completely surrounded by brackish marsh, bayous, man-made canals, and bays.

A cross-section of the Weeks Island salt dome is provided as Figure 5.3-1. The Weeks Island salt dome is roughly circular with somewhat squared corners on the northwest and southwest (resulting in a "D-shape"), and it has a diameter of approximately two miles. There is no caprock over the dome, with the exception of a minor cap found on the periphery. The surface expression over the salt dome, which is caused by domal upthrusting, forms the island and includes the highest elevation (52 meters) in southern Louisiana. The top of the salt itself is 13 meters above msl.[150] The proposed site would be located on the eastern side of the dome at an approximate elevation of 15 meters above msl.[151] A major salt overhang occurs on the north side of the dome; however, because the site would be located on the eastern portion of the dome, it would not be affected by the overhang.[152] The placement of individual caverns would be influenced by the presence of a shear zone that runs through the proposed site. However, it is estimated that 500 acres within the -600 to -1,500 meter depth range are potentially suitable for the development of crude oil storage caverns with a potential storage volume of more than 160 MMB.[153]

The unconsolidated sedimentary deposits between the top of the salt and the land surface are composed of a series of Pleistocene to recent sands and gravels with discontinuous lenses of clays and silts. Overlying soils consist of Frost soils found primarily on the foot slopes of the dome and Memphis soils found on the bulk of the salt dome. Together they form the Memphis-Frost association which covers the island. The Frost soils, found on the dome periphery and in depressions in terrace uplands, are poorly drained, slowly permeable, and loamy throughout. The Memphis series are well-drained, moderately permeable, and loamy throughout.[154]

Figure 5.3-1
Cross-Section of the Weeks Island Salt Dome



Note: Cavern locations and depths are diagrammatic and only convey approximations.

Source: U.S. Department of Energy, Preliminary Site Geological Characterization for Strategic Petroleum Reserve (SPR) Expansion Candidates, Volume II, Sandia National Laboratories, Albuquerque, NM, March 1991.

Since 1983, the average rate of subsidence over the existing SPR oil storage mine at Weeks Island has been 3.6 cm/yr, and subsidence is expected to continue at that rate. Salt creep closure has also occurred at the site over this time period, resulting in some tilting of the vertical shafts to the existing oil storage mine.

5.3.2 Hydrogeology

Weeks Island lies 15 miles south of New Iberia at the northeast shore of Vermilion Bay in Iberia Parish, Louisiana. The dominant subsurface units in the vicinity of Weeks Island consist of, in order of increasing depth beneath the land surface, the Gonzales formation, the Sangamon clays, the Illinoian sands, and the Nebraskan sands. Each of these units is characterized in Table 5.3-1.

The dominant surface soils at Weeks Island consist of silty loams and sands of the Memphis series. Depth to groundwater varies from approximately five meters bls in some perched water tables (where a clay bed supports saturated sand above the normal water table)[155] to near sea level (50 meters bls) where no perched water tables intervene.[156] Predominant aquifers within the Gonzales include the Alton sands and, at greater depth, the Wisconsin sands. Water within both of these aquifers is fresh. Freshwater at the site extends to a depth of approximately 240 meters bls, which corresponds to the base of the lower Wisconsin sands.

The Wisconsin sands sit on top of the Sangamon clays, which are pierced by the salt dome at Weeks Island. These clays in the vicinity of Weeks Island are continuous, highly impermeable (permeability of 1×10^{-6} cm/sec), and approximately 90 to 120 meters thick. As a result, the Sangamon clays serve as an effective confining unit that separates the freshwater in the Gonzales from the saline groundwater that exists below.

Beneath the Sangamon clays are two water-bearing units that consist primarily of sands, the Illinoian (which starts at a depth of approximately 360 meters bls) and the Nebraskan (which starts at a depth of approximately 670 meters bls). Both of these units contain saturated brine.

The natural flow of groundwater in the Gonzales units above the dome is in a southeast direction. Saline water encroachment into freshwater zones due to heavy withdrawals by population centers has become an increasing problem in the region.[157] However, the phenomenon presents no major problems at Weeks Island, where the freshwater supply is sufficient to meet industrial demands.[158]

Although there are no population centers within nine miles of Weeks Island,[159] 21 wells exist within three miles of the site. Of these, 14 are industrial wells, five are unused or monitoring wells, and two are actively used by DOE.[160] Only the two DOE wells are actually on Weeks Island. Due to the nature of the surrounding environment (swampy) and the lack of a local resident population, public water supply development around Weeks Island is unlikely.

The characterization of regional hydrogeology presented in section 4.2.2, as well as the site-specific characterization above, covers the course of the water intake and brine discharge pipelines. The proposed raw water pipeline and the brine pipeline run for approximately one mile over southern Weeks Island, above the Gonzales, before the water intake line terminates in the ICW and the brine diffuser continues its path through Vermilion Bay to the Gulf of Mexico.[161] No critical groundwater sources would be jeopardized by the pipelines. The

Table 5.3-1
Characterization of Major Units Underlying the Weeks Island Site

Unit	Depth to Unit (m bls)[a]	Overlying Soils/ Permeability (cm/sec)	Karst	Water Quality; Degree of Salinity[b]	Major Uses
Gonzales	-5 to -50	Memphis series, silt loams and sands at surface. Lenses of clays, sands, and silts. Alton and Wisconsin sands: $3x10^{-4}$; Alton gravels: $1x10^{-2}$.	None	Freshwater	Industry/ DOE
Sangamon Clays	-240; Dome pierces through	Overlain directly by Wisconsin sands; Sangamon clay very impermeable: 1×10^{-6}.	None	Confining unit (not productive)	None
Illinoian and Nebraskan Sands	-360 to -670	Overlain by impermeable clay layer	None	Brine	None

a Meters Below Land Surface.
b Salinity determined by dissolved solids content, in ppt: Freshwater, Less than 1 ppt; Slightly saline, 1-3 ppt; Moderately saline, 3-10 ppt; Very saline, 10-35 ppt; Brine, More than 35 ppt.
Sources: Soil Survey of Iberia Parish, LA; "Weeks Island"; Ortiz, Tom; Smith, Gordon, Candiace; Environmental Survey Preliminary Report; Hydrologic Investigations: Effects of Ground-water Withdrawals; Engineering Aspects of Karst; USGS Water-Supply Paper 2220; Magorian, Tom.

regional characterization of groundwater resources presented in section 4.2.2 also generally covers the course of the existing oil distribution pipeline from the Weeks Island site east to St. James Terminal.

5.3.3 Surface Water Environment

Major surface water bodies that could be affected by the proposed expansion at Weeks Island include: (1) the Gulf of Mexico; (2) the ICW; and (3) other inland water bodies near the expansion site and/or crossed by proposed pipeline routes. The baseline conditions of each of these surface water bodies are characterized in separate sections below.

5.3.3.1 Gulf of Mexico

Weeks Island previously has not discharged brine to the Gulf of Mexico, because the existing storage cavern at the site was originally a "room-and-pillar" salt mine that did not generate any brine. However, the leaching of new storage caverns will generate large volumes of brine which must be disposed. DOE is considering brine diffusion in the Gulf of Mexico (see Figure 3.3-2).

The brine pipeline route passes westerly through Vermilion Bay, then runs southwest to cross Southwest Point Peninsula east of Portage Lake, and then extends for roughly 15 miles offshore to a diffuser site in the Gulf of Mexico (at latitude 29°25' and longitude 92°16'). The water depth over the length of the diffuser would be roughly 25 feet.

This section describes the physical and chemical conditions in the Gulf for this pipeline route and diffuser location and the oil and gas exploration and production activities near the site. Descriptions of the climatology and biological conditions of the area are provided in sections 5.3.4 and 5.3.5, respectively, and a detailed description of the baseline environmental conditions at the proposed brine diffuser location is given in Appendix K. The information presented below was derived from existing data sources that cover the northern Louisiana Gulf in general and from DOE field investigations in the area.

Physical Conditions

Vermilion Bay, Atchafalaya Bay, Marsh Island, and Point au Fer Island are the dominant nearshore features at the Weeks Island proposed pipeline and diffuser site. The outer boundary of Atchafalaya Bay is formed by Point au Fer Shell Reef, once an oyster-producing area. A submarine extension of additional reefs points northwestward for 14 miles to Rabbit Island. Four shoals including Tiger Shoal, Trinity Shoal, and two unnamed shoals, lie farther offshore in the vicinity of the proposed diffuser site.

As discussed above for Stratton Ridge (section 5.2.3.1), current patterns are the most significant factor in determining dispersal of brine. Local winds have a major influence on the nearshore circulation pattern. For example, easterly to southeasterly winds during most of the year cause a westerly to northwesterly drift current. Although the tides in the Gulf have a small range (usually less than 2.5 feet), they are integral in the modification of currents and the acceleration of water movement through narrow passages. Tidal forces are dominant during the summer, when westerly winds are generally weak. During spring, discharge from the Mississippi and Atchafalaya Rivers contributes to the westward motion, reducing the influence of the tides.[162] Current speeds are quite variable, with measured values around the proposed Weeks Island diffuser ranging from 4.6 feet per second during winter storms to almost zero during stagnant periods in the summer. Bottom currents are less than 0.1 feet per second only 10 to 15 percent of time and greater than 0.6 feet per second only about 16 percent of time. Bottom currents are more typically about 0.3 feet per second.

The floor of the northwestern Gulf has been heavily influenced by deltaic sedimentation from the adjacent river systems, especially the Mississippi River. The continental shelf west of the Mississippi delta, in the vicinity of Cote Blanche and Weeks Island, grades from sand inshore to silt and clay nearshore and offshore.[163] Analyses of bottom sediments in the general area of the proposed diffuser sites showed variable mixtures of sand, silt, and clay.[164]

Water temperature and salinity distributions off coastal Louisiana are highly variable as they are influenced by freshwater inflow from the Mississippi and Atchafalaya Rivers, localized heavy precipitation, thermal heating and cooling due to weather changes, and energetic mixing by wind stress on the sea surface. Salinity within five to six miles of the Louisiana coast ranges from 15 to 35 ppt as a result of seasonal variations in riverine discharges.

Chemical Conditions

Section 5.2.3.1 above on the surface water environment around Stratton Ridge discusses the chemical conditions in the northern Gulf, and Appendix J provides a more detailed discussion of these conditions. These conditions also reflect the general chemical conditions of the Gulf waters around the proposed Weeks Island diffuser site.

Oil and Gas Activities

NOAA's nautical charts, which identify only a selection of submerged pipelines and oil platforms, indicate that a very active oil and gas area lies close to the proposed Weeks Island diffuser site. A one-mile radius area approximately six miles northeast of the proposed diffuser site contains over 30 oil platforms. In addition, a submerged pipeline traverses this platform area in a southeasterly direction. The closest platform is situated three miles west of the proposed site while two other platforms lie five miles southwest and six miles southeast of the proposed site.

5.3.3.2 Intracoastal Waterway

Raw water needed for the proposed expansion at Weeks Island will be obtained from the ICW. From the Mississippi River in the east, to the Vermilion River in the west, the ICW is 160 miles long. In the eastern half of this stretch, the ICW parallels West Cote Blanche Bay and Vermilion Bay (Figure 5.3-2). The Weeks Island site is located on the ICW at the western end of Weeks Bay, an extension of Vermilion Bay. Major water bodies intersecting the ICW in this region are the Atchafalaya River, Wax Lake Outlet, and the Charenton Drainage and Navigation Canal.

The proposed RWI structure would be located on the eastern bank of the ICW near the southwest corner of Weeks Island at 29°48'N and 91°49'W (Figure 3.3-3). To the immediate south of the RWI structure, the ICW is intersected by man-made canals and pipelines. Gurrett Bayou and Two Mouth Bayou link the ICW to Weeks Bay. Within one mile to the south, the ICW bends to a generally east-west orientation. Approximately six miles to the south and east of the proposed raw water intake is Cote Blanche Island, the other candidate SPR expansion site in Louisiana. East of Cote Blanche Island, the ICW parallels the north shore of West Cote Blanche Bay. Further description of the area around Cote Blanche can be found in section 5.5.3.

Immediately north of the proposed Weeks Island RWI structure, a narrow island separates the ICW from Weeks Bay. One mile to the north, the ICW runs tangential to Weeks Bay. On the eastern bank of the ICW, north of Weeks Island, the ICW is intersected by Weeks Bayou and Bayou Carlin. Near Bayou Carlin, the ICW turns to the west, running generally parallel to Vermilion Bay. This portion of the ICW is intersected by numerous canals and bayous. Some of these connect the ICW to Vermilion Bay, including Weeks Bay Channel, Avery Canal, Tigre Lagoon, Oaks Canal, Bayou Boston, and Four Mile Cutoff. Table 5.3-2 summarizes the key characteristics of the primary water bodies that intersect the ICW within five miles in either direction of the proposed raw water intake at Weeks Island.

Hydrologically, the ICW in the area of Weeks Island is rather complex. The entire region along the ICW, between the Atchafalaya River to the Vermilion River, is considered marshland with a general flow of water from east to west. The primary source of water to the ICW, its tributaries, and neighboring wetlands is the Atchafalaya River. From the ICW, water flows into

Figure 5.3-2
Louisiana Coast from the Atchafalaya River to the Vermilion River

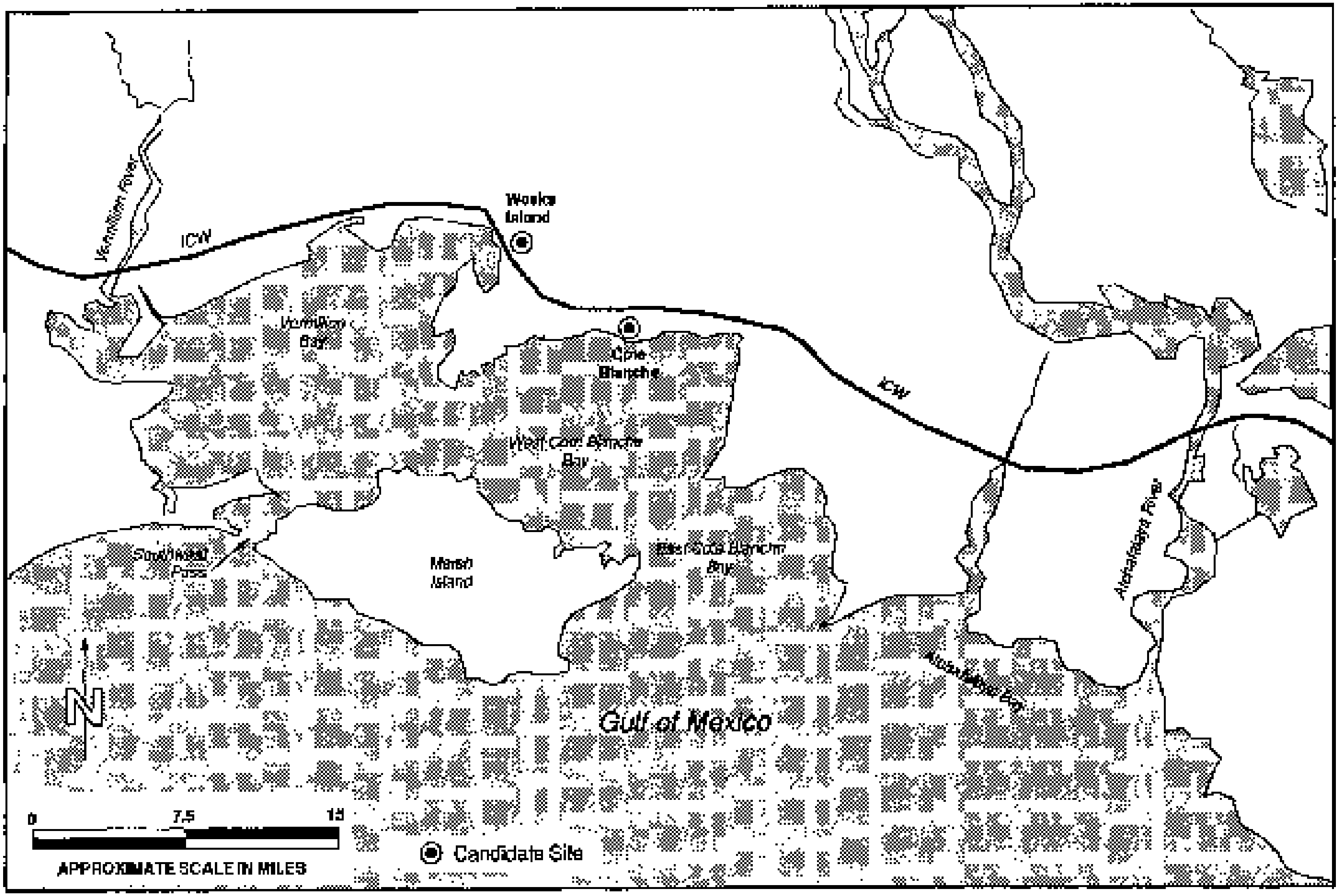


Table 5.3-2
Characteristics of Surface Water Bodies Intersecting the Intracoastal Waterway Within Five Miles of the Proposed Raw Water Intake at Weeks Island

Surface Water System	Distance from RWI (miles)	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses[a]
Weeks Bay	1.0	13,000	5	Tidal	No downstream public intake	None	Brackish	Commercial traffic; contact recreation
Weeks Bayou	1.6	1,400	12	Tidal	No downstream public intake	None	Fresh, Brackish	Oil well service; barge traffic
Bayou Garrett	0.4	80	2	Tidal	No downstream public intake	None	Fresh, Brackish	No known uses
Unnamed Oil Service Canal	0.2	150	8	Tidal	No downstream public intake	None	Fresh, Brackish	Oil well service; barge traffic
Two Mouth Bayou	1.0	160	6	Tidal	No downstream public intake	None	Fresh, Brackish	No known uses
Bayou Cypremort	3.0	100	6	Tidal	No downstream public intake	None	Fresh, Brackish	No known uses
Bayou Carlin	5.0	250	12	Tidal	No downstream public intake	None	Fresh, Brackish	Oil well service; barge traffic

[a] Although not explicitly designated, these waters also may be used for recreational purposes (e.g., fishing and boating).

the Gulf of Mexico via Vermilion Bay, West Cote Blanche Bay, and direct channels. Direct exchanges with open waters occur at Weeks Bay adjacent to Weeks Island, and West Cote Blanche Bay at an embayment called The Jaws. The ICW is intersected by many bayous, small lakes, artificial canals, and rivers. These water bodies and contiguous marshlands exchange water freely along much of the ICW. The entire segment of the ICW is tidally influenced with a range of about 1.6 feet.[165]

Water in the ICW near the proposed Weeks Island site is generally fresh due to inflow from the Atchafalaya River and Wax Lake Outlet.[166] Salinity in the entire segment from the Atchafalaya River to the Vermilion River is typically five ppt or less.[167] To the west of Weeks Island, there is a water quality monitoring station on the ICW at Vermilion Lock near Intracoastal City (approximately 25 miles west of the proposed RWI structure). Based on data collected between 1974 and 1981 at Vermilion Lock, the ICW salinity averages about two ppt.[168] Although salinity levels as high as 13.9 ppt have been observed, they are typically much lower. Additionally, all salinity data collected in 1973 by the Corps of Engineers at The Jaws, about eleven miles east of the proposed RWI structure, are less than one ppt (ranging from 0.05 to 0.21 ppt, with a mean of 0.11 ppt).[169]

While the primary use of the ICW is navigation, this segment of the ICW is classified by the State of Louisiana for secondary contact recreation and propagation of fish and wildlife.[170] Land bordering the ICW near the proposed Weeks Island site is almost entirely marshland. The marshes are predominantly intermediate with patches of fresh and brackish marsh, as well as swamp forest.[171]

5.3.3.3 Inland Water Bodies

The following sections describe: (1) inland water bodies within a five-mile radius of the proposed site at Weeks Island; and (2) water bodies crossed by proposed crude oil, raw water, and brine discharge pipelines.

Water Bodies Within Five Miles of the Proposed Site

Weeks Island is located in the transition between the Chenier and the Deltaic Plains of south-central Louisiana, in the Marsh Island-Bayou Teche Drainage area. Weeks Island salt dome is one of the most elevated areas in southern Louisiana (up to 170 feet above msl, though the expansion would be in an area ranging from five to 75 feet above msl). From 1951 through 1989, New Iberia, which is approximately 15 miles northeast of Weeks Island, received an average of 57 inches of precipitation annually.[172] Drainage of stormwater and surface waters from the candidate site area is to the east, north, and south into nearby Warehouse Bayou and surrounding wetlands. The land above the salt dome is 95 percent dry land, but the surrounding area is primarily brackish and intermediate marsh and swamp forest.[173] Thirty-one surface water bodies are located within five miles of the proposed expansion site and are characterized in Table 5.3-3. The water bodies that are closest to the site and/or are regionally significant include Plantation Lake, Sandy Bottom Pond, Warehouse Bayou, Weeks Bayou, Bayou Patout, Long Ride Barge Bayou, Stumpy Bayou, Bayou Pete, the ICW, Bayou Cypremort, Bayou Carlin, Bayou Garrett, Two Mouth Bayou, Shark Bayou, Sheepshead Bayou, the Vermilion River, Weeks Bay, and Vermilion Bay.

Table 5.3-3
Characteristics of Surface Water Bodies Within Five Miles of the Proposed Expansion at Weeks Island, Louisiana

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Plantation Lake	0.2	none	1300	10	Lake	No downstream public intake	None	Fresh	No known uses
Sandy Bottom Pond	0.2	none	900	6	Lake	No downstream public intake	None	Fresh	No known uses
Warehouse Bayou	0.1	Weeks Bayou, Bayou Patout	200	20	Tidal	No downstream public intake	None	Fresh, Brackish	Oil well service barge traffic
Bayou Patout	0.4	Iberia-St. Mary Canal, Stumpy Bayou	175	12	Negligible	No downstream public intake	None	Fresh, Brackish	Oil well service barge traffic
Weeks Bayou	1.0	Long Ride Barge Bayou, Bayou Pete, ICW, Weeks Bay	700	20	Tidal	No downstream public intake	None	Fresh, Brackish	Oil well service barge traffic
Intracoastal Waterway	1.4	See ICW Section	400	12	Tidal	No downstream public intake	None	Fresh, Brackish	Rec., fish and wildlife prop.
Two Mouth Bayou	2.0	ICW, Weeks Bay	550	2	Tidal	No downstream public intake	None	Fresh, Brackish	No known uses
Bayou Garrett	1.7	ICW, Weeks Bay	200	2	Tidal	No downstream public intake	None	Fresh, Brackish	No known wells
Bayou Carlin	3.1	ICW, Bayou Jack Canal	250	12	Tidal	No downstream public intake	None	Fresh, Brackish	Small boat traffic
Bayou Jack Canal	3.6	Bayou Carlin	100	6	Storm Drain	No downstream public intake	None	Fresh, Brackish	Oil well service barge traffic

Table 5.3-3 (Continued)
Characteristics of Surface Water Bodies Within Five Miles of the Proposed Expansion at Weeks Island, Louisiana

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Bayou Pete	1.8	Weeks Bayou	150	8	Tidal	No downstream public intake	None	Fresh	Oil well service barge traffic
Long Ride Barge Bayou	1.6	Weeks Bayou	60	8	Tidal	No downstream public intake	None	Fresh	Oil well service barge traffic
Stumpy Bayou	1.3	Bayou Patout, Weeks Bayou, Weeks Canal	200	8	Storm Drain	No downstream public intake	None	Fresh	No known uses
Weeks Canal	3.1	Stumpy Bayou	75	6	Storm Drain	No downstream public intake	None	Fresh	Small boat traffic
Iberia-St. Mary Canal	2.0	Bayou Patout, Long Ride Barge Bayou, Bayou Pete	100	6	Storm Drain	No downstream public intake	None	Fresh	No known uses
Pipeline Canal	1.9	none	75	6	Negligible	No downstream public intake	None	Fresh	No known uses
Patout Canal	3.8	Iberia-St. Mary Canal	60	4	Storm Drain	No downstream public intake	None	Fresh	No known uses
Delahoussaye Canal	4.8	Iberia-St. Mary Canal	60	4	Storm Drain	No downstream public intake	None	Fresh	Oil well service barge traffic
Ivanhoe Canal	4.0	Williams Canal, ICW, Bayou Cypremort	120	8	161 (51.4-324)	No downstream public intake	None	Fresh	No known uses
Bayou Cypremort	2.5	ICW, Ivanhoe Canal	80	3	Tidal	No downstream public intake	None	Fresh	No known uses
Williams Canal	4.1	ICW, Ivanhoe Canal	40	4	Tidal	No downstream public intake	None	Fresh	No known uses

Table 5.3-3 (Continued)
Characteristics of Surface Water Bodies Within Five Miles of the Proposed Expansion at Weeks Island, Louisiana

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Shark Bayou	3.4	Vermilion Bay, Weeks Bay	375	7	Tidal	No downstream public intake	None	Fresh, Brackish	No known uses
Sheephead Bayou	3.1	Vermilion Bay, Weeks Bay	150	3	Tidal	No downstream public intake	None	Fresh Brackish	No known uses
Bayou Pirre	4.8	Vermilion Bay, Weeks Bay	100	3	Tidal	No downstream public intake	None	Fresh, Brackish	No known uses
Prince Lake	4.8	Horse Bayou	1700	3	Lake	No downstream public intake	None	Fresh, Brackish	No known uses
Horse Bayou	4.4	West Cote Blanche Bay	10	2	Tidal	No downstream public intake	None	Fresh, Brackish	No known uses
New Iberia Southern Drainage Canal	3.8	Carlin Bayou, ICW	175	12	Storm Drain	No downstream public intake	None	Fresh	Oil industry barge traffic
Weeks Bay	1.8	Weeks, Two Mouth, Sheepshead, Shark, and Garret Bayous	15000	5	Tidal	No downstream public intake	None	Fresh, Brackish	Commercial traffic; contact recreation
Vermilion Bay	3.5	Numerous	40000	8	Tidal	No downstream public intake	None	Fresh, Brackish	Rec., fish & oyst. prop.
West Cote Blanche Bay	4.4	Numerous	60000	6	Tidal	No downstream public intake	None	Fresh, Brackish	Rec., fish & oyst. prop.
Phillips Canal	4.1	Iberia-St. Mary Canal, Ivanhoe Canal	10	3	Negligible	No downstream public intake	None	Fresh	No known uses

As shown in Table 5.3-3 most of the surface water bodies near the Weeks Island site are either fresh or brackish, and are tidally influenced. None of the water bodies presently serve as a public water supply source. Other than recreational fishing and boating, the waters also have limited present uses. The State-designated uses for Vermilion Bay and West Cote Blanche Bay include oyster propagation (see section 5.3.5.2 for a discussion on the distribution of oysters in the area). A few, such as Warehouse Bayou, Bayou Patout, Weeks Bayou, and some others, also may be used for oil field service, small boat traffic, and/or barge traffic.

Pipeline Crossings

Under the 270-day drawdown criterion, the existing pipeline from Weeks Island to the St. James Terminal would be used for crude oil distribution with the construction of one booster station along the existing pipeline route. The pump station would be located about one mile west of Sterling; a second pump station required under a 180-day drawdown criterion would be located about two miles southwest of Pierre Port.[174] The major water bodies in the vicinity of these sites include Charenton Drainage and Navigation Canal, Bayou Teche, Mud Lake, Belle River, Old River, Bay Natchez, Lake Verret, and the ICW. The quarter-mile spur connecting the caverns to the existing pipeline would cross no bodies of water.

To meet a 180-day drawdown criterion, DOE would add a second booster station to the existing pipeline, upgrade the St. James Terminal (see section 5.6.3 of this DEIS), and construct an eight-mile spur north from Weeks Island to the Texas 22" pipeline, connecting with Texas 22" at a point nine miles northwest of the Julian Station. Along this eight-mile distance, the spur would cross the following water bodies: Warehouse Bayou, Bayou Patout, Stumpy Bayou, and Little Valley Bayou. Warehouse Bayou, Bayou Patout, and Stumpy Bayou are characterized in Table 5.3-3. Little Valley Bayou is a very small (approximately five feet wide) creek bordered on both sides by wetlands. Near the point where the spur would cross Little Valley Bayou, it has been dredged to a uniform width, providing canal connections to Stumpy Bayou and Wilkins Canal (which turns into Bayou Jack Canal and, eventually, Bayou Carlin).

The raw water and brine pipelines would follow the same ROW west from the site for approximately two miles to the ICW where the raw water intake structure would be located. Between the site and the ICW, these pipelines would cross no bodies of water. The brine disposal pipeline would cross the ICW before passing through the nearshore bays described above and extending to the diffuser in the Gulf of Mexico.

5.3.4 Climate and Air Quality

The area around the Weeks Island site has a maritime climate largely influenced by the Gulf of Mexico. The average summer air temperature for the area is 85°F; the average winter air temperature is 54°F. July and August are the warmest months; January and February are the coldest months. The highest amount of rainfall occurs during the summer months in association with either local thunderstorms or an occasional tropical storm. Winter precipitation generally results from frontal activity and falls as slow, steady rainfall; it may occur at any time of the day and continue intermittently for several days.[175] The mean annual precipitation is approximately 56 inches.[176] Frozen precipitation in the area is rare; over a 25-year period (1946-1971) the mean annual snowfall was 0.2 inches.[177]

The Weeks Island site is located in Iberia Parish, Louisiana, an attainment area for ozone, although small very localized problems may as yet be unidentified due to incomplete data. The existing Weeks Island facility does not monitor air quality; however, the Louisiana Department of Environmental Quality (DEQ) maintains a monitoring station in Morgan City, located approximately 35 miles southeast of the Weeks Island site. The NAAQS for ozone was not exceeded in 1988 or in 1989. The highest ozone measurement in 1988 for this monitoring station was recorded on October 8, 1988, registering 0.076 ppm; the highest ozone measurement during 1989 was recorded on October 3, 1989, registering 0.109 ppm.[178]

5.3.5 Ecology

Weeks Island is located within the Deltaic Plain ecosystem in the outer coastal floodplain province.[179] The proposed Weeks Island expansion site is located in the eastern portion of the island. The following sections discuss vegetation, wildlife, and rare, threatened, and endangered species at the proposed Weeks Island site, biological communities in the Gulf near the proposed diffuser sites, and those that are expected to be encountered in the vicinity of the pipelines and pump stations included in the proposed action. The information presented here is from previous SPR documents,[180] the existing literature, information obtained from various Federal and state agencies, and a site visit conducted in June 1991.

5.3.5.1 Ecosystems at the Site and Nearby

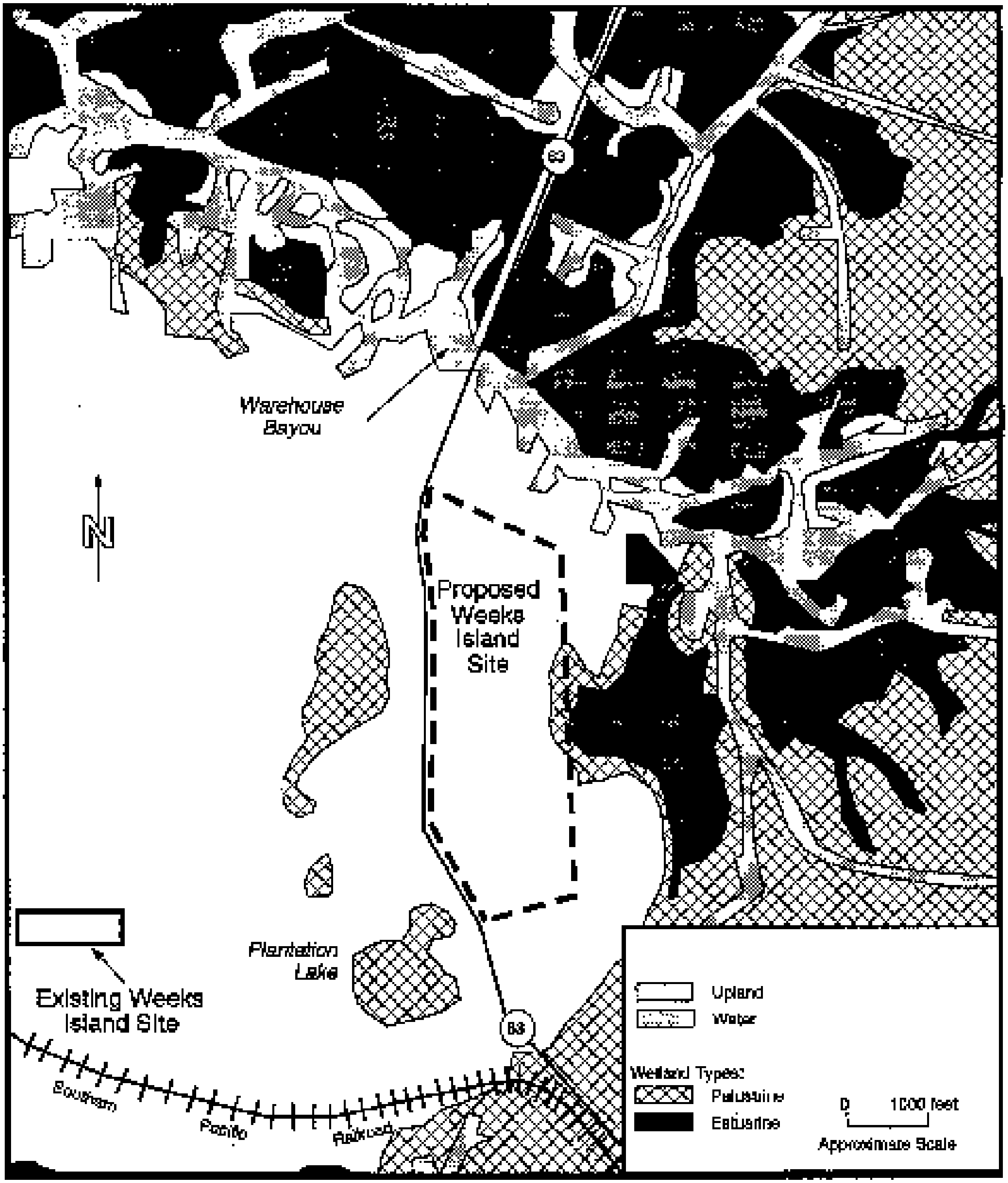
Vegetation

The proposed site is predominately agricultural fields (primarily sugarcane, although corn, soybean, sorghum, and peanuts also are reportedly grown there). Approximately one-half of the site consists of hardwood forests, with sweetgum, water oak, hickory, and southern magnolia the dominant tree species. Ferns are dominant herbaceous species in several areas. Figure 5.3-3 shows wetland and upland habitats at the proposed site.

Although the upper one-third of the property has many features typical of forested upland and is documented on NWI maps as uplands, some signs of wetland hydrology (e.g., buttressing of trees) are evident. The shrub layer contains sweet bay, yaupon, southern bayberry, and magnolia. The overstory is dominated by sweetgum, water oak, and magnolia. Several of the water oaks are three to four feet in diameter (breast height). In lower areas, water oak and sweetgum are dominant overstory species. Ferns, the dominant herbaceous species, are dense in the lower portions of slopes in this area. At the bottom of the drainage way, pennywort is prevalent. Numerous crayfish holes also were observed here during the site visit. Along the forest/field edge, cypress vine occurs.

The central one-third of the proposed property contains agricultural fields and forested areas. Shining sumac and southern bayberry are the prevalent understory species in the forested area adjacent to an old road which enters the site from Route 83. Both planted and fallow fields are present. Sugarcane was the only planted crop species observed during the site visit. A leguminous species was the dominant species in the fallow fields. East of the agricultural fields is a forested area which slopes down towards a wetland associated with Warehouse Bayou. Although a wetland delineation was not conducted, it is possible that the wetland extends further into the site boundary than depicted on the National Wetland Inventory map and in Figure 5.3-3. The mature trees in this area (oak and magnolia) are approximately six meters high, and the

Figure 5.3-3
Wetlands and Upland Habitats: Proposed Weeks Island Site



Source: National Wetland Inventory Map; Weeks, LA Quadrangle canopy is closed; the understory and herbaceous layers are sparse. Signs of flooding or inundation were observed during the site visit from the nearby sugarcane fields into the forest edge. Magnolia, sweetgum, white oak, red maple, and water oak are the prevalent tree species. Sedges occur along the edge of the field between the wooded areas.

The southern one-third of the property contains a moderately sloping forested area of approximately 30 acres surrounded by sugarcane fields. Royal fern is prevalent in the lower elevation areas. Yaupon is abundant in the shrub layer. The overstory is dominated by sweetgum, although water oak and bitternut hickory also are present. The trees in this area are buttressed, indicating that the area is commonly inundated or saturated to the surface with water. Trees along the edge of this forested area are predominantly Chinese tallow tree. Trumpet vine and palmetto are additional species that occur here.

The proposed RWI structure would be located at the ICW approximately two miles southwest of the site (see section 5.3.3.2). The vegetation in this area as observed during the site visit is a disturbed, overgrown area consisting mostly of shrubs and herbaceous vegetation.

Terrestrial Wildlife

Bird species observed during the site visit are killdeer, mourning dove, mockingbird, boat-tailed grackle, cardinal, nighthawk, and cattle egret. Deer tracks (probably white-tailed deer) also were observed, and a bear track was observed in the middle section of the proposed site, at the edge of a sugarcane field and forest. This track is presumably that of the Louisiana black bear, which is the only bear known to occur in the Gulf Coast region; it is a Federal and State threatened species in Louisiana because it is at the southernmost limit of its range.

Based on previous studies, common birds which may be observed at the site include hawks, owls, woodpeckers, thrushes, vireos, and warblers. Other species which are likely inhabitants are mink, nutria, river otter, raccoon, swamp rabbit, bobcat, squirrels, and coyote.

Aquatic Life

The various swamps, marshes, bayous, lakes, and bays of the southern Louisiana delta area support diverse aquatic flora and fauna. Important characteristics and typical biota of freshwater systems, coastal swamps, and estuarine bays are summarized below.

Warehouse Bayou is the water body closest in proximity to the proposed site. In the freshwater areas such as this, macrophytes are the dominant aquatic vegetation. Macrophytes provide a food source for insects, mammals, and birds, and a substrate for periphytes. Benthic and suspended algae are abundant and also provide a significant food source.[181]

Freshwater wetlands support zooplankton populations of copepods, cladocerans, rotifers, ostracods, and amphipods. Benthic invertebrates include dipterans, oligochaetes, and amphipods. Clams, snails, and crayfish are the molluscs typically found in freshwater areas. At least 68 species of freshwater fish inhabit this region.[182] Some common species are largemouth bass, crappie, catfish, gar, buffalo, sunfish, gizzard shad, and suckers.[183] Freshwater environments also support millions of waterfowl, particularly surface-feeding ducks.[184]

Commercially important species found in freshwater environments include crayfish, catfish, buffalo, and drum. Some reptiles (turtles and bullfrogs) are also commercially important.[185]

Coastal Louisiana's swamps and marshes are important wildlife areas that are particularly sensitive to changes in salinity and water level. There are three categories of coastal marshes: salt marsh, brackish marsh, and intermediate marsh. Salt marshes have a relatively low floral diversity, high vegetative productivity, and diverse fauna. Typical herbs and grasses include wire grass, three corner grass, coco, and widgeon grass. Fiddler crabs, mud crabs, clams, snails, and shrimp are common molluscs. The typical fish are killifish, cyprinids, and immature mullet spot.[186]

In the intermediate and brackish marshes, common flora include wire grass, saw grass, and wild millet. Common molluscs are snails, oysters, crabs, clams, and shrimp. Typical fish include killifish, catfish, and gar. The diverse assemblage of common amphibians and reptiles includes the mobile cooter, southern legged frog, broad-banded water snake, speckled king snake, and western cottonmouth.[187]

Threatened or Endangered Species

The bald eagle (*Haliaeetus leucocephalus*), a Federal endangered species, is reported to nest within Iberia County, although USFWS reported that it is not of concern in the Weeks Island vicinity (see also Appendix D). Based on an observed bear track (July 1991) and information received from USFWS, the black bear, a Federal and State threatened species, is believed to occur on Weeks Island. The biological assessment (Appendix F) discusses the bald eagle and the Louisiana black bear. Additionally, based on information supplied by the U.S. Fish and Wildlife Service in Louisiana and the Louisiana Department of Wildlife and Fisheries, several plant species listed as rare in Louisiana are reported to occur at or within a one-mile radius of the Weeks Island site; these are listed in Table 5.3-4. Note that these species are not listed in Appendix D because they have not been designated as endangered or threatened by Louisiana or USFWS.

Table 5.3-4
Rare Plant Species Occurring Within A One-Mile Radius of the Weeks Island Site

Glade Fern	*Athyrium pycnocarpon*
Climbing Bittersweet	*Celastrus scandens*
Lance-Leaved Glade Fern	*Diplazium lonchophyllum*
Southern Shield Wood-Fern	*Dryopteris ludoviciana*
Snow Melanthera	*Melanthera nivea*
Three-Lobed Coneflower	*Rudbeckia triloba*
Broad-Leaved Spiderwort	*Tradescantia subaspera*

Source:
Letter from Gary Lester, State of Louisiana, Department of Wildlife and Fisheries, July 10, 1991.

Other Biological Resources of Concern

Avery Island Bird Sanctuary is located ten miles northwest of Weeks Island, and Marsh Island National Wildlife Refuge is located 17 miles to the south. Off the southern shore of Marsh Island is an eight-acre bird nesting area designated as Shell Keys National Wildlife Refuge. Directly west of Marsh Island across Southwest Pass is State Wildlife Refuge and Paul J. Rainey Wildlife Sanctuary (administered by the National Audubon Society).

5.3.5.2 Ecosystems Crossed by Pipelines

Raw water intake and brine disposal pipelines as well as one pump station to upgrade the existing DOE Weeks Island to St. James pipeline would be constructed as part of development of the Weeks Island site. Under a 180-day drawdown criterion, an additional crude oil pipeline from the Weeks Island site to the Texas 22" pipeline would be constructed, an additional pump station would be constructed, and the St. James Terminal would be expanded. The specific water bodies crossed by the proposed pipelines are identified and characterized in section 5.3.3.3. The ecosystems crossed by the pipelines are discussed below. Tables 5.3-5, 5.3-6, and 5.3-7 list species and ecological areas of interest that may occur along the proposed pipeline routes. Ecosystems in the vicinity of the St. James Terminal expansion are discussed in section 5.6.5. No threatened or endangered species were identified along pipeline ROWs by USFWS as of significant concern.

Crude Oil Distribution Enhancements: Pump Stations and Pipelines

Crude oil distribution would be through the existing distribution pipeline to the St. James Terminal, with the addition of one pump station to boost its capacity.

Pump Stations. A large portion of the existing pipeline route to St. James Terminal crosses through palustrine emergent and palustrine forested wetlands. The western pump station would be located roughly one-third of the way along the pipeline to St. James. It is located in a wetland that extends inland approximately five miles from West Cote Blanche Bay, and is three miles south of Bayou Teche. Based on the Gulf Coast Ecological Inventory Map (New Orleans map), the location is not near any breeding grounds or other areas of ecological interest. The second pump station would be located near Lake Verret, one of several moderately large lakes known to have concentrated breeding populations of the Federal endangered bald eagle. It also is located in a palustrine forested wetland between Lake Verret and Belle River. The existing pipeline between these two pump stations crosses the Atchafalaya Basin Floodway, which is considered to be a sensitive area, and a portion of the pipeline crosses the Attakapas Island Wildlife Management Area, in which historical occurrences of the Federal endangered Florida panther are reported. Two endangered or threatened species are listed in St. Mary Parish (in which the western pump station would be located) and Assumption Parish, where the eastern pump station would be located (Appendix D).

Weeks Island to St. James Pipeline Spur. A one-mile spur would be built from the expansion site to the existing Weeks Island to St. James pipeline. While endangered plant species listed in Table 5.3-4 could exist in the vicinity, this short spur does not cross any areas of ecological interest for other reasons. The spur is entirely within Iberia County, in which two endangered or threatened species are listed (Appendix D).

Texas 22" Pipeline Spur. A pipeline that would be constructed to achieve a 180-day drawdown is an eight-mile spur from the existing Weeks Island site to the Texas 22" pipeline.

Table 5.3-5
Species Likely to be Found Along the Proposed Weeks Island Brine Pipeline

BIRDS		
	Dabbling ducks	Shorebirds
	Geese	Wading birds
	Rails	
FISH		
	Atlantic croaker	Red drum
	Bay anchovy	Redear sunfish
	Black crappie	Sand seatrout
	Black drum	Sea catfish
	Blue catfish	Sheepshead
	Bluegill	Silver perch
	Buffalo drum	Silver seatrout
	Channel catfish	Southern flounder
	Drum	Southern kingfish
	Freshwater drum	Spot
	Gafftopsail catfish	Spotted seatrout
	Gars drum	Spotted sunfish
	Gizzard shad	Stripped mullet
	Gulf kingfish	Warmouth
	Gulf menhaden	White crappie
	Largemouth bass	Yellow bass
	Pinfish	
INVERTEBRATES		
	Blue crab	Eastern oyster
	Brackish-water clam	Shrimp
	Brown shrimp	White shrimp
MAMMALS		
	Atlantic bottlenose dolphin	

Source:
Gulf Coast Ecological Inventory Map, New Orleans, LA and Port Arthur, TX. U.S. Fish and Wildlife Service. 1982.

Table 5.3-6
Species Likely to be Found Along the
Proposed Weeks Island and Cote Blanche Crude Oil Pipeline Routes

BIRDS AND DUCKS		
Bald eagle [E]	Herons	
Common snipe	Rails	
Dabbling ducks	Waterfowl	
Egrets		
FISH		
Atlantic croaker	Gafftopsail catfish	Sheepshead
Bay anchovy	Gars	Southern flounder
Black crappie	Gars drum	Southern kingfish
Black drum	Gizzard shad	Spot
Blue catfish	Green sunfish	Spotted bass
Bluegill	Gulf kingfish	Spotted seatrout
Bowfin	Gulf menhaden	Spotted sunfish
Buffalo drum	Largemouth bass	Striped mullet
Buffalos	Longear sunfish	Warmouth
Carp	Red drum	White bass
Channel catfish	Redear sunfish	White crappie
Flathead catfish	Sand seatrout	Yellow bass
Freshwater drum	Sea catfish	
INVERTEBRATES		
Blue crab		
Brown shrimp		
Crayfish		
White shrimp		
MAMMALS		
Atlantic bottlenose dolphin		
Black bear [S]		
Eastern cottontail		
Mink		
Muskrat		
Nutria		
Raccoon		
River otter		
Whitetail deer		

Source: Gulf Coast Ecological Inventory Map, New Orleans, LA. U.S. Fish and Wildlife Service. 1982.

Table 5.3-7
Areas of Habitat Use Within One-Half Mile of the Proposed Pipeline to or from Weeks Island

Area	Pipeline Type: Raw Water	Pipeline Type: Brine	Pipeline Type: Texas 22" Spur Crude Oil
Breeding		X	X E
Nursery		X	X
Adult concentration		X	X E
Unusual distribution or specimen			X
Migratory		X	X
Commercial harvesting		X	X
Sport fishing/hunting		X	X
Wildlife refuge/Management area		X	X

E = Pipeline crosses several concentrations of the following endangered species: bald eagle.
Source: Gulf Coast Ecological Inventory Maps, New Orleans, LA and Port Arthur, TX. U.S. Fish and Wildlife Service, 1982.

The pipeline follows Route 83 north from the expansion site, to the Texas 22" pipeline which is just south of the town of Boudreaux. Nearly 75 percent of the land crossed by this pipeline is wetland, which extends inland from Vermilion roughly six miles. This pipeline does not cross through any wildlife refuges, although the wetlands are used as breeding grounds by wading birds such as snowy egrets, and little blue herons, and by waterfowl, particularly anhingas. The spur is entirely within Iberia County, in which two endangered or threatened species are listed (Appendix D).

Brine Disposal Pipeline. The brine disposal pipeline route is a 41-mile pipeline routed west from the site across the ICW, southwest through Weeks Bay and Vermilion Bay, and around the west side of Marsh Island, crossing State Wildlife Refuge and Paul J. Rainey Wildlife Refuge prior to going out into the Gulf (see Figure 3.3-2). The route is located in Iberia and Vermilion Parishes, in which five endangered or threatened species are listed (Appendix D).

The route would cross nearshore bays, such as Weeks Bay, Vermilion Bay, West Cote Blanche Bay, and East Cote Blanche Bay. Like the many other estuarine bays that form the coast of Louisiana, Vermilion Bay is a highly productive, important nursery ground for many species of shellfish and finfish. The diverse zooplankton fauna includes at least 45 taxa, including copepods, which dominate, and the eggs and larvae of commercially important brown shrimp, white shrimp, and blue crabs. Polychaete worms, snails, clams, oysters, white and brown shrimps, and blue crabs are the typical benthic organisms in these bays. Approximately 100 species of fish live in Louisiana coastal bays and nearshore regions, including bay anchovies, Atlantic croaker, Gulf menhaden, and sea catfish. Freshwater fishes are found in these bays during the frequent periods of low salinity.[188] Brackish-water clams are harvested from Vermilion Bay.[189]

Estuarine and near-coastal water near Weeks Bay are very important for oysters. Virtually all of Vermilion Bay and contiguous West Cote Blanche, East Cote Blanche, and Atchafalaya Bays are State-regulated oyster seed areas, as marked in Figure 5.3-4. Private oyster harvest is not permitted within these seed areas, but the State of Louisiana oversees the transplanting of oysters from seed areas to private lease areas, where they may be harvested. Figure 5.3-4 also illustrates the approximate boundaries of the private lease areas off the coast of Marsh Island and south of Cheniere Tigre. These boundaries designate the locations where oysters may or may not be harvested, not the only places where they exist. As shown in Figure 5.3-4, there is active oystering near the western end and southern half of the private leased area, but there is a band of private leases directly beneath the Paul J. Rainey Wildlife Refuge where oysters are not presently being harvested. The exact extent of oysters within the designated seed areas and the private lease areas is not known, but the oysters could theoretically exist throughout both areas. Similarly, the extent of oyster beds outside of the designated areas is not known, as oysters could be present in many other areas.[190] Prior to choosing the final placement of the brine discharge pipeline from Weeks Island, a detailed field survey and assessment of oyster population, including living and non-living, would be prepared.

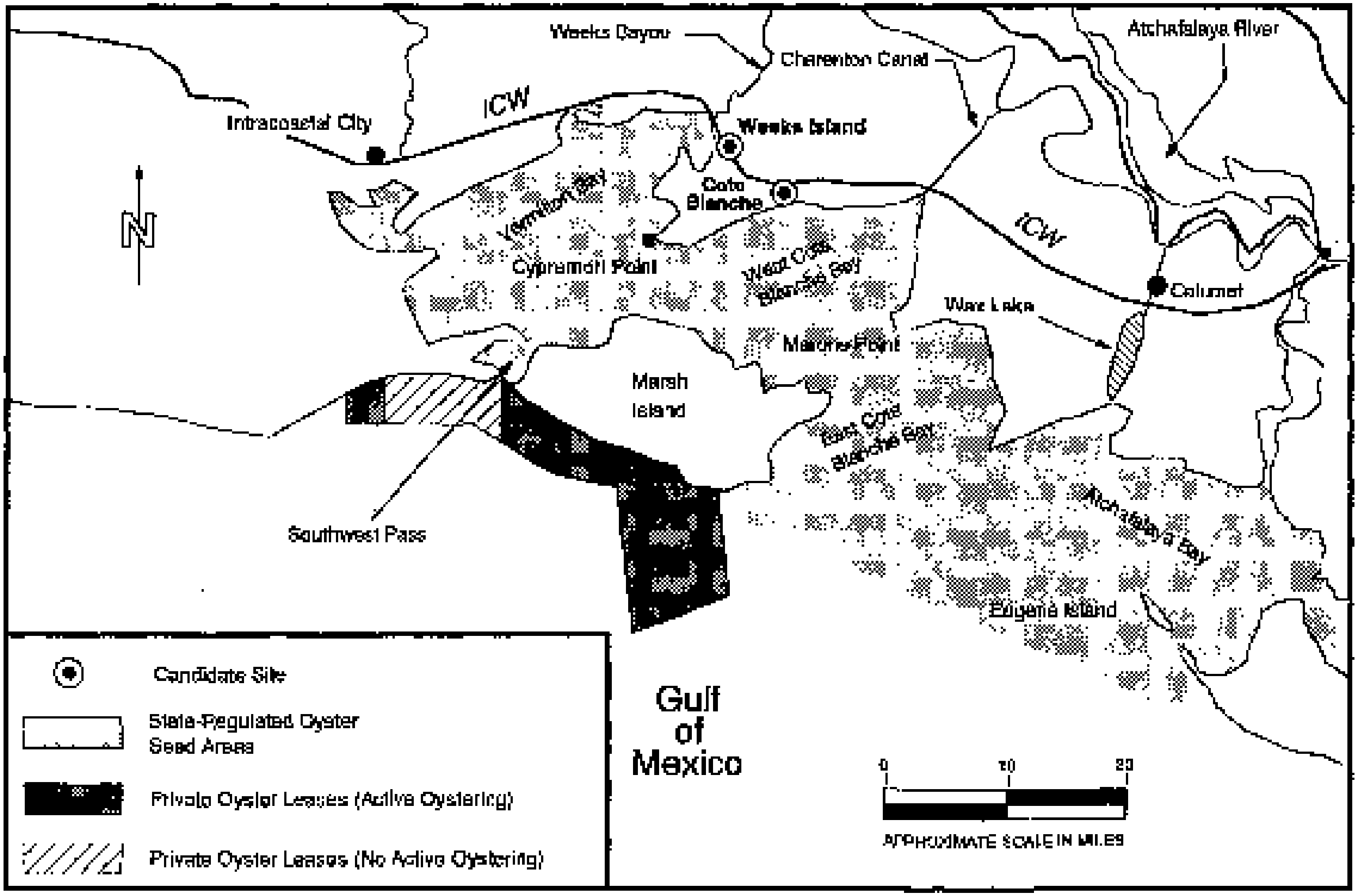
A brine disposal alternative is injection into disposal wells along the first five miles of the existing pipeline ROW to the St. James Terminal. This segment runs southeast from Weeks Island and crosses Route 83 east of Ivanhoe, Louisiana. The existing pipeline ROW is periodically maintained, and the vegetation present is likely a mixture of grasses, shrubs, and saplings. There are no known endangered species nesting areas or other unique ecological areas along this segment of pipeline.

Raw Water Pipeline. The raw water pipeline would run two miles directly west from the expansion site to the ICW. Based on observations during the site visit, the majority of the raw water pipeline route (and the short segment of the brine disposal pipeline route which parallels it) is a disturbed, overgrown area consisting mostly of shrub and herbaceous vegetation. The dominant canopy species is sweetgum. Other species observed are southern bayberry, magnolia, Chinese tallow tree, yaupon, passion vine, rattlebox, partridge pea (the prevalent herbaceous species), Virginia creeper, honeysuckle, shining sumac, and deer pea. Kudzu is prevalent over many portions of the forested areas. Based on limited observations made during the site visit, and information depicted on the Gulf Coast Ecological Inventory map (New Orleans, LA map), there are no unusual habitats or ecologically-significant areas along this pipeline route. The proposed RWI system and pipeline route are entirely within Iberia Parish, in which two endangered or threatened species are listed (Appendix D).

5.3.5.3 Ecosystems Near the Brine Diffuser Location in the Gulf of Mexico

The general discussion of the baseline biological conditions in the Gulf of Mexico at Stratton Ridge (section 5.2.5.3) applies to the Louisiana sites as well. This section supplements the preceding discussion of Stratton Ridge by providing new information specific to the proposed

Figure 5.3-4
Oyster Seed Grounds and Leases in the Weeks Island Vicinity



Source: Fred Dunham, Louisiana Department of Wildlife and Fisheries

Weeks Island diffuser site. See section 5.2.5.3 and Appendix B for a discussion of threatened or endangered species and unique or important habitats in the Gulf, including the general area of the proposed Weeks Island diffuser site.

The Atchafalaya and the Mississippi Rivers greatly affect the plankton community near the Louisiana coast. Nutrient levels on the continental shelf are derived primarily from these river systems, and to a lesser extent from the outflow of other streams and from upwelling. Consequently, phytoplankton levels tend to be much higher and more variable off Louisiana than off south Texas, and higher and more variable inshore than offshore.[191] The phytoplankton community observed near Weeks Island is characteristic of the plankton community of the coastal waters off Louisiana. Although dominated by diatoms, the plankton populations are diverse and can tolerate wide fluctuations in temperature and salinity. Due to the mixing of freshwater with Gulf waters, marine, estuarine, and freshwater plankton species may all be found in the vicinity of the Weeks Island site.[192]

The abundance of zooplankton tends to parallel that of phytoplankton. Zooplankton is much more abundant in coastal waters off Louisiana than off south Texas and much more abundant nearshore than offshore. Copepods tend to make up a large portion of the zooplankton at all seasons and localities.[193]

Benthic invertebrate distribution and abundance is greatly affected by environmental factors such as sediment type, water depth, dissolved oxygen, salinity, and temperature. In general, species in the area of the proposed Weeks Island diffuser are acclimated to naturally wide variations in these factors. Species composition and numbers of benthic animals from the nearshore Louisiana coast also show seasonal variations, including effects from seasonal storm surges. Polychaetes tend to be the most significant as a group throughout the year in terms of biomass and numbers of individuals. There are seasonal trends in dominance within this group, and studies have shown that there are distinct differences in the polychaete species composition at different sites.[194]

The regional ichthyofauna are comprised of at least 105 fish species.[195] Some of the more abundant fish of the region include the bay anchovy, Atlantic croaker, sea catfish, rock seabass, Gulf menhaden, Atlantic cutlassfish, fringed flounder, spot, sand seatrout, Gulf butterfish, Atlantic bumper, blue spotted sea robin, and Atlantic threadfin.[196] Other, more elusive species are also likely to inhabit the area, since more than 600 species of fish are known to occur in coastal Gulf water off Texas.[197]

Louisiana is the most productive state in the Gulf region in terms of commercial fisheries because of its extensive estuaries, coastal marshes, and nutrient input from the Mississippi and Atchafalaya Rivers. Some of the major fisheries include shrimp, menhaden, oysters, and blue crabs. Sportfishing in the Louisiana coastal area is extremely popular and provides for a large industry. The bays and nearshore regions yield Atlantic croaker, spot, red drum, seatrout, black drum, southern flounder, sheepshead, and spadefish. Louisiana ranked first among central and western states in total commercial fishery landings for 1989 with commercial fish landings amounting to 1.2 billion pounds valued at $264.2 million.

5.3.6 Floodplains

The proposed facilities at Weeks Island would cover approximately 300 acres at an elevation of about 17 meters.[198] The site covers both floodplain and non-floodplain areas. The southernmost one-third of the site rests in a non-floodplain area; the remaining two-thirds are in a floodplain (see Figure 5.3-5).[199] Because the existing Weeks Island storage site is not in a floodplain, no flood protection is in place at the Weeks Island site, although measures have been taken to protect the site from stormwater runoff. The proposed brine disposal and raw water pipelines, sharing the same ROW while on land, would pass through 0.7 miles of wetlands.[200] In addition, a RWI structure would be constructed in a floodplain on the ICW.

5.3.7 Natural and Scenic Resources

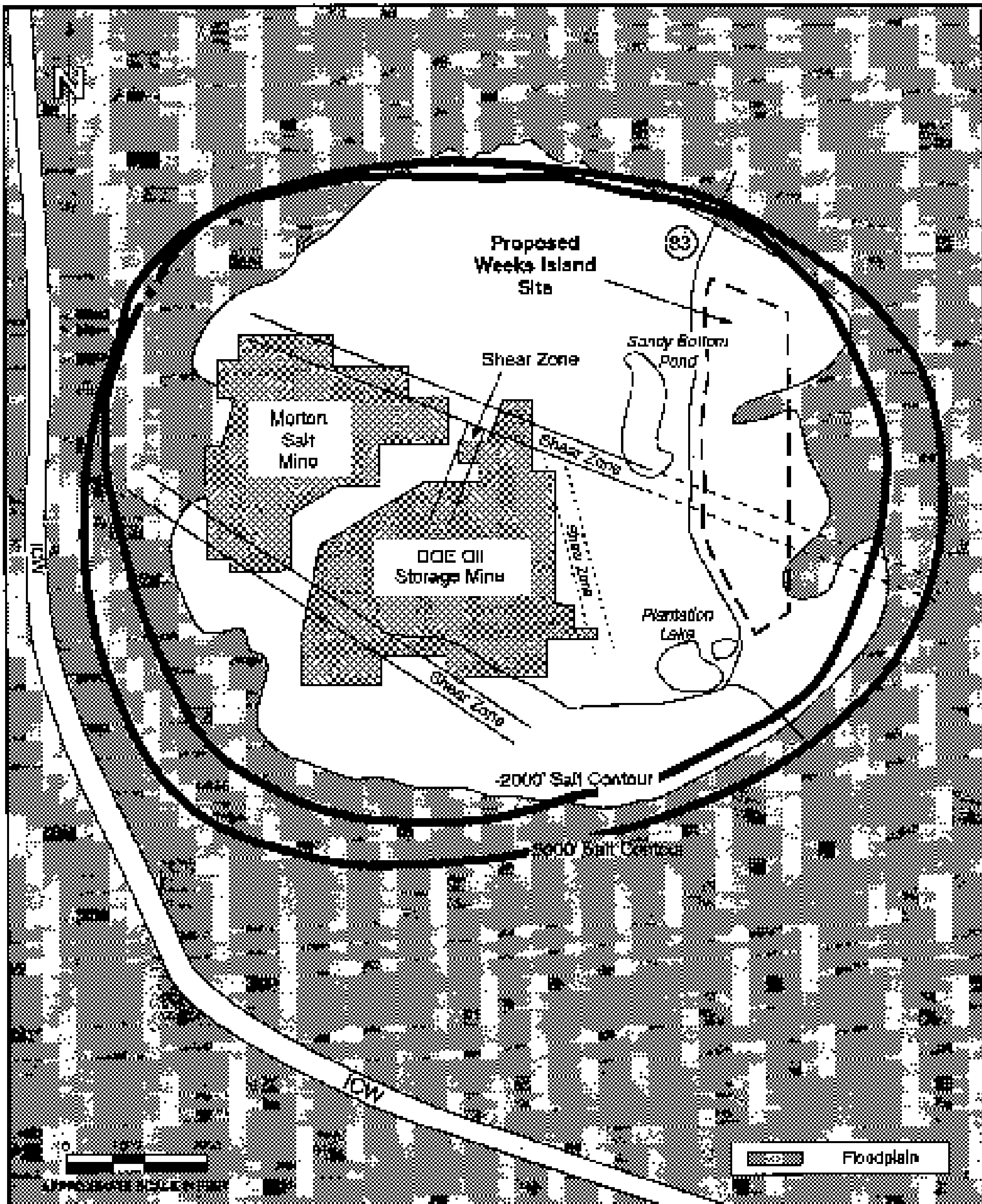
The proposed site is primarily agricultural fields, but also includes hardwood forests. Coastal wetlands in the surrounding area include a combination of saline and brackish marshes, bayous, man-made canals (including the ICW), and bays contiguous with the Gulf of Mexico. The proposed expansion area would be located above the marsh, except the outside cavern row, where wetland alteration may be required for flood protection. Several small, shallow ponds occur on the east side of the salt dome, the area being considered for expansion. Based on the NWI map for the site, approximately six acres of wetlands exist.

Avery Island, a 200-acre wooded bird sanctuary, is located ten miles northeast of Weeks Island; and the Russell Sage Foundation-Marsh Island National Wildlife Refuge is located 17 miles to the south. Off the southern shore of Marsh Island is an eight-acre bird nesting area designated as Shell Keys National Wildlife Refuge. Other nearby wildlife areas include Cypremort Point State Park, on the Vermilion Bay peninsula; Burns Point, a site on Cote Blanche Bay; and Louisiana State Wildlife Refuge, a 15,000-acre wildlife preserve situated directly west of Vermilion Bay. The proposed brine disposal route would cross State Wildlife Refuge and the Paul J. Rainey Wildlife Refuge before entering the Gulf of Mexico.

5.3.8 Archaeological, Historical, and Cultural Resources

DOE contacted the Louisiana Department of Culture, Recreation, and Tourism for information on culturally important resources in the area and vicinity of the proposed Weeks Island expansion and pipeline routes. In response, the State of Louisiana performed a file search and identified two recorded archeological sites that lie within the impact area of the Weeks Island project. North Hill, which is owned by Morton Salt Company, is located on the northeast corner of the area proposed for the Weeks Island expansion. The site is listed as a cultivated field used for farming purposes (1979). Archaeologists presume that the site served as a village camp associated with the salt dome. Excavations at this site uncovered scattered artifacts from the prehistoric period. The second site, Plantation Lake, is located on the west central portion of Weeks Island. Archaeologists have also found scattered artifacts from the prehistoric period in this location. According to the State of Louisiana Department of Culture, Recreation, and Tourism, the National Register eligibility of these two sites is undetermined. There are no identified archaeological, historical, or cultural sites in the vicinity of the pipeline corridors.

Figure 5.3-5
Weeks Island Floodplain Assessment



Source: Federal Emergency Management Agency, Flood Insurance Rate Maps

5.3.9 Socioeconomics

Weeks Island is located in the southern part of Iberia Parish on Vermilion Bay. Four other parishes, St. Mary, St. Martin, Vermilion, and Lafayette, surround the site and comprise the region where a direct socioeconomic effect of the Weeks Island SPR development would likely be felt. The City of Lafayette, the largest city in the region, is about 35 miles northwest of the site. New Iberia (15 miles away) is also within this five-parish region. The section discusses the socioeconomic conditions in this five-parish region.

5.3.9.1 History and Cultural Patterns

The original inhabitants of the Iberia Parish and surrounding area were the Attakapas Indians. Traces of the Attakapas are still visible today; an Indian "midden" (burial ground) in the shape of an alligator can be found on Weeks Island, and excavations at Avery Island and Loreauville have unearthed traces of Indian life from thousands of years ago. The first attempt at settlement of the Attakapas region was made by the French in 1765, making this one of the oldest settlements in the State of Louisiana. Exiled Acadians from Nova Scotia followed these first settlers and, in 1765, the first white settlement, called the "Postes des Attakapas," was established by the French government near the present site of St. Martinville. When the property was transferred from France to Spain, Spanish settlers found their way into the region.

In the 1770s, French and Spanish officials began making land grants along streams and bayous. Although the earliest settlers were primarily fisherman and trappers, a more settled lifestyle based on agriculture and ranching soon flourished. The bayous and smaller waterways, called "coulees," were the chief means of transportation and also provided good drainage for agriculture. After the Louisiana Purchase in 1803, English settlers arrived from Virginia and the Carolinas and began sugarcane plantations. On October 30, 1868, the Parish of Iberia was formed from parts of St. Martin and St. Mary Parishes.

There are two Native American Reservations in or near the Weeks Island region. The Coushatta Native American Reservation, in Elton, LA is 75 miles northwest of the Weeks Island site. Because of the distance from the site, the Native Americans are not expected to have any concerns with the development of the SPR sites. The Chitimacha Native American Reservation in Charenton, LA is located along the Southern Pacific Railroad, north of Grand Lake. This area is 20 miles northeast of the proposed expansion site. However, development of the site is not expected to have any impact on the reservation.

5.3.9.2 Population

The Weeks Island region experienced a modest 4.8 percent increase in population during the period 1980 to 1990. This increase, however, does not reflect the large fluctuations that took place during the same period. The regional population grew from a low of 366,694 in 1980 to a high of 404,000 in 1986, but then declined during latter half of the decade to a total of 385,178 in 1990. Population increased in Iberia Parish, from 63,752 in 1980 to 68,297 in 1990.

There are two cities within a 15-mile radius of the proposed expansion site. New Iberia is the largest city in Iberia Parish with 31,828 residents, followed by Jeanerette with 6,511 residents. Although the population in New Iberia and other large towns in the Parish declined in the 1980s, the population in smaller towns and in unincorporated areas grew from 22,259 to 28,286 during the decade. Figure 5.3-6 shows the population distribution among small and large towns in Iberia Parish and in the Weeks Island region.

With the exception of St. Mary Parish, the population in each of the other parishes within the five-parish region experienced a net increase during the 1980s. Lafayette Parish is the largest of the five parishes; the city of Lafayette itself accounts for almost 25 percent of total population of the five parishes, and is more than three times the size of the city of New Iberia. In Vermilion Parish, the population of the small towns grew during the 1980s, while that of Abbeville, the largest city in the parish, declined from 12,391 to 11,187 (almost a ten percent decline). The largest city in St. Martin Parish, St. Martinville, also declined in population, although most of the smaller towns and unincorporated areas increased their populations during the same period. Franklin, the parish seat of government, is within 20 miles of Weeks Island and is the parish's second largest city with a population of 9,004 in 1990. The closest town to Weeks Island is Ivanhoe, a small town in St. Mary Parish.

5.3.9.3 Economic Activities

The regional economy in the Weeks Island area experienced wide fluctuations during the 1980s. The regional workforce rose from 167,150 in 1980 to 194,250 in 1984, but then declined to 168,600 in 1988. The regional unemployment peaked at 19 percent in 1986 and but steadily declined to 6.1 percent in 1990. The unemployment rate in Iberia Parish displayed a similar, but even more pronounced trend, peaking at over 20 percent in 1986 (Figure 5.3-7). Depressed energy prices during the 1980s had a severe negative impact on the economy throughout Louisiana.

Although there is no single dominant industry in Iberia Parish, the top four sectors, manufacturing, service, retail trade, and government employ about 61 percent of the workforce and account for 64 percent of earnings (Figure 5.3-8). These same sectors also account for the majority of economic activity in the region as a whole (Figure 5.3-9).

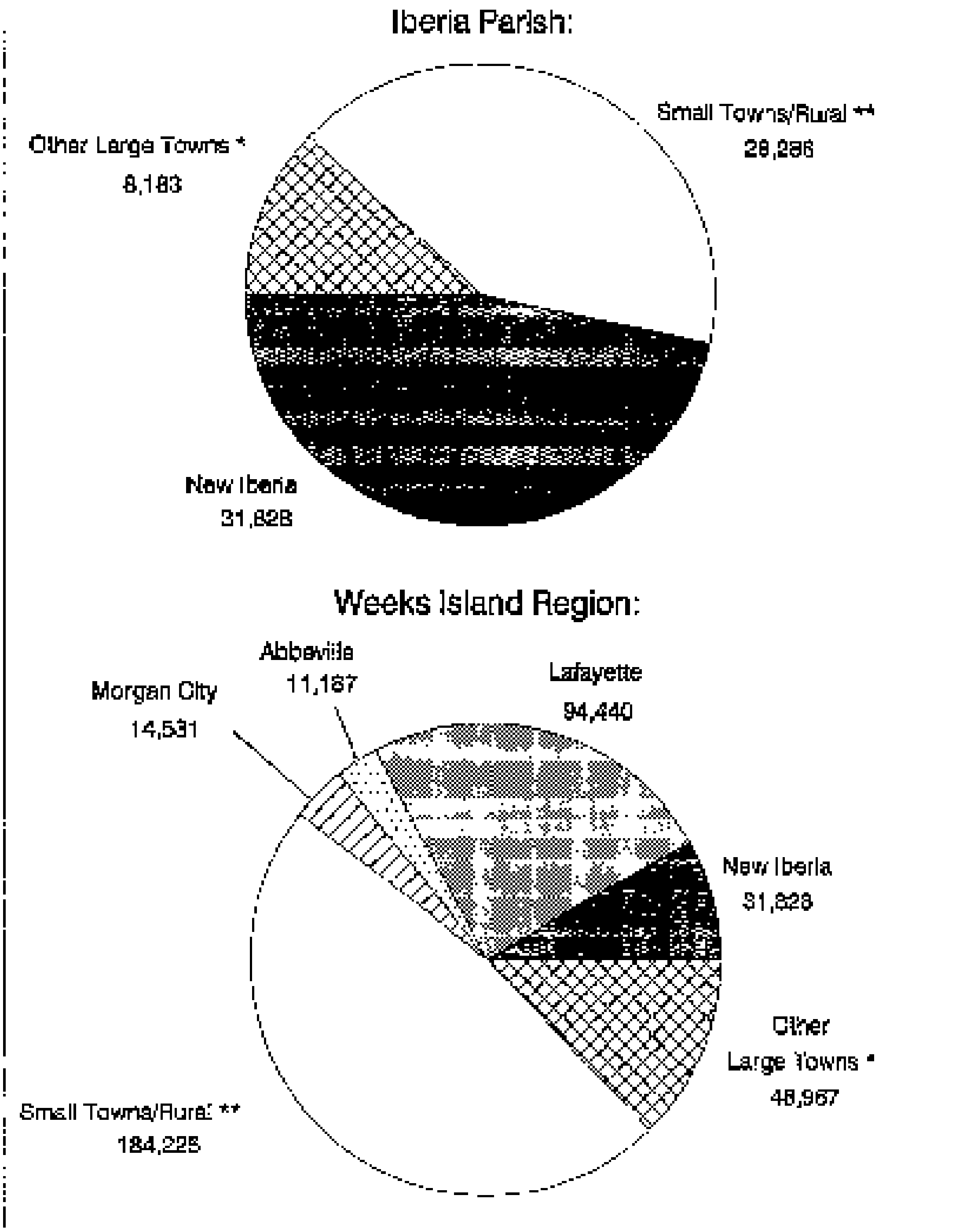
Total annual industry earnings in Iberia Parish were approximately $549 million or $18,970 per worker in 1989. Industry earnings for the region were $3.9 billion or $20,710 per worker. Lafayette and St. Mary Parishes had the highest earnings per worker, while St. Martin had the lowest.

5.3.9.4 Transportation Systems

Settlement patterns and transportation systems in the Weeks Island region have, to a large extent, been determined by topography and drainage. In the low lying regions, natural levees have provided areas for development and have allowed access to the waterways that at one time were the main means of local transportation. Most major State highways and railroads also follow these levees. An extensive system of connecting canals has been built to provide navigable waterways. The map in Figure 5.3-10 illustrates the transportation systems in the Weeks Island region.

U.S. Highway 90 is the main thoroughfare in the region, crossing east to west through most of the large towns including Morgan City, Franklin, Jeanerette, New Iberia, and Lafayette. State and parish highways also serve the area near Weeks Island. State Route 83 crosses U.S. 90 at two points, near Franklin and again further west at New Iberia, providing access to both the

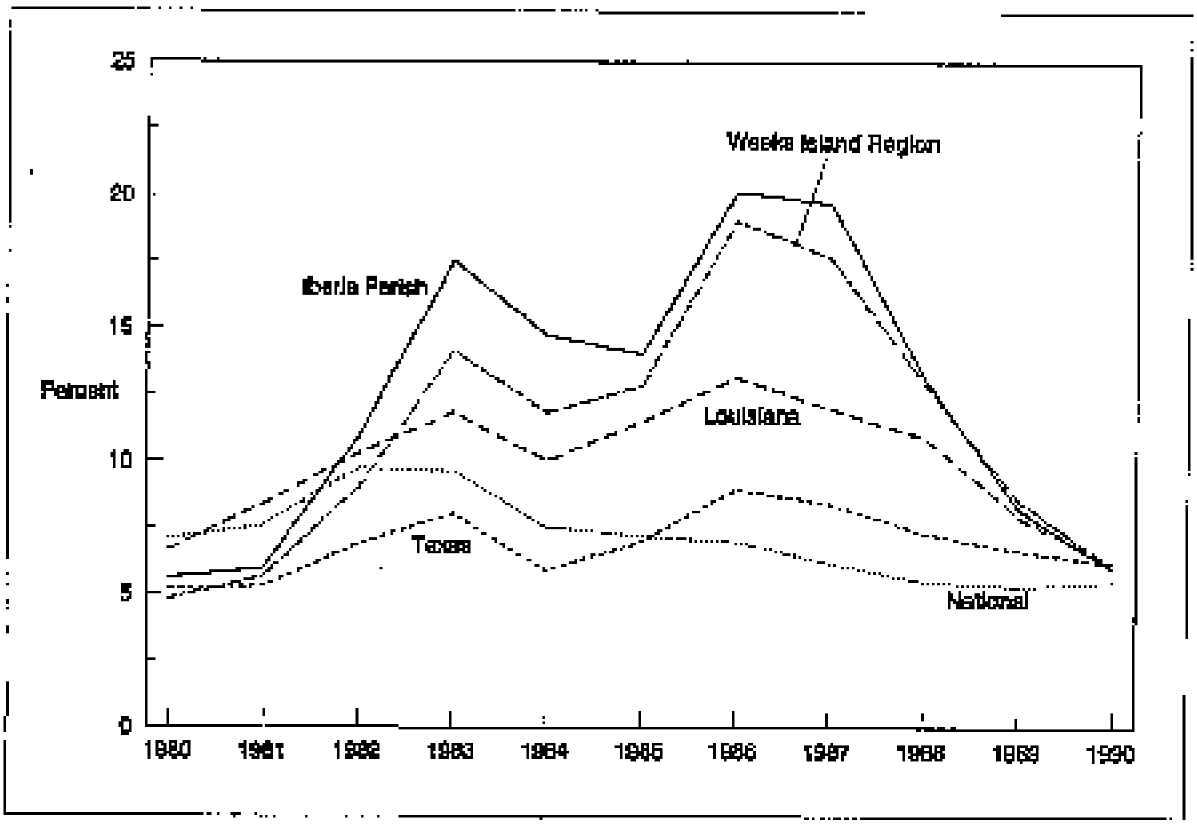
Figure 5.3-6
Population Distribution in Iberia Parish and the Weeks Island Region, 1990



* Cities and towns with populations greater than 10,000 residents.
** Towns and rural areas with populations less than 1,000 residents.

Source: STF-1A Selected Highlights from the 1990 Census. Table 1. Louisiana Division of Administration. Office of Planning and Budget. State Demographic Office.

Figure 5.3-7
Unemployment Rate in the Weeks Island Region, 1980 - 1990



Source: 1980-1990 CPS Tables on Labor and Employment, Louisiana Department of Employment and Training, Research and Statistics Unit.

Figure 5.3-8
Iberia Parish Industry Earnings and Workforce, 1989

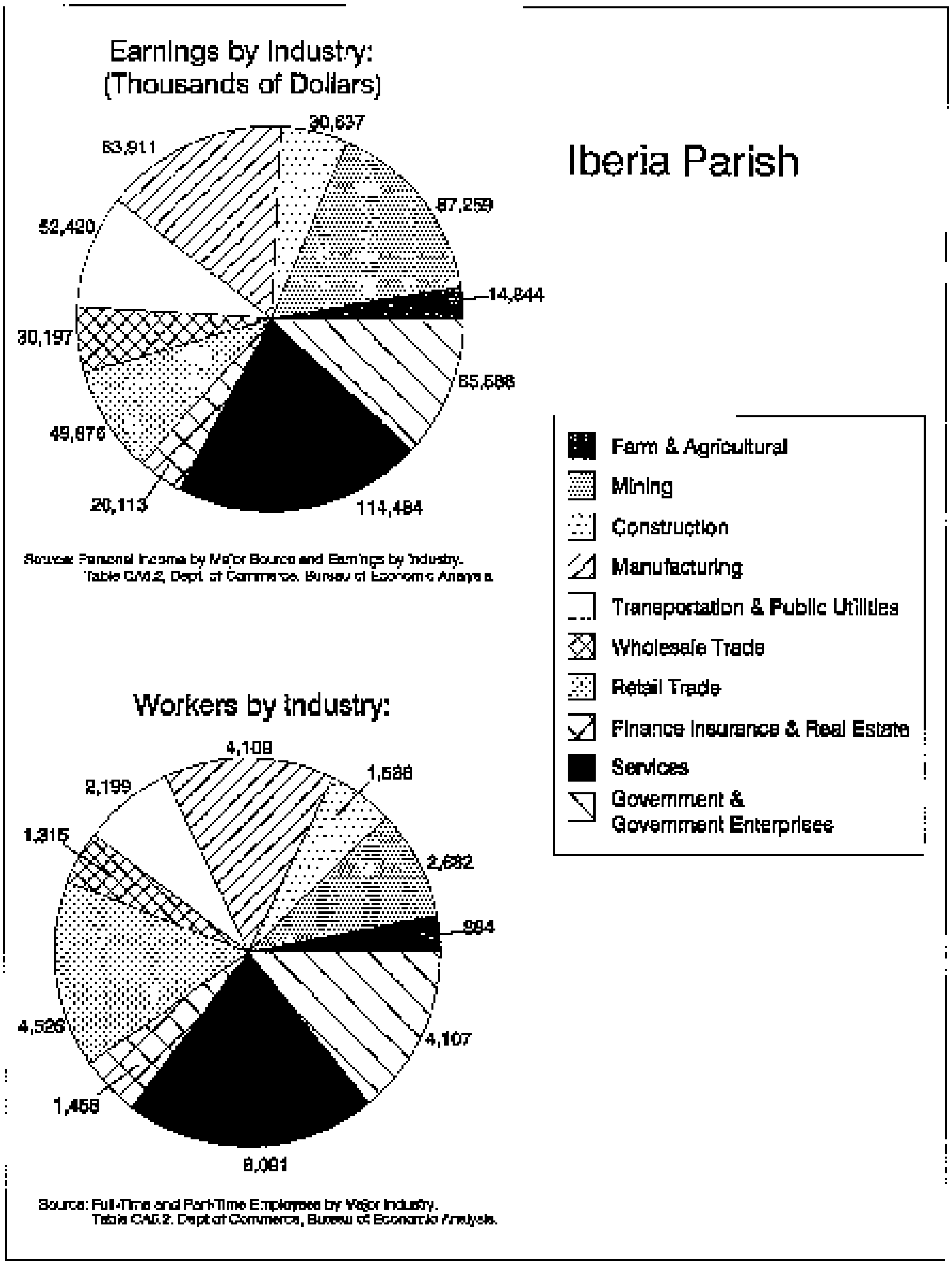


Figure 5.3-9
Weeks Island Region Industry Earnings and Workforce, 1989

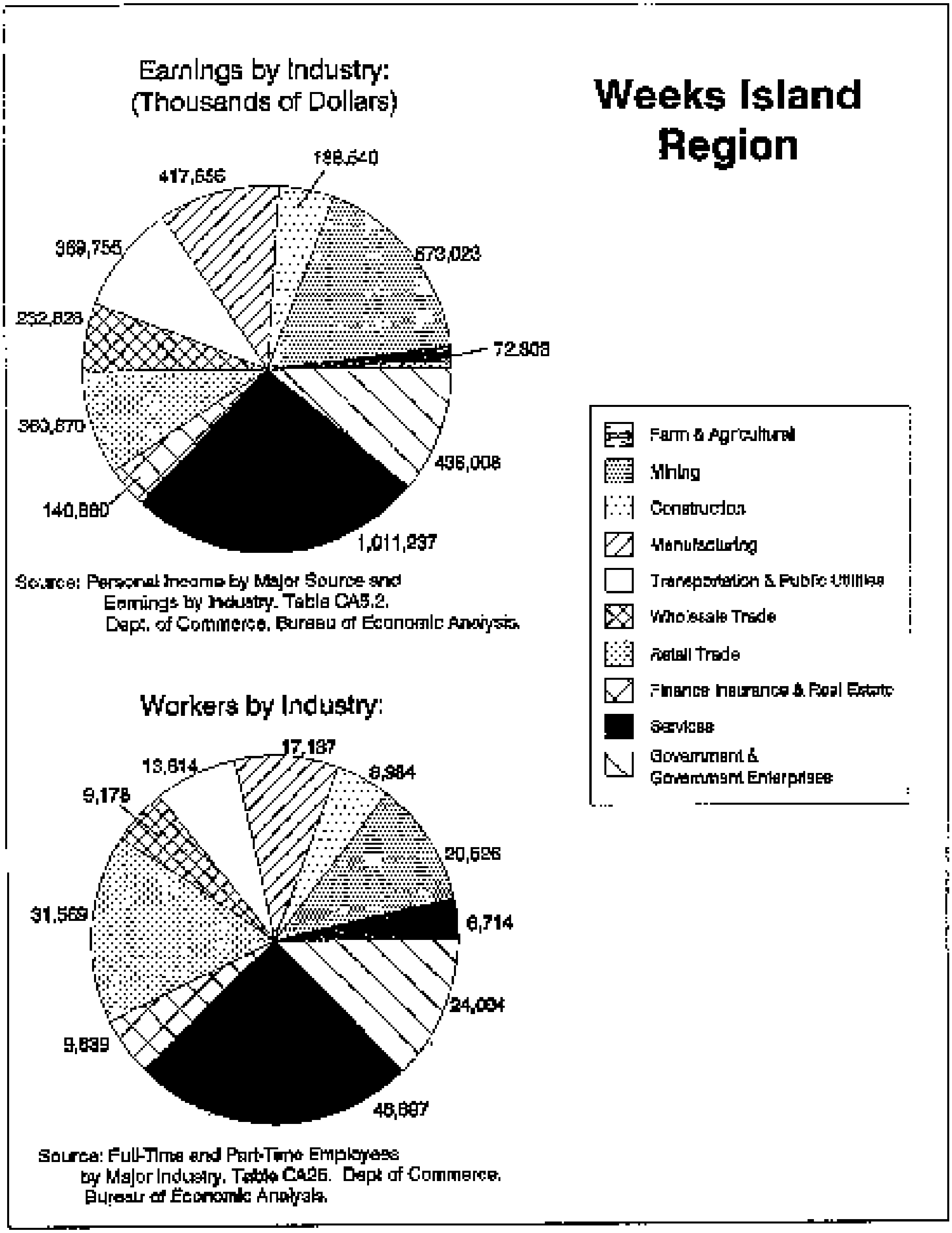
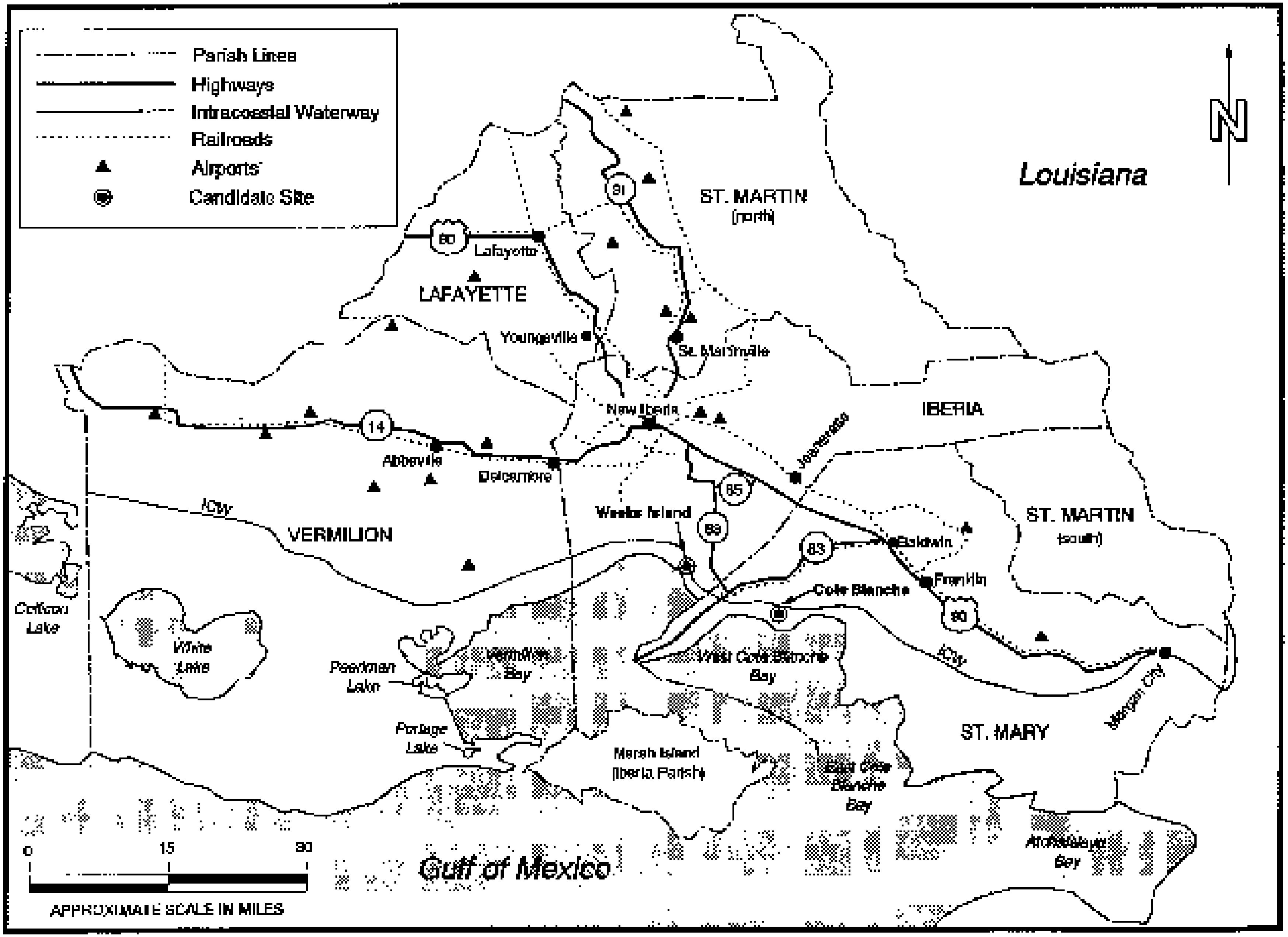


Figure 5.3-10
Transportation Systems in the Weeks Island & Cote Blanche Regions



Source: U.S. Geological Survey

Weeks Island site and the nearby Cote Blanche site. Route 83's road surface is bituminous, and its condition has been classified by Louisiana Department of Transportation as "fair." The existing, paved access road to the site is short in length because the current Weeks Island site borders Route 83's right-of-way. All on-site roads have two lanes and are paved. No information regarding bridges was available from the Louisiana DOT.

More than half of the employees at the current Weeks Island facility reside in New Iberia and travel the short stretch of U.S. 90 to Route 83 to get to work. Workers residing in other cities north and west of the site would also use Route 83. Highway U.S 90 in Lafayette, Route 14 east from Abbeville and Delcambre, and Route 31 south from St. Martinville all converge on the same U.S. 90 to 83 route from New Iberia to Weeks Island.

Probably because of the site's accessibility to New Iberia, few of those employed at the current Weeks Island facility live in cities to the east of the site. The few that reside in the Franklin area travel west on U.S. 90 to the east access of Route 83 down to Cypremort Point and around to Weeks Island. Only about two percent of current employees live further east than Franklin. Table 5.3-8 shows these potential travel routes, and summarizes road characteristics and traffic statistics (1990). Cities and towns of origin reflect those areas where workers at the current Weeks Island site reside. Commuter routes were chosen based on current worker distribution and routes of least distance from point of origin to the site. Because of accessibility, it is likely that the majority of employees relocating in the area for the construction and operation of an expanded SPR site at Weeks Island would also reside in the New Iberia area.

Lafayette Regional Airport is the main commercial airport in the region. Acadana Regional Airport, Abbeville Airport, Kaplan Municipal Airport, Memorial Airport in Patterson, and the Jeanerette Air Strip provide services for general aviation and agriculture. Two commercial bus companies provide bus service throughout Iberia and St. Mary parishes. In addition, two rail lines serve the area; the main branch of the Southern Pacific Railway serves many of the larger towns and a branch line of the Missouri Pacific Railroad provides freight service.

Water transportation by barge is available on the ICW, which cuts through this part of Louisiana east to New Orleans and west to the Louisiana-Texas Border. Over 53,000 vessels travelled on the ICW in 1989 between the Mississippi River and the Sabine River.[201] For estimated impacts on barge and tanker traffic on the ICW, see section 7.3.3.3. Small and large barge traffic is supported by the Vermilion River, Atchafalaya River, Bayou Teche, and many smaller bayous and canals.

5.3.9.5 Housing and Public Services

The following section describes the availability of housing in the Weeks Island area and summarizes the available education, health care facilities, and public utility services.

Housing

There are approximately 153,000 housing units in the Weeks Island region. Of this total, about 135,000 or about 88 percent were occupied during 1990. The remaining units were vacant because they were being offered for rent or sale, used seasonally for vacation or second homes, or

Table 5.3-8
Road Characteristics and Traffic Statistics for Likely Commuting Routes to Weeks Island

City/Town of Origin	Route(s)	Distance[1] (miles)	No. of Lanes, Road Width	Daily Vehicle Counts[2] (1990)	Vehicle Capacity	% of Trucks	Number of Accidents (1990)
New Iberia	US 90E to 83 (west access) 83S to Weeks Island	2 12.3	4 lanes, 48 feet 2 lanes, 20 feet	13,930 1,800 - 4,130	3,361 1,486	19 9	36 25
Lafayette/Youngsville	US 90E to 83 (west access) 83S to Weeks Island	23.5 12.3	4 lanes, 48 feet 2 lanes, 20 feet	13,930 - 17,160 1,800 - 4,130	3,194 - 3,568 1,486	19-24 9	615 25
Jeanerette	US 90W to 85 85W to 83 83S to Weeks Island	4 3.8 7.2	4 lanes, 48 feet 2 lanes, 20-24 feet 2 lanes, 20 feet	9,280 - 9,820 600 - 1,400 1,800 - 3,400	3,328 1,479 - 3,560 1,486	19 9 9	17 3 9
Delcambre/Abbeville	14E to US 90 US 90E to 83 (west access) 83S to Weeks Island	18.7 3.2 12.3	2-4 lanes, 24-48 feet 4 lanes, 48 feet 2 lanes, 20 feet	6,130 - 7,110 13,930 - 17,160 1,800 - 4,130	1,639 - 3,246 3,361 1,486	22 19 9	231 54 25
Franklin/Baldwin	US 90W to 83 (east access) 83W to Weeks Island	3.8 18	4 lanes, 40-48 feet 2 lanes, 20 feet	9,640 - 10,200 870 - 1,490	3,328 1,486 - 3,633	19 9	17 15
St. Martinville	31S to US 90 US 90E to 83 (west access) 83S to Weeks Island	8.6 3.2 12.3	2 lanes, 24 feet 4 lanes, 48 feet 2 lanes, 20 feet	5,020 - 5,660 13,930 1,800 - 4,130	1,407 - 1,852 3,361 1,486	8-19 19 9	129 54 25

[1] Distance and accident data reflect estimates from mile marker information by the Louisiana Highway Safety Commission.

[2] Average number of vehicles traveling on road during 1990. Range is indicated where data for more than one point of the segement were available.

Source: Louisiana Department of Transportation, Lafayette Division. Average Daily Traffic maps, 1990. Department of Public Safety and Corrections, Louisiana Highway Safety Commission, Traffic Accident Statistics, 1990. Selected Highway Statistics, Louisiana Department of Transportation, Highway Needs Division, 1992.

used for migratory workers. Of the occupied units, approximately 68 percent were owner-occupied and 32 percent were renter-occupied.

The number of units available for either rent or sale in the Weeks Island region numbered 7,659 during 1990. Of this total, 5,601 were rental units and 2,058 were units for sale (Figure 5.3-11). Lafayette Parish accounted for over 52 percent of the total available housing in the region. In Iberia Parish, there were total of 25,472 housing units in 1990. Of this total, 882 were available for rent and 363 were up for sale. Of those units occupied during 1990, 71 percent were owner-occupied. Currently, over half the workers at the existing Weeks Island facility reside in New Iberia.

Health Care

Iberia Parish has 78 physicians, or one physician for every 876 residents (Table 5.3-9). In its two hospitals, Iberia Parish has 243 beds or one for every 281 residents. The closest hospital to Weeks Island is located about 15 miles from the site in New Iberia. Health care facilities vary widely in the Weeks Island region from seven hospital facilities in Lafayette Parish, to no facilities in St. Martin Parish. Throughout the region, 577 physicians were practicing medicine in 1990, (one for every 668 residents) and there are 1,919 hospital beds (one for every 201 residents).

Education

During the 1990 - 1991 school year there were 15,254 students in 31 public schools in Iberia Parish (Table 5.3-10). An additional 1,871 students attended five private schools. The five public secondary schools are located in Delcambre, Jeanerette, Loreauville, and two in New Iberia. Impacts of workers' children on area schools are discussed in section 7.3.9.8.

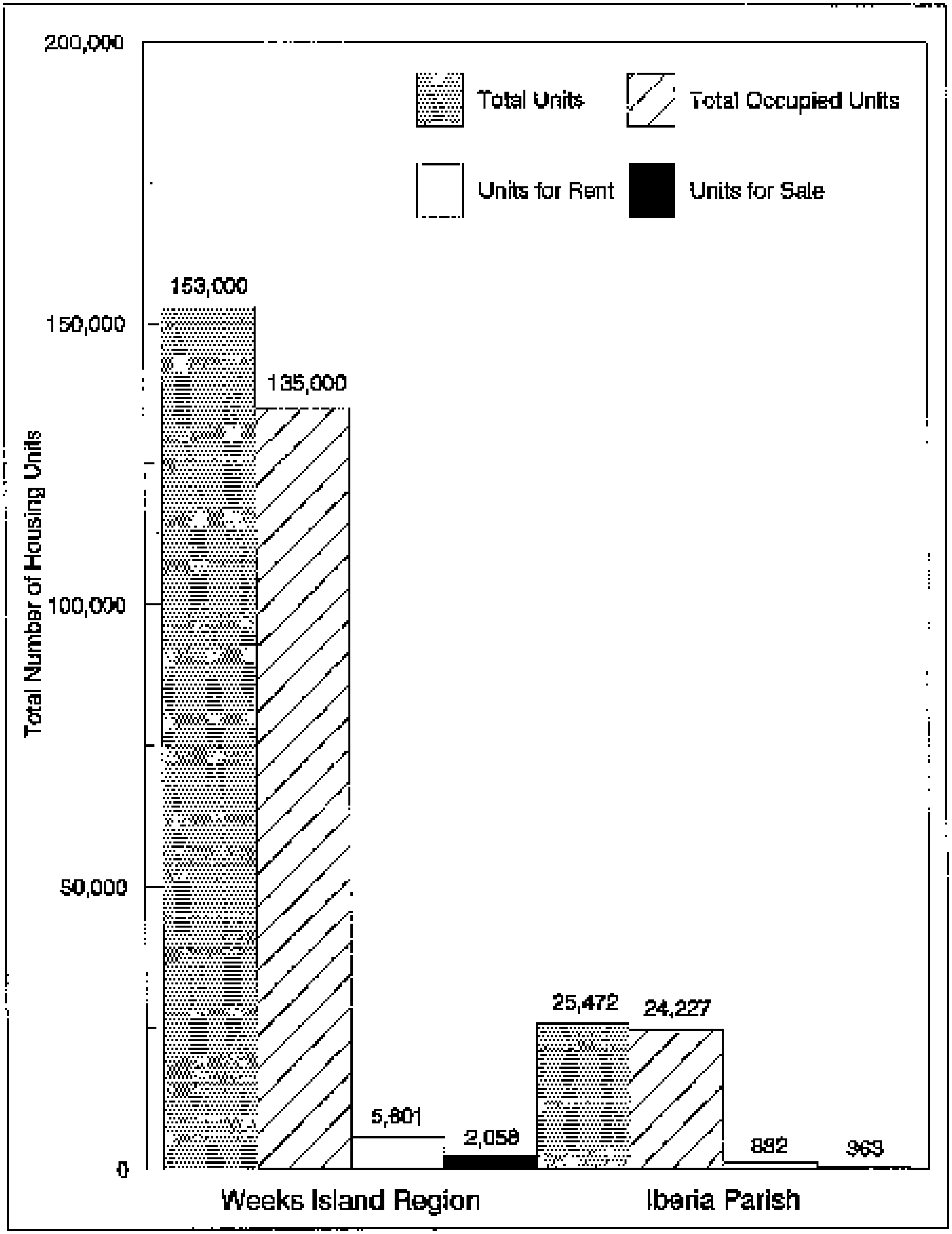
Utilities

Gulf State Utilities (GSU), provides power to South Central Louisiana as well as Southeast Texas, and currently services the Weeks Island facility. GSU is one of four utility suppliers in the Iberia and St. Mary Parish area. The other three utility companies include Central Louisiana Electric Company (CLECO), and two cooperatives: the Teche Electric cooperative which serves Cypremort Point, and South Louisiana Electric Company (SLECO). Gulf States currently services Weeks Island with one 138 kV transmission line that runs north to south along State Route 83 from New Iberia. The line is linked to the GSU's Bayou Warehouse substation about 1.5 miles east of Weeks Island where the voltage is dropped to 34.5 kV. The Bayou Warehouse substation has two transformers, each with a 25 megavolt-ampere (MVA) capacity. A line runs from the Bayou Warehouse substation to the DOE substation at Weeks Island where the voltage is stepped down further to serve DOE's power loads. A second line runs east from the DOE substation and connects to a 138 kV transmission line several miles to the east owned by CLECO, creating a loop that allows power to be supplied from two possible directions.

5.3.9.6 Government Revenues and Expenditures

The Federal government spent over $840 million in the Weeks Island region in 1990 (Table 5.3-11) or about $2,183 per capita. Almost one-fifth of that spending, $150.6 million

Figure 5.3-11
Housing in the Weeks Island Region



Source: U.S. Department of Commerce, Bureau of the Census, 1990.

Table 5.3-9
Health Care Facilities and Personnel, 1990

Parish	Hospitals	Hospital Beds	Residents per Bed	Physicians	Residents per Physician
Iberia	2	243	281	78	876
St. Mary	2	132	440	45	1,291
St. Martin	0	0	0	13	3,383
Vermilion	1	137	365	43	1,164
Lafayette	7	1,407	117	398	414
Region	12	1,919	201	577	668

Source: Louisiana Department of Health and Hospitals, Health Standards Division.

amounting to over $2,205 per capita, was in Iberia Parish. Local government expenditures in 1987 were $504 million with $35 million spent by governments within Iberia Parish (Table 5.3-12).

The Weeks Island site has an assessed value of about $62 per acre. In 1990, property taxes were 0.79 percent and totalled approximately $245.

5.3.9.7 Emergency Response Capabilities

Emergency services would be available for the Weeks Island site from both Iberia and St. Mary Parishes. Police services for Iberia Parish are provided by the Iberia Parish Sheriff's Department. The department is located at the court house in New Iberia and employs 72 full-time and 18 part-time officers and support staff. The Sheriff's Department has 37 vehicles, of which twelve are used for patrol. Four municipal police departments are provided in the following cities and towns: New Iberia, Jeanerette, Delcambre, and Loreauville. Staffing levels at these departments vary from a minimum of one on-duty officer at the Delcambre and Loreauville stations, to a minimum of six officers at the New Iberia station. The New Iberia police department, located about 15 miles from the site, would be the first from Iberia Parish on the scene at Weeks Island. Officers in Iberia Parish have received hazardous materials training and first responder operational level training.

Police protection for St. Mary Parish is provided by the St. Mary Parish Sheriff's Department located in the parish court house in Franklin. This sheriff's department employs 90 personnel, and uses 19 patrol cars and a total of 30 police vehicles. There are five municipal police departments and one police department located on the Chitamache Native American Reservation in St. Mary Parish. First response to the Weeks Island site from a police department in St. Mary Parish would come from the Baldwin Police Department about 20 miles away. No branches of the Louisiana State Police are located in St. Mary Parish.

Table 5.3-10
Iberia Parish Education Data, 1990

Iberia Parish	Number of Schools	Number of Students	Average $/Student	Average Number of Students/Teacher
Public Primary (K-8)	26	11,820	NA	19
Secondary (9-12)	5	3,434	NA	14
Private (K-12)	5	1,871	NA	NA

Source: 141st Annual Financial and Statistical Report, Session 1989-1990, Bulletin 1472. Louisiana Department of Education, Bureau of Education and Analytical Services.

Seven volunteer fire departments and one full-time fire department constitute Iberia Parish's firefighting capabilities. Fire suppression and hazardous materials training are required of all firefighters. Emergency medical training is required as well, and two of the nine fire departments provide ambulance and rescue service in addition to their other duties. Fire units can arrive at the Weeks Island site approximately ten to 15 minutes after first notification.

St. Mary Parish has a total of twelve fire departments, of which ten are volunteer departments and two are full-time. All St. Mary fire personnel have completed basic fire suppression training at the fire academy. At least one person at each of the twelve fire departments has had hazardous materials (hazmat) training. St. Mary plans to have a fully operational hazmat team in the near future. The Franklin fire station is the nearest to the Weeks Island site with an approximate response time of ten to 15 minutes.

There are seven independent ambulance and rescue units available for Weeks Island from Acadian Ambulance Service in Lafayette. In addition, there are two units provided by the fire department in Iberia Parish. Each one of the units can provide advanced (or paramedic) life support with the nearest unit about 20 minutes away from the Weeks Island site. Iberia General Hospital and Dautrive Hospital are closest to Weeks Island (within 15 miles) as is the nearest medical evacuation helicopter support available. A trauma center in the city of Lafayette is approximately 30 miles away.

5.3.9.8 Land Use

The Weeks Island salt dome is located in Iberia Parish, Louisiana, on the eastern edge of Weeks Bay. Land is used in Iberia Parish primarily for agriculture and forestry. The primary crops in the parish are sugarcane, soybeans, rice, native pecans, and hay. Most of the forest land in the parish is covered by bottomlands forest type. Bottomland forest type includes tupelo, blackgum, sweetgum, oaks, or southern cypress, singly or in combination.

Weeks Island is about nine miles south of Lydia, approximately 14 miles south of New Iberia, and 95 miles west of New Orleans. The dome itself is virtually uninhabited and the surrounding area is sparsely populated. Weeks Island is predominantly covered with second

Table 5.3-11
Federal Government Expenditures in the Weeks Island Region, 1990
(Thousand Dollars)

Parish	Expenditure
Iberia	150,598
St. Mary	147,341
St. Martin	88,385
Vermilion	129,138
Lafayette	325,526
Total	840,988

Source: Consolidated Federal Funds Report FY 1990, Department of Commerce

Table 5.3-12
Local Government Expenditures in the Weeks Island Region, 1987
(Thousand Dollars)

Parish	Expenditure
Iberia	94,078
St. Mary	96,595
St. Martin	43,485
Vermilion	73,736
Lafayette	195,929
Total	503,823

Source: 1987 Census of Governments, Vol. 4, No. 3 and Vol. 4, No. 5, Department of Commerce

growth deciduous forest, except for a few hundred acres on the eastern portion of the dome that are used for sugar cane farming. Other operations on the dome include table salt production at Morton Salt Company's two leached caverns, located on the southwest corner of the dome, and oil and gas production at Shell Oil Company's facility on the north overhang. Additional oil and gas fields are located at the northern and southern edges of the island.

Coastal wetlands in the area surrounding the dome include a combination of saline and brackish marshes, bayous, man-made canals (including the ICW), and bays contiguous with the

Gulf of Mexico. The dome also has several freshwater ponds on the island, with the largest pond, Plantation Pond, being approximately 20 acres in size and approximately ten feet in depth.

The major land resources areas in Iberia Parish consist of Southern Mississippi Valley Alluvium in the northern and eastern portions of the parish; Southern Mississippi Valley Silty Uplands in the northwest portion of the parish; and Gulf Coast Marsh in the southern and southwestern portions of Iberia Parish. Southern Mississippi Valley Silty Uplands are considered the area that poses the risk for the highest soil erosion rates.[202]

Agricultural crop yields and values in Iberia Parish are presented in Table 5.3-13. The 1990 sugar cane yield in Iberia Parish was approximately 640,422 cwt (about 23 cwt/acre), and the gross farm value of the sugar cane exceeded 14 million dollars.[203] Soybeans, native pecans, commercial nursery crops, rice, tabasco-red peppers (for processing) and pecans round out the remaining important crops produced in Iberia Parish.

The proposed Weeks Island expansion site contains no prime and unique farmland. The proposed pipeline right-of-way contains a total of 1.9 acres of prime and unique farmland, as identified by the U.S. Soil Conservation Service.[204]

In Iberia Parish, 35 percent of the land is forested. Of that 35 percent of forested land, 7,100 acres (about five percent) are state-owned; 7,100 acres (about five percent) are owned by farmers; 92,300 acres (about 62 percent) are owned by cooperatives or corporations; and 42,600 acres (about 28 percent) are individually-owned forested properties.

Approximately two-thirds of the forested land contains sawtimber, one-third poletimber, and the remainder is designated nonstocked areas.[205] Softwoods must be at least nine inches in diameter at breast height and hardwoods at least eleven inches. Poletimber is defined as growing-stock trees of commercial species at least five inches in diameter at breast height, but smaller than sawtimber size. Nonstocked areas are classified as areas with timberland less than 16.7 percent stocked.

According to the Forest Service, in 1984, the average net annual growth of growing stock and sawtimber on timberland in Iberia Parish was 3.9 million cubic feet for growing stock and 18.4 million board feet for sawtimber. Growing-stock volume is defined as the cubic-foot volume of sound wood in growing-stock trees at least five inches in diameter at breast height, from a one-foot stump to a minimum four-inch top diameter outside bark of the central stem, or to the point where the central stem breaks into limbs.

5.3.10 Ambient Noise

Primary sound sources at Weeks Island are operations of the existing SPR site and the Morton Salt mine adjacent to the SPR site. Because the Weeks Island SPR site has oil stored in a room-and-pillar salt mine rather than in leached caverns, the specific noise sources at the Weeks Island site differ from those of the other SPR sites.

According to industrial hygiene inspections of the existing SPR site, major ongoing noise sources consist primarily of the two mine shaft hoists. Shaft hoist operators are exposed to an average of 85 dBA over an eight-hour shift. When the hoists are in operation, sound levels around the shaft manifold rooms range from 89 dBA 150 feet from the exhaust fans of the

Table 5.3-13
Iberia Parish Crop Production, 1990

Crop	Units of Measure	Yield Per Acre	Total Production	Gross Farm Value (dollar)
Nursery Crops	Wholesale			2,940,000
Pecans (native)	Pounds	200	160,000	78,400
Rice	cwt	43.74	57,868	376,142
Soybeans	Bushels	38	323,000	2,018,750
Sugar Cane	cwt Raw Sug.	25.14	640,422	14,089,298
Tabasco-Red Peppers	cwt	35	1,750	105,000

Source: Louisiana Agricultural Statistics Service

manifold buildings, to 118 dBA two feet from the exhaust fans. Pump noise is also present during oil fill, oil transfer, and in the event of a drawdown. Sound monitoring data are not available for the Morton Salt mine, but it is likely to be comparable to the levels produced by the Weeks Island SPR site. Based on this information, ambient sound levels present during daily operations at the current SPR site are comparable to a suburban area (i.e., 55 dBA). When the oil pumps are in operation, sound levels are more likely comparable to a noisy urban area (i.e., 63 to 68 dBA).

The proposed expansion site is nearly a mile from the major Weeks Island noise sources discussed above. The most immediate noise source at the proposed expansion site is traffic noise from State Route 83, which is immediately adjacent to the site. Ambient sound levels at the proposed site and within the 5,000-foot impact zone are estimated to be comparable to a suburban area (i.e., L_{dn} = 53 to 58 dBA). As of 1980, there were approximately 17 residences or places of business within the impact zone. The nearest residence was approximately three-fourths of a mile from the site.[206] (See Appendix H for information on methods for estimating noise levels.)

5.4 Cote Blanche (Capline Complex Site)

The Cote Blanche salt dome is one of the alternate sites proposed for expansion in the Capline Complex. Under this alternative, DOE would create up to 16 storage caverns with a storage capacity of up to 160 MMB. To accomplish this proposed action, DOE proposes similar distribution and brine disposal options as those assessed for expansion at the Weeks Island salt dome.

5.4.1 Geology

The proposed Cote Blanche expansion site is located in St. Mary Parish, less than 8 miles southeast of the existing Weeks Island SPR site, and 18 miles southeast of New Iberia, Louisiana.[207] The Cote Blanche salt dome lies on the north shore of Cote Blanche Bay and is surrounded on three sides by brackish water, marsh, and the man-made ICW. The salt dome forms a geographic high point that rises to approximately 23 meters above msl.[208]

A cross-section of the Cote Blanche salt dome is provided as Figure 5.4-1. The Cote Blanche salt dome is elliptical in shape, with diameters of about three miles north to south and nearly two miles east to west within the -1,500-meter salt contour. A major salt overhang occurs on the north side of the dome with a dip of 60 degrees to the south. Approximately half of the salt dome lies beneath West Cote Blanche Bay and is not suited for the development of oil storage caverns.[209] There is no caprock over the Cote Blanche salt dome.[210] Oil seeps have been noted within the large salt overhang, possibly occurring from oil that is trapped under the overhang moving up through tension cracks in the salt caused by the overhang.[211] The eastern portion of the salt dome is characterized by both oil seeps and gas outbursts, indicating the probability of a shear zone in this area. Despite these salt dome irregularities, approximately 450 contiguous acres are available on the salt dome and would support the development of crude oil storage caverns within the -600 meter salt contour. This does not include the existing mine area, which would not be used for cavern development. A total volume of up to 250 MMB could potentially be stored at this site. Because of the shallow salt depth at Cote Blanche (approximately 300 meters to the top of the salt), the majority of caverns developed would be within the -600 to -1,200 meter depth range.[212]

Because the Cote Blanche site is less than eight miles from the Weeks Island site, the general surface and subsurface geology of the two sites is very similar. The overlying soils consist of Frost soils found primarily on the foot slopes of the dome and Memphis soils found throughout the island. Together they form the Memphis-Frost association, which covers all of the salt dome islands in the Vermilion Bay area. Sand and gravel layers, similar to those at Weeks Island, are found immediately off the edge of the salt dome.[213]

The land area directly over the existing salt mine at Cote Blanche Island has shown some local subsidence on the order of cm/yr, however, subsidence data for the privately-owned mine are not available. Local subsidence rates would be increased by the operation of oil storage caverns, but this is not expected to be a problem because of the relatively high elevation of the site.[214]

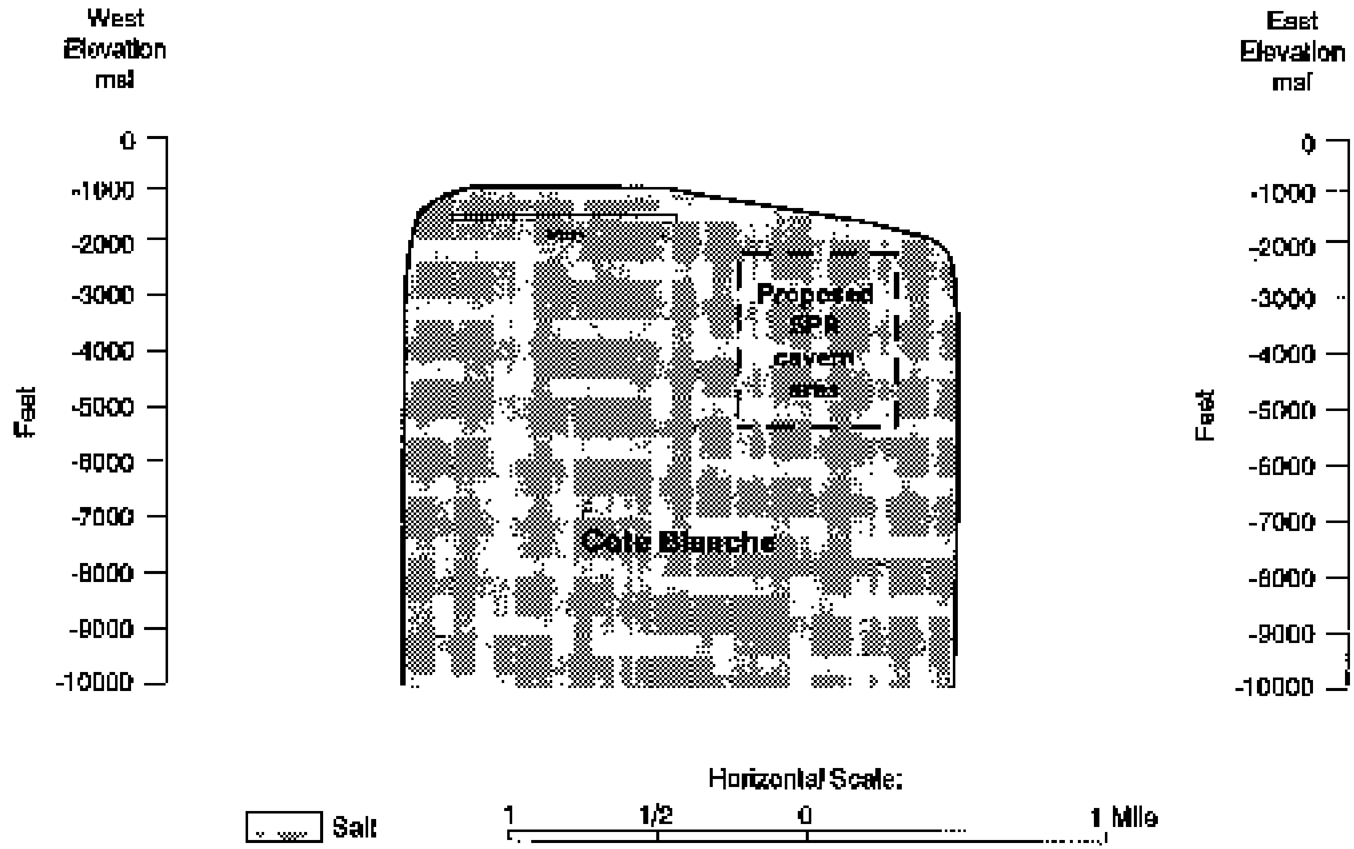
5.4.2 Hydrogeology

Compared to Weeks Island, information is scarce regarding the site-specific groundwater characteristics of Cote Blanche. Nonetheless, because of the two sites' proximity, similar elevations, and some common underlying hydrologic units, some of the prominent characteristics of Weeks Island hydrogeology may be used to make inferences about the hydrogeology of the Cote Blanche site.

Beaumont clays underlie one to five meters of surface loess from Memphis series soils. The clays are generally three to nine meters thick in most areas of Cote Blanche, but there are discontinuities where little or no clay separates the loess from the deeper sandy layers, making both aquifers semiconfined relative to the surface. Lenses of sands provide for some perched water tables just below the clays.[215]

Table 5.4-1 characterizes the aquifer system underlying Cote Blanche. The Atchafalaya and Gonzales are both near the surface, with the Atchafalaya being more prominent on the eastern side of the island due to its Mississippi alluvial plain origins. The subsurface pattern of each of the aquifers is patchy, as either aquifer can be tapped in many specific points in the vicinity. The Gonzales and the Atchafalaya are in only limited hydrologic contact in the area, resulting in only limited, localized flow between the two aquifers.[216] The hydrogeologic

Figure 5.4-1
Cross-Section of Cote Blanche Salt Dome



Note: Cavern locations and depths are diagrammatic and only convey approximations.

Source: U.S. Department of Energy, Preliminary Site Geological Characterization for Strategic Petroleum Reserve (SPR) Expansion Candidates, Volume II, Sandia National Laboratories, Albuquerque, NM, March 1991.

Table 5.4-1
Characterization of Aquifers Underlying the Cote Blanche Site

Aquifer	Depth to Aquifer (meters bls)[a]	Overlying Soils/ Permeability (cm/sec)	Karst	Water Quality; Degree of Salinity[b]	Major Uses
Atchafalaya	-3 to -10	Loess at surface ($1x10^{-4}$ to $5x10^{-3}$); 3-9 m of clays ($1x10^{-7}$ to $1x10^{-5}$) underlying loess; aquifer sands below ($1x10^{-4}$ to $1x10^{-1}$)	None	Freshwater to Brine	Industry and Commercial.
Gonzales	-5 to -200	Discontinuous clay beds; aquifer sands ($1x10^{-4}$ to $1x10^{-1}$)	None	Freshwater to Brine	Industry
Evangeline/ Jasper	Dome pierces through; away from dome, > 750	Underlying clay beds ($1x10^{-7}$ to $1x10^{-4}$)	None	Very Saline to Brine	None

a Below Land Surface.
b Salinity determined by dissolved solids content, in ppt: Freshwater, Less than 1 ppt; Slightly saline, 1-3 ppt; Moderately saline, 3-10 ppt; Very saline, 10-35 ppt; Brine, More than 35 ppt.
Sources: *Hydrologic Investigations*; USGS Water-Supply Paper 2220; *Engineering Aspects of Karst*; Touchet, Arville; Gordon, Canciacs.

characteristics of the Cote Blanche site differ from the characteristics of Weeks Island because the Atchafalaya underlies Cote Blanche and the Gonzales is subdivided into two aquifers at Weeks Island. The Evangeline/Jasper Association is virtually confined, too deep, and unused to be a considerable risk cavern.

Loess at the surface is rather permeable for a surface soil, and much more permeable than the immediately underlying clay beds. The sands underneath are usually saturated up to just below the bottom of the clays, due to the marine environment and lack of pumpage in the area.[217]

There are perched freshwater and saline water-bearing units just below land surface,[218] although the majority of freshwater is in deeper aquifers (down to about 240 meters bls), the regional base of freshwater. Slightly saline and moderately saline waters are also available at slightly deeper levels just off the sides of the dome, to almost 300 meters bls.[219] The Gonzales and Atchafalaya both grade into brines near the salt dome, and there exist all classes of salinity in the immediate vicinity.

The Cote Blanche area is an undeveloped, swampy area where no public wells are in use. In fact, in a three-mile radius from the island, the only wells in use are two that tap the Atchafalaya, and one that taps the Gonzales. Similar to the other sites, these wells are drilled much deeper than the initial freshwater[220] to tap some of the thicker (up to 40 meters thick) sands.[221] Rural wells and flow into the Gulf are the two main means of discharge in the region, while recharge occurs both from sandy surface outcroppings and the Mississippi alluvial system.[222] Lake Charles pumpage affects groundwater flow at Cote Blanche enough to reverse groundwater flow from its natural southeastward direction to a northward flow.[223]

The proposed water intake and eastern brine discharge pipeline routes each traverse approximately one mile of Cote Blanche upland before, in the case of the raw water pipeline, emptying into the ICW and, in the case of brine pipeline, continuing out to the Gulf of Mexico. The proposed water intake pipeline runs north to the ICW, and the eastern brine discharge pipeline runs south to West Cote Blanche Bay. Both pipelines run directly away from the SPR site and do not pass near any wells on the island. The western brine discharge pipeline would pass in a generally northwest direction from the site, following the existing Weeks Island to St. James crude oil pipeline, before traversing the south side of Marsh Island and emerging into Weeks Bay. The hydrogeology along this ten-mile on-land stretch of the pipeline is basically the same as that described for the Weeks Island and Cote Blanche sites.

The proposed spur into the Weeks Island oil distribution pipeline travels two miles primarily to the northeast over marshy areas. The pipeline is routed directly away from the island, and does not pass near any population centers or groundwater withdrawal points along its route.

5.4.3 Surface Water Environment

As for the other candidate expansion sites, construction and operation of the site at Cote Blanche could affect: (1) the Gulf of Mexico; (2) the ICW; and (3) other inland waters near the site itself and/or crossed by proposed pipeline routes. The baseline conditions of each of these surface waters are characterized in separate sections below.

5.4.3.1 Gulf of Mexico

The proposed brine disposal pipeline at Cote Blanche would pass either to the west of Marsh Island out to a diffuser located roughly 15 miles offshore (at latitude 29°25'N and longitude 92°16'W). The water depth over the length of the diffuser would be roughly 25 feet. This proposed pipeline route and diffuser location is the same as the option being considered for Weeks Island. The baseline characterizations of this area of the Gulf provided in section 5.3.3.1 for Weeks Island and Appendix K, therefore, apply to Cote Blanche.

5.4.3.2 Intracoastal Waterway

Raw water for operation at the proposed Cote Blanche site would be obtained from the ICW (at 29°46'N and 91°42'W).[224] The entire ICW, its immediate tributaries, and surrounding marshlands are tidally influenced. The portion of the ICW in the vicinity of the Cote Blanche site lies less than two miles north of West Cote Blanche Bay (Figure 3.4-2). The area surrounding the Cote Blanche site is mostly marshland and contains many bayous and channels that intersect the ICW.

The RWI for the site would be located on the ICW near the northeast point of Cote Blanche Island. Canals on both the east and west sides of the proposed RWI connect the ICW with West Cote Blanche Bay. Ivanhoe Canal, a natural waterway, connects the ICW to West Cote Blanche Bay approximately three miles to the west of the proposed RWI. About five miles east of the site, the ICW connects with West Cote Blanche Bay at an outlet called The Jaws. This area is also the confluence of the Charenton Drainage and Navigation Canal, Mud Lake, and Bayou Bartholomew. The ICW becomes contiguous with Bayou Bartholomew farther to the east.

Approximately five miles to the west of the proposed RWI, the ICW bends north along the western edge of Weeks Bay. The Weeks Island site lies to the immediate west of the ICW in this area. Just to the north of Weeks Island, the ICW runs tangentially to Weeks Bay. Beyond this point, the ICW returns to a generally east-west orientation, following the northern shore of Vermilion Bay. Before reaching the Vermilion River, the ICW is connected to Vermilion Bay by Weeks Bay Channel, Avery Canal, Tigre Lagoon, Oaks Canal, Boston Bayou, and Four Mile Cut. Table 5.4-2 summarizes key characteristics of the major surface waters that intersect the ICW within an area five miles east or west of the proposed RWI structure for Cote Blanche.

The portion of the ICW in the Cote Blanche area is considered a part of the Vermilion Bay hydrological basin.[225] Water in the basin flows generally east to west, driven by outflow from the Atchafalaya River. Outflow from the Vermilion Basin is primarily through Southwest Pass in Vermilion Bay to the Gulf of Mexico.[226] The average tidal range in the basin (measured in West Cote Blanche Bay) is 1.6 feet.

The salinity of much of the Vermilion Basin, including all the ICW in the basin, varies widely but is typically less than five ppt. ICW salinity data collected by the U.S. Army Corps of Engineers from 1974 to 1981 at Vermilion Lock (approximately 30 miles west of the proposed RWI) range from 0.04 to 13.9 ppt, but average slightly less than two ppt.[227] Additionally, all salinity data collected in 1973 by the Corps of Engineers at The Jaws, about five miles east of the proposed raw water intake, are less than one ppt (ranging from 0.05 to 0.21 ppt, with a mean of 0.11 ppt).[228] The low salinity in the basin is maintained by abundant fresh water discharge from the Atchafalaya River and Wax Lake Outlet, and is protected from increases because saltwater intrusion to Vermilion Bay and West Cote Blanche Bay is limited by Marsh Island.[229]

Nearly all of the ICW near the Cote Blanche site is bounded on both sides by marshland. Patches of swamp forest are also present.[230] These wetlands and the adjacent bays have large populations of estuarine fish and invertebrates including shrimp, gulf menhaden, and blue crab. State designated uses for the ICW include primary and secondary contact recreation (i.e., swimming and fishing) and the propagation of fish and wildlife. Although the State has not explicitly established uses for the waters that intersect the ICW within five miles east and west of the proposed RWI structure, they appear to be used in the same general manner as the ICW itself.

5.4.3.3 Inland Water Bodies

The following sections describe: (1) inland water bodies within a five-mile radius of the proposed Cote Blanche site; and (2) water bodies crossed by proposed crude oil, raw water, and brine discharge pipelines.

Water Bodies Within Five Miles of the Proposed Site

The Cote Blanche site lies in the transition between the Chenier and the Deltaic Plains of south central Louisiana, in the Vermilion Teche Basin.[231] The land overlying the Cote Blanche salt dome ranges from three to 15 meters above msl and is dry except for a small stream

Table 5.4-2
Characteristics of Surface Water Bodies Intersecting the Intracoastal Waterway Within Five Miles of the Proposed Raw Water Intake at Cote Blanche

Surface Water System	Distance from RWI (miles)	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses[a]
Bayou Cypremort	5.1	80	3	Tidal	No downstream public intake	None	Fresh, Brackish	No designated uses
Ivanhoe Canal	2.6	120	8	161 (51.4-324)	No downstream public intake	None	Fresh	No designated uses
Williams Canal	1.4	40	4	Tidal	No downstream public intake	None	Fresh	No designated uses
Hackberry Lake	4.1	2,000	3	Lake	No downstream public intake	None	Fresh	No designated uses
Bayou Gregorie	4.8	200	3	Tidal	No downstream public intake	None	Fresh	No designated uses
Bayou Auger	5.0	10	2	Negligible	No downstream public intake	None	Fresh	No designated uses
Jaws Bay	4.8	900	2	Tidal	No downstream public intake	None	Fresh	Boat/barge traffic
Hog Bayou	3.6	80	3	Tidal	No downstream public intake	None	Fresh	No designated uses

[a] Although the State has not explicitly established uses for many of these waters, they appear to be used in the same general manner as the ICW itself; that is, for recreation (swimming, fishing, boating) and for the propagation of fish and wildlife.

and pond. From 1951 through 1989, New Iberia, which is approximately 20 miles northwest of Cote Blanche, received an average of 57 inches of precipitation annually.[232] Stormwater and surface waters from the candidate site generally drain to the south and east into the adjacent wetlands that, in turn, drain into West Cote Blanche Bay.

There are 14 sizeable water bodies within five miles of the site; these waters are depicted in Figure 5.3-1 and characterized in Table 5.4-3. Numerous smaller unnamed water bodies are located in the wetlands near the proposed expansion site. The water bodies that are closest to the site, and/or are regionally significant, are West Cote Blanche Bay, the ICW, Bayou Cypremort, and Bayou Gregorie. As shown in Table 5.4-3, none of the water bodies within five miles of the candidate site presently serves as a public water supply source. Most of the water bodies are fresh or, at times, slightly brackish. Although many do not have uses explicitly established by the State, most of the waters appear to be used for recreation and the propagation of fish and wildlife. West Cote Blanche Bay has been designated by the State as an oyster propagation area (section 5.3.5.2 characterizes the distribution of oysters in the area in more detail). A few of the water bodies, including West Cote Blanche Bay and Ivanhoe Canal, also are large enough to support boat or barge traffic.

Pipeline Crossings

DOE is considering the same crude oil pipeline alternatives for Cote Blanche as discussed for Weeks Island. The preferred alternative would upgrade the existing Weeks Island- to-St. James pipeline with one pump station (270-day drawdown criterion) and would also require the construction of a spur pipeline from Cote Blanche to the existing pipeline. Under a 180-day criterion, DOE would add a second pump station, expand the St. James Terminal, and construct a pipeline from the existing Weeks Island site to the Texas 22" pipeline. The surface waters in the vicinity of these enhancements are characterized in section 5.6.3 (St. James) and section 5.3.3 (all others).

The only water body that would be crossed by the spur to the existing Weeks Island to St. James pipeline is the ICW. Major waters within five miles of each of the proposed new pumping stations include Charenton Drainage and Navigation Channel, Bayou Teche, the ICW, Mud Lake, Belle River, Old River, Bay Natchez, and Lake Verret. Waters crossed by the spur to the Texas 22" pipeline include the ICW, Warehouse Bayou, and Stumpy Bayou.

The raw water pipeline would exit via the northeast corner of the candidate expansion site, and travel less than one mile in this direction to the RWI structure on the ICW. The proposed brine disposal pipeline to the east of Marsh Island would exit the site from the south and run about 45 miles through West Cote Blanche and Atchafalaya Bays and into the Gulf of Mexico, ending at the diffuser. Along this route, neither the raw water intake line nor the brine disposal pipeline would cross an inland water body. The proposed brine disposal pipeline to the west of Marsh Island would exit the site and run west through Vermilion Bay, turn south through Hell Hole, an existing channel, and Portage Lake before entering into the Gulf of Mexico and end at the diffuser.

5.4.4 Climate and Air Quality

The Cote Blanche site is located seven miles southeast of the Weeks Island site, and thus experiences essentially similar climatic patterns to those at Weeks Island (see section 5.3.4). The

Table 5.4-3
Surface Water Bodies Within Five Miles of the Proposed Cote Blanche Site

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses[a]
West Cote Blanche Bay	0.2	Horse Bayou, Ivanhoe Canal, Hammock Bayou	60,000	6	Tidal	No downstream public intake	None	Fresh, Brackish	Contact recreation, propagation of fish and wildlife, oyster production, and barge traffic
Intracoastal Waterway	0.5	See ICW Section	400	12	2500	No downstream public intake	None	Primarily Fresh	Contact recreation, propagation of fish and wildlife, and small boat and barge traffic
Williams Canal	1.2	ICW, Ivanhoe Canal	40	4	Tidal	No downstream public intake	None	Fresh	No designated uses
Ivanhoe Canal	1.9	Pipeline Canal, ICW, Bayou Cypremort	120	8	161 (51.4-324)	No downstream public intake	None	Fresh	No designated uses
Bayou Cypremort	2.3	ICW, Ivanhoe Canal, Vermilion Bay	80	3	Tidal	No downstream public intake	None	Fresh, Brackish	No designated uses
Hog Bayou	2.4	Hackberry Lake, ICW	80	3	Tidal	No downstream public intake	None	Fresh	No designated uses
Hackberry Lake	4.0	Hog Bayou	2000	3	Lake	No downstream public intake	None	Fresh	No designated uses
Horse Bayou	4.4	West Cote Blanche Bay, Prince Lake	10	2	Tidal	No downstream public intake	None	Fresh, Brackish	No designated uses

Table 5.4-3 (Continued)
Surface Water Bodies Within Five Miles of the Proposed Cote Blanche Site

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses[a]
Phillips Canal	4.5	Iberia-St. Mary Canal, Ivanhoe Canal	10	3	Negligible	No downstream public intake	None	Fresh	No designated uses
Bayou Gregoric	4.7	Pipeline Canal, ICW, Jaws Bay	10	2	Negligible	No downstream public intake	None	Fresh	No designated uses
Prince Lake	4.8	Horse Bayou, West Cote Blanche Bay	1700	3	Lake	No downstream public intake	None	Fresh, Brackish	No designated uses
Scott Canal	3.8	Pipeline Canal, Kelley Canal	10	2	Negligible	No downstream public intake	None	Fresh	No designated uses
Unnamed Oil Service Canal	4.2	ICW, Weeks Bay	100	2	Tidal	No downstream public intake	None	Fresh	Oil well service, barge traffic
Pipeline Canal	3.2	Phillips Canal, Bayou Cypremort	50	2	Negligible	No downstream public intake	None	Fresh	No designated uses

[a] Although most of these waters do not have uses established explicitly by the State, they appear to be used primarily for recreation (swimming, fishing, boating) and for the propagation of fish and wildlife.

site is located in St. Mary Parish, Louisiana, which is a nonattainment area for ozone with incomplete data (i.e., the monitoring data from the parish are insufficient to prove compliance). No air monitoring activities are carried out at the proposed Cote Blanche site; however, as noted in section 5.3.4, the Louisiana DEQ maintains a monitoring station in Morgan City, approximately 30 miles southeast of the Cote Blanche site. An ozone survey of the Weeks Island and Cote Blanche sites taken in the late 1970s revealed that Weeks Island was an attainment area for ozone, but that Cote Blanche had not reached attainment status. Since the Morgan City monitoring data have not shown a change in the ozone status of the entire area, the status of the each site is assumed to have remained static over time.

5.4.5 Ecology

Cote Blanche is located southeast of Weeks Island, within the Deltaic Plain ecosystem in the outer coastal floodplain province.[233] Because of its proximity to Weeks Island, the Cote Blanche proposed site has the same general ecology as that of the Weeks Island site. The following section describes those aspects where the ecology in the Cote Blanche area differs from that described for Weeks Island in section 5.3.5. The information presented here is based on a site visit conducted in June 1991 and information obtained from various Federal and state agencies.

5.4.5.1 Ecosystems at the Site and Nearby

This section characterizes the ecology at the site and in nearby areas. Discussion is provided for vegetation, terrestrial and aquatic life, threatened or endangered species, and other biological resources of potential concern.

Vegetation

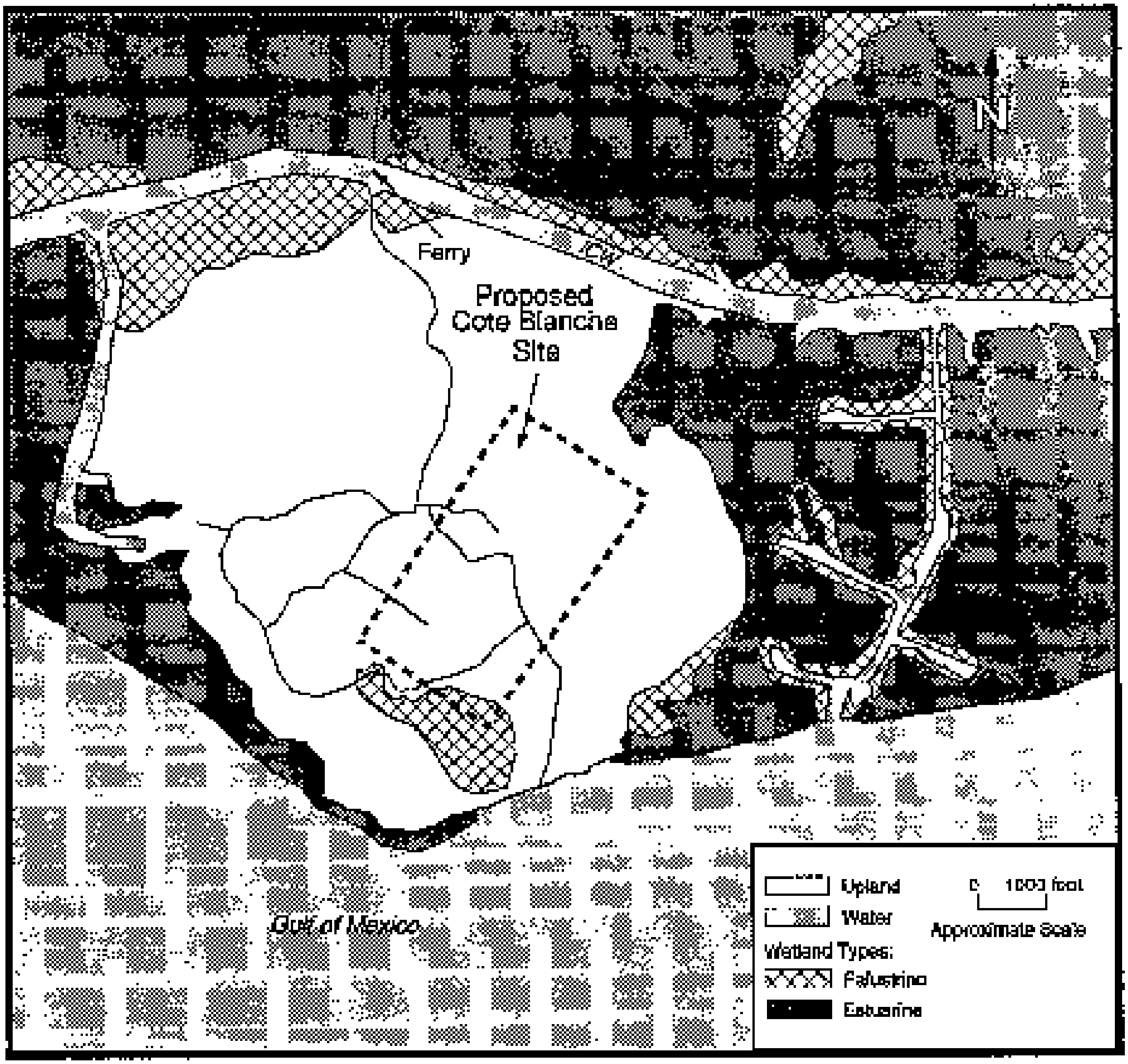
The vegetation at the proposed site consists of dense stands of very young forest with a moderately heavy understory. Figure 5.4-2 shows wetland and upland habitats at the proposed site. Several abandoned roads which penetrate into these forests contain grasses and scrub-shrub vegetation. Sweetgum, Chinese tallow tree, and white oak are dominant overstory species, with dogwood, yaupon, pecan, and honey locust being commonly observed understory species. Willows are abundant in an old pond bed at the proposed site. Devil's walking stick, blackberry, Virginia creeper and bayberry are common, and palmetto is scattered throughout the site. Herbaceous species include partridge pea, blue vervain, and bitterweed.

There are no wetlands on the site. The island, however, is bounded on all sides by emergent wetlands. Overall, vegetation at the proposed site appears to be in an earlier successional stage than that at Weeks Island.

Terrestrial Wildlife

Terrestrial wildlife observed during the site visit consisted of swamp rabbit, white-tailed deer, northern cardinal, and an unidentified hawk. The low number and variety of species observed may largely be due to inclement weather during this site visit. Other species likely to occur on the island include raccoons, opossums, tree squirrels, numerous species of ground-dwelling rodents (e.g., mice, moles, and voles). Bobwhite and wild turkey are game birds that

Figure 5.4-2
Wetlands and Upland Habitats: Proposed Cote Blanche Site



Source: National Wetland Inventory Maps; Kemper and Marone Point, LA Quadrangles could occur on the island. Resident and migratory nongame bird species such as warblers, vireos, and thrushes are probably abundant.

Aquatic Life

The description of aquatic life in inland and nearshore waters in the vicinity of Weeks Island (section 5.3.5.3) applies to the Cote Blanche vicinity as well.

Threatened or Endangered Species

Two endangered or threatened species are listed in St. Mary Parish, in which the site is located (Appendix D), and only the Louisiana black bear has been identified by USFWS as of significant concern (Appendix F). Additionally, based on information supplied by the U.S. Fish and Wildlife Service in Louisiana and the Louisiana Department of Wildlife and Fisheries, there are three rare plant species found within one mile of the proposed site; these species are listed in Table 5.4-4. Note that these species are not listed in Appendix D because they have not been designated as endangered or threatened by Louisiana or the USFWS. Additionally, a hardwood slope forest is a habitat of concern within one mile of the proposed site. There are no waterbird nesting colonies or turtle nesting areas known to occur at or near the site.

Other Biological Resources of Concern

Avery Island Bird Sanctuary is located approximately 15 miles northwest of Cote Blanche. Marsh Island National Wildlife Refuge is located to the south-southwest. Shell Keys National Wildlife Refuge, an eight-acre bird nesting area, is located off the southern shore of Marsh Island. State Wildlife Refuge and Paul J. Rainey Wildlife Sanctuary are located west of Marsh Island.

5.4.5.2 Ecosystems Crossed by Pipelines

Raw water intake and brine disposal pipelines will be constructed as part of development of the Cote Blanche site. The oil distribution enhancements are the same as for Weeks Island, with the addition of a spur from Cote Blanche to Weeks Island. The ecosystems crossed by these pipelines are discussed below. No threatened or endangered species have been identified by USFWS as of significant concern along the pipeline ROWs.

Oil Distribution Pipeline

The alternatives for the oil distribution pipeline associated with the proposed Cote Blanche site are the same as those discussed for Weeks Island in section 5.3.5.2, except that a two-mile pipeline would need to be constructed from Cote Blanche to the DOE pipeline (see Figure 3.4-2). This pipeline crosses estuarine and palustrine wetlands.

Brine Disposal Pipeline

The brine disposal route is the same as that described for Weeks Island, with the addition of a 9.3 mile pipeline from Cote Blanche to Weeks Island. This pipeline uses an existing ROW which crosses through wetlands between the two salt domes. There are no wildlife refuges or other ecological areas of interest along this portion of pipeline. The remainder of the pipeline crosses Vermilion Bay, and State Wildlife Refuge and Paul J. Rainey Wildlife Refuge prior to going out into the Gulf. As with Weeks Island, a brine disposal alternative for Cote Blanche is

Table 5.4-4
Rare Species and Natural Communities
Within One Mile of the Cote Blanche Site

Texas Aster
Woodland Bluegrass
Broad-Leaved Spiderwort
Hardwood Slope Forest

Source: Letter from Gary Lester, State of Louisiana Department of Wildlife and Fisheries, July 11, 1991.

injection into disposal wells which would be constructed along the existing pipeline ROW to the St. James Terminal.

Raw Water Pipeline

A raw water pipeline would be constructed to the ICW; this pipeline would cross estuarine intertidal wetlands. The proposed RWI pipeline and structure are within St. Mary Parish, in which two endangered or threatened species are listed (Appendix D).

5.4.5.3 Ecosystems Near the Brine Diffuser Location of the Gulf of Mexico

Because the same diffuser site is being considered for Cote Blanche and Weeks Island, the biological communities described for Weeks Island in section 5.3.5.3 also are relevant for this site.

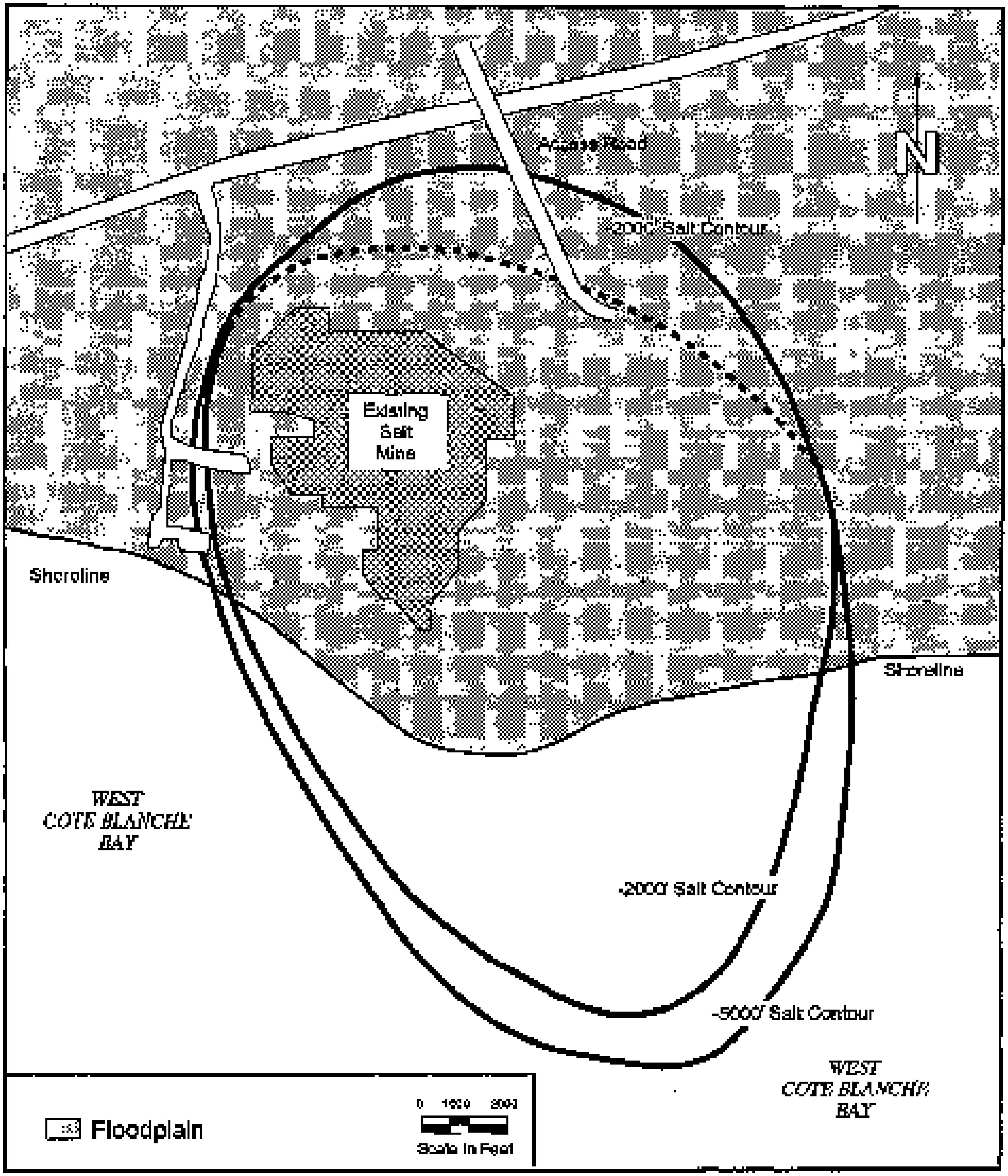
5.4.6 Floodplains

The Cote Blanche site would cover 300 acres at an elevation of up to 25 meters.[234] This storage site would be located in a floodplain (see Figure 5.4-3), but it is possible that all construction will occur outside the 100-year floodplain. Roads to the site, however, would be within a floodplain.[235] The brine disposal pipeline and the raw water pipeline would also pass through wetlands (0.21 miles and 0.53 miles, respectively).[236] The fill/distribution options for Cote Blanche are the same as those discussed for Weeks Island. A RWI structure would be constructed in a floodplain on the ICW.

5.4.7 Natural and Scenic Resources

The Cote Blanche salt dome is surrounded on three sides by coastal wetlands and forms an "island" that is separated from the mainland by the ICW. Coastal wetlands surrounding the proposed site include a combination of saline and brackish marshes, bayous, man-made canals, and bays contiguous with the Gulf of Mexico. The natural uninhabited wilderness at Cote Blanche Island is considered to be unique. Based on the NWI map for the site, there are no wetlands within the proposed site boundary.

Figure 5.4-3
Cote Blanche Floodplain Assessment



Source: Federal Emergency Management Agency, Flood Insurance Rate Maps

Avery Island, a 200-acre wooded bird sanctuary, is located 17 miles to the northwest of Cote Blanche; the Russell Sage Foundation-Marsh Island National Wildlife Refuge is located ten miles to the southwest. Off the southern shore of Marsh Island is an eight-acre bird nesting area designated as Shell Keys National Wildlife Refuge. Other nearby wildlife areas include Cypremort Point State Park, on the Vermilion Bay peninsula; Burns Point, a site on Cote Blanche Bay; and Louisiana State Wildlife Refuge, a 15,000-acre wildlife preserve situated directly west of Vermilion Bay. The proposed brine disposal route would cross State Wildlife Refuge and the Paul J. Rainey Wildlife Refuge before entering the Gulf of Mexico.

5.4.8 Archaeological, Historical, and Cultural Resources

DOE contacted the Louisiana Department of Culture, Recreation, and Tourism for information on culturally important resources in the area and vicinity of the proposed Cote Blanche site pipelines, and RWI structure. In response, the State of Louisiana performed a file search and determined that there are no recorded archeological or historical sites located within the proposed Cote Blanche project area, pipeline corridors, or RWI structure. Three recorded archeological sites, however, lie on Cote Blanche Island near the project boundaries: Burk Hill, Alligator Hole, and Cote Blanche Landing. Little is known about any of the sites in the vicinity. Two might have been camp sites, and the third has been destroyed by natural activity.[237]

5.4.9 Socioeconomics

Cote Blanche is located in the northern part of St. Mary Parish in West Cote Blanche Bay, cut off from the mainland by the ICW. Direct effects of SPR development and expansion would impact a five-parish area, including Iberia, St. Mary, St. Martin, Vermilion, and Lafayette Parishes. Lafayette, the largest city in the surrounding region, is about 50 miles northwest from the site. New Iberia, 20 miles from the site, is also within this five-parish region. This section discusses the socioeconomic conditions in this five-parish region.

5.4.9.1 History and Cultural Patterns

Because of the proximity of the sites, the general history of the Weeks Island area, described in section 5.3.9.1, also applies to the Cote Blanche area.

In 1811, St. Mary Parish became the first parish created from the original St. Martin Parish territory. The town of Franklin in St. Mary Parish became a major supply point for steamboats travelling up the Bayou Teche. By the 1830's, the Bayou Teche was the main "street" in the region, and particularly in St. Mary Parish, with plantations lining either side of the waterway.

The Coushatta Native American Reservation in Elton, LA, is 85 miles northwest of the Cote Blanche site. Because of the distance from the site, the Native Americans are not expected to have any concerns with the development of the SPR sites. The Chitimacha Native American Reservation in Charenton, LA is located along the Southern Pacific Railroad, north of Grand Lake, in an area which is 20 miles northeast of the proposed site. However, development of the site is not expected to have any impact on the reservation.

5.4.9.2 Population

The Cote Blanche region which encompasses the same five parish region as Weeks Island, experienced a modest 4.8 percent increase in population during the period 1980 to 1990. This increase, however, does not reflect the large fluctuations that took place during the same period. The regional population grew from a low of 366,694 in 1980 to a high of 404,000 in 1986, but then declined during latter half of the decade to a total of 385,178. Population in St. Mary Parish decreased from 64,253 in 1980 to 58,086 in 1990. Four of the five largest communities in St. Mary Parish, including Morgan City with a population of 14,531, are at least 30 miles from Cote Blanche. Franklin, the seat of government, and the second largest town in the parish with a population of 9,004 (1990) is located about 15 miles from the site.

With the exception of St. Mary Parish, the population in the other parishes within the five-parish region increased during the past decade. Two cities in the Iberia Parish are within a 20 mile radius of Cote Blanche; New Iberia, the largest city in the parish with 31,828 residents, and Jeanerette with 6,511 residents. Although the population in New Iberia and other large towns in the Iberia Parish declined in the 1980s, the population of the parish as a whole increased.

Lafayette Parish is the largest of the five parishes; the city of Lafayette itself accounts for almost 25 percent of total population of the five parishes, and is more than three times the size of the city of New Iberia. In Vermilion Parish, the population of the small towns grew during the 1980s, while that of Abbeville, the largest city in the parish, declined from 12,391 to 11,187. The largest city in St. Martin Parish, St. Martinville, also declined in population, although most of the smaller towns and unincorporated areas increased their populations during the same period. Figure 5.4-4 shows the population distribution among small and large towns in St. Mary Parish and the Cote Blanche Region.

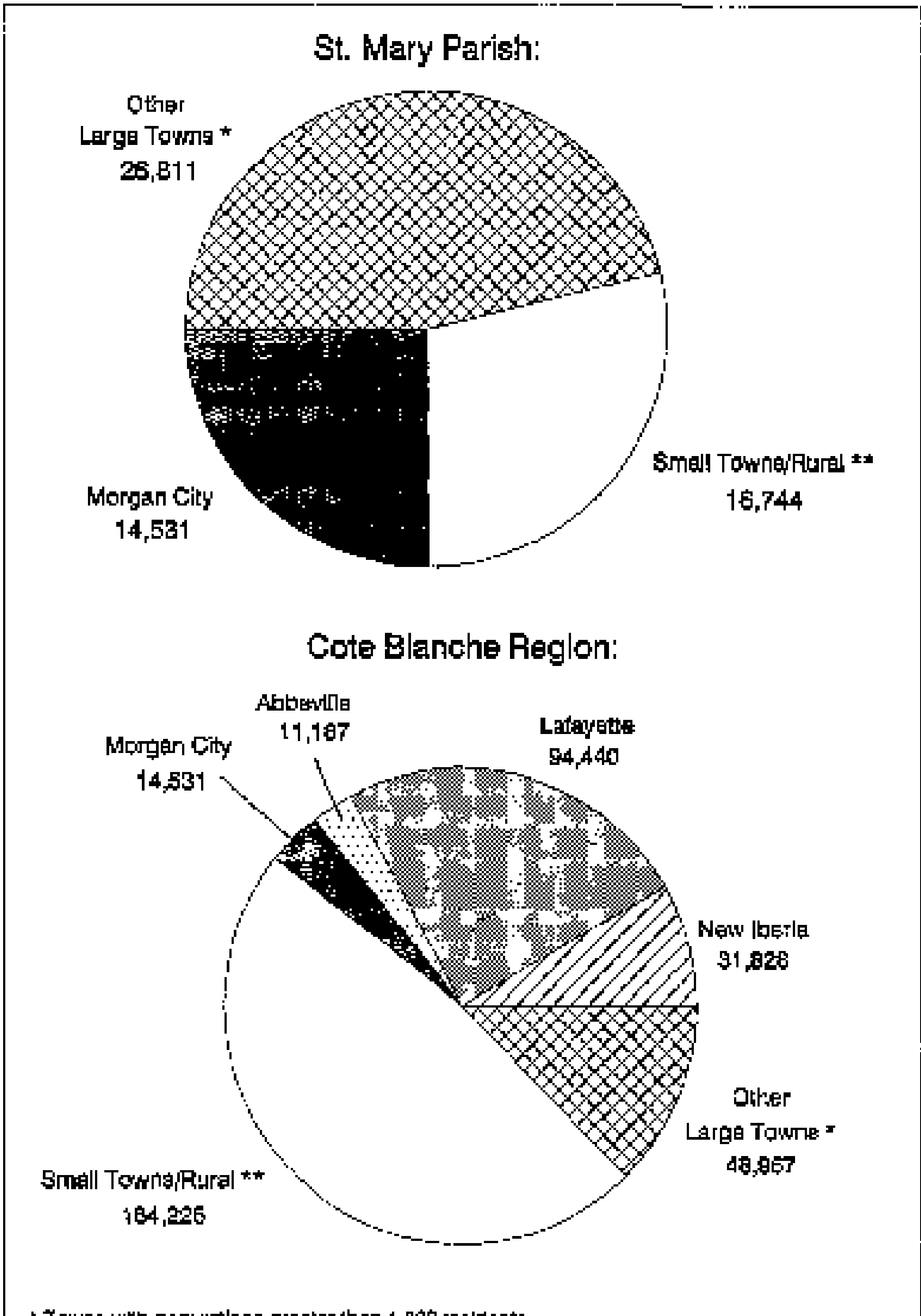
5.4.9.3 Economic Activities

The regional economy in the Cote Blanche area underwent wide fluctuations during the 1980s. The regional workforce rose from 167,150 in 1980 to 194,250 in 1984, but then declined to 168,600 in 1988. The regional unemployment peaked at 19 percent in 1986, but steadily declined to 6.1 percent in 1990 (Figure 5.4-5). The unemployment rate in St. Mary Parish reached among the highest levels in the region, peaking at 24 percent during 1986. The high unemployment rate in this parish as well as throughout the region was the result of the depressed energy industry in the mid-1980s.

Total annual industry earnings in St. Mary Parish was around $678 million or $22,786 per worker in 1989. Industry earnings for the five-parish region were $3.9 billion or $20,710 per worker. Lafayette and St. Mary Parishes had the highest earnings per worker, while St. Martin had the lowest.

Although no single industry dominates, the major sectors in St. Mary Parish in terms of employment and earnings are services, manufacturing, retail trade, and government. Together these sectors employ 57 percent of the total workforce and account for 52 percent of the earnings (Figure 5.4-6). Non-metallic mining and construction are also important sectors to the parishes' economy. These same sectors also account for the majority of economic activity in the region as a whole (Figure 5.4-7).

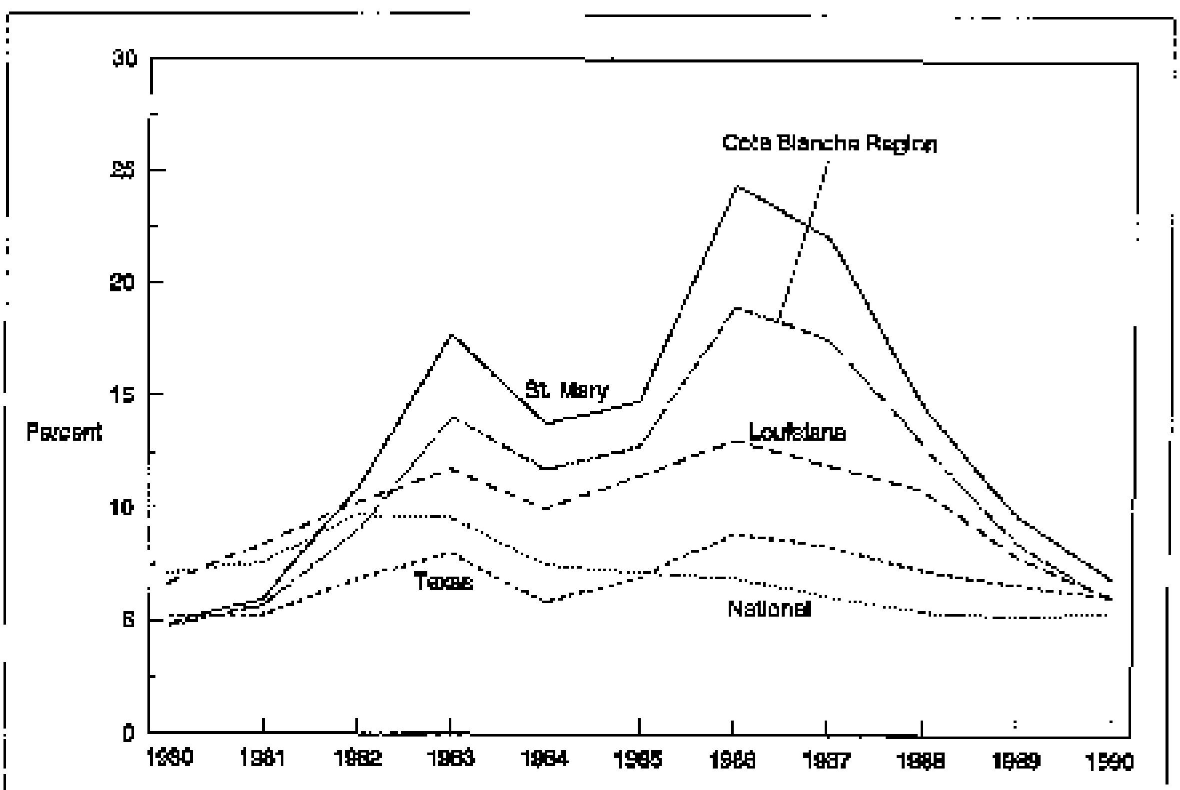
Figure 5.4-4
Population Distribution in St. Mary Parish and the Cote Blanche Region, 1990



* Towns with populations greater than 1,000 residents.
** Towns and rural areas with populations less than 1,000 residents.

Source: STF-1A. Selected Highlights from the 1990 Census. Table 1. Louisiana Division of Administration. Office of Planning and Budget. State Demographic Office.

Figure 5.4-S
Unemployment Rate in the Cote Blanche Region, 1980 - 1990



Source: 1980-1990 CPS Tables on Labor and Employment, Louisiana Department of Employment and Training, Research and Statistics Unit.

Figure 5.4-6
St. Mary Parish Industry Earnings and Workforce, 1989

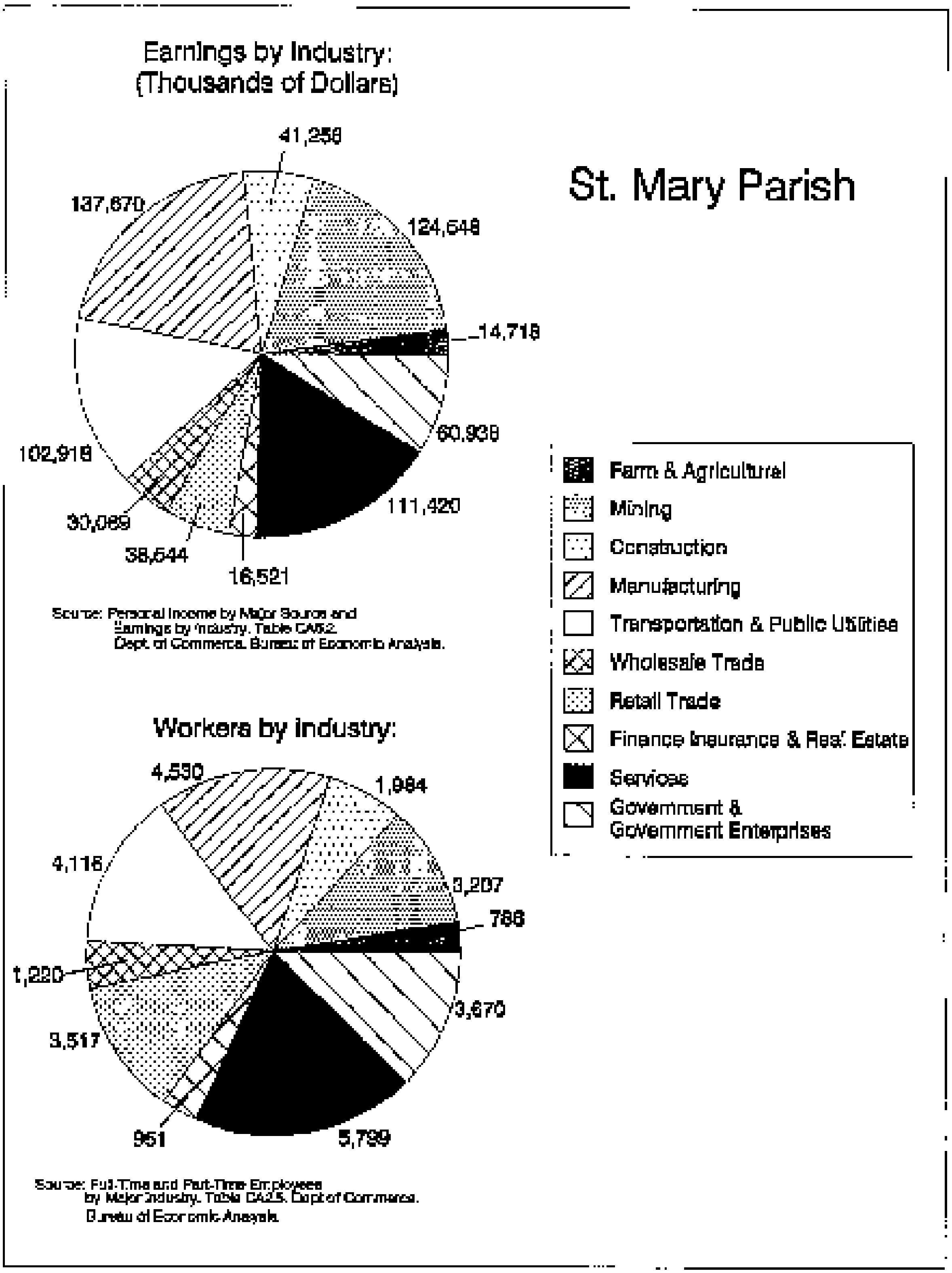
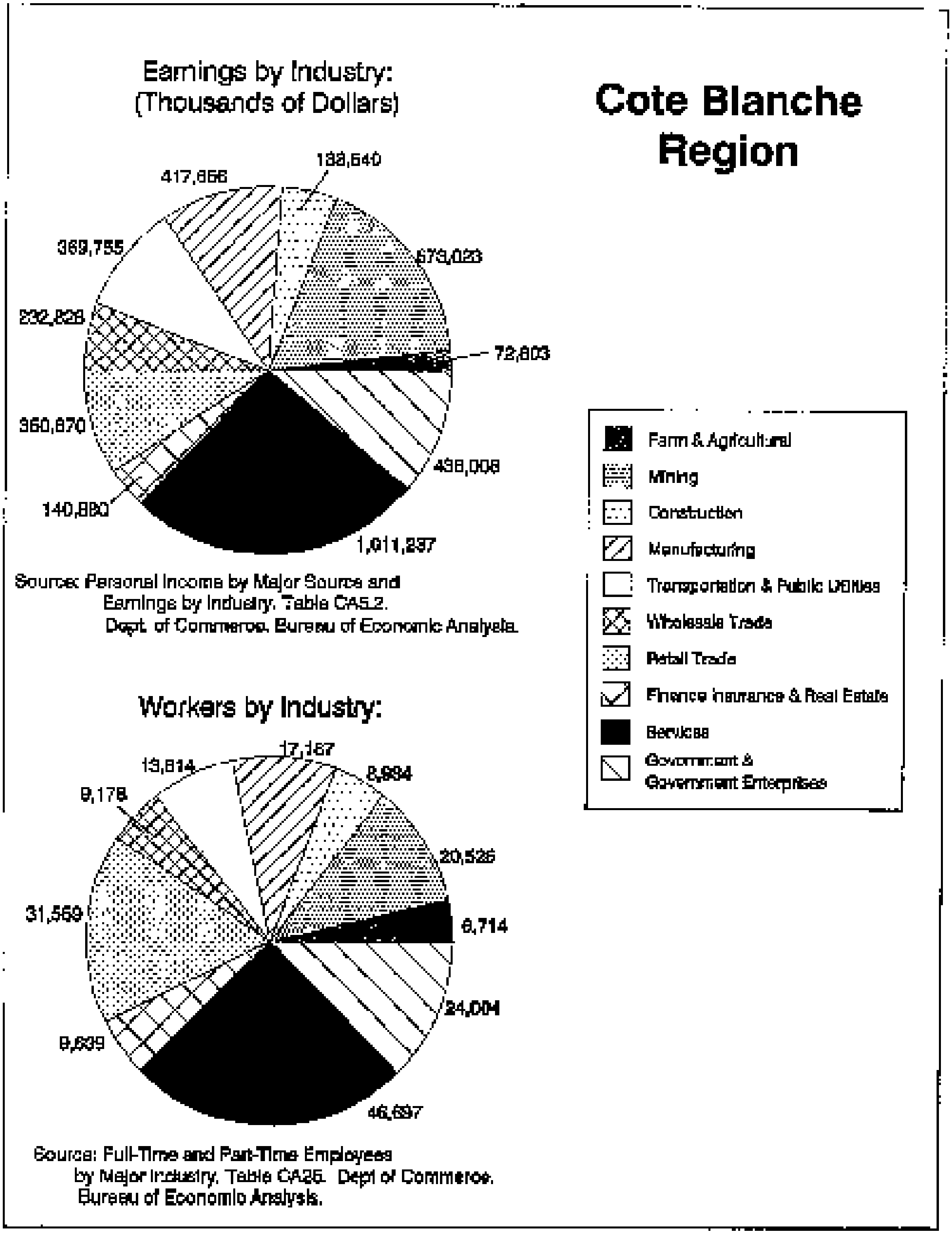


Figure 5.4-7
Cote Blanche Region Industry Earnings and Workforce, 1989



5.4.9.4 Transportation Systems

Settlement patterns and transportation systems in the Cote Blanche region have, to a large extent, been determined by topography and drainage. In the low lying regions, natural levees have provided areas for development, and have allowed access to the waterways that at one time, were the main means of local transportation. Most major State highways and railroads also follow these levees. An extensive system of connecting canals has been built to provide navigable waterways. The map in Figure 5.3-10 illustrates the transportation system in the Cote Blanche region.

U.S. Highway 90 is the main thoroughfare in the region, crossing east to west through most of the region's large towns including Morgan City, Frankline, Jeanerette, New Iberia, and Lafayette. State and parish highways also serve the area near Weeks Island. State Route 83 cross U.S. 90 at two points, one near Franklin, and again further west at New Iberia. Thus, Route 83 provides two points of access to both the Weeks Island site and the nearby Cote Blanche site. Route 83 has a bituminous surface and its condition is classified as "fair." Currently, no paved access road exists from Route 83 to the proposed site. No information on bridges in the Cote Blanche area was available from the Louisiana DOT. Currently, no site access from Route 83 nor any bridge over the ICW exists to provide entry to the Cote Blanche site.

The majority of employees at Cote Blanche would most probably live in New Iberia and travel the short stretch of U.S. 90 to the west access of Route 83 to get to work. Because the proposed site appears to be equally accessible from both the west and east accesses to Route 83, however, one could expect a larger percentage of employees to reside in cities east of the site than those from the nearby Weeks Island facility. Commuters from points east, such as Baldwin, Franklin, Patterson, Morgan City, and beyond, would travel west on U.S. 90 to the east access of 83 and turn south towards Cypremort Point and Cote Blanche. Other cities north and west of the site would connect with the 90 to 83 route from New Iberia past Weeks Island to Cote Blanche. Table 5.4-5 shows these potential routes, road characteristics and traffic statistics for 1990. Cities and towns of origin were selected based on current distribution of workers from the Weeks Island site and population centers. Commuting routes are based on routes of least distance between town of origin and the site.

Lafayette Regional Airport is the main commercial airport in the region. Acadiana Regional Airport, Abbeville Airport, Kaplan Municipal Airport, Memorial Airport in Patterson, and the Jeanerette Air Strip provide services for general aviation and agriculture. Two commercial bus lines provide service throughout the region. In addition, two rail lines serve the area, the main branch of the Southern Pacific Railway serves many of the larger towns, and a branch line of the Missouri Pacific Railroad provides freight service.

The ICW cuts through this part of Louisiana as does the Mississippi River. Over 53,000 vessels travelled on the ICW between the Mississippi River and the Sabine River in 1989.[238] For estimated impacts on ICW vessel traffic, see section 7.4.3.3. Small and large barge traffic is supported by the Vermilion River, Atchafalaya River, Bayou Teche, and many smaller bayous and canals.

Table 5.4-5

Road Characteristics and Traffic Statistics for Likely Commuting Routes to Cote Blanche

City/Town of Origin	Route(s)	Distance[1] (miles)	No. of Lanes, Road Width	Daily Vehicle Counts[2] (1990)	Vehicle Capacity	% of Trucks (1986)	Number of Accidents (1990)
New Iberia	US 90E to 83 (west access)	2	4 lanes, 48 feet	13,930	3,361	19	36
	83S to Cote Blanche	18.8	2 lanes, 20 feet	960 - 4,130	1,486	9	31
Franklin/Baldwin	US 90W to 83 (east access)	3.8	4 lanes, 40-48 feet	9,640 - 10,200	3,328	19	17
	83W to Cote Blanche	11.5	2 lanes, 20 feet	870 - 1,490	1,486 - 3,633	9	9
Jeanerette	US 90W to 85	4	4 lanes, 48 feet	9,280 - 9,820	3,328	19	17
	85W to 83 (west access)	3.8	2 lanes, 20-24 feet	600 - 1,400	1,479 - 1,560	9	3
	83S to Cote Blanche	13.7	2 lanes, 20 feet	360 - 5,400	1,486	9	15
Morgan City	US 90W to 83 (east access)	26	4 lanes, 48 feet	9,390 - 24,260	3,328	19	163
	83W to Cote Blanche	11.5	2 lanes, 20 feet	870 - 1,490	1,486 - 3,633	9	9
Lafayette/Youngsville	US 90E to 83 (west access)	23.5	4 lanes, 48 feet	13,930 - 17,160	3,194 - 3,568	19-24	615
	83S to Cote Blanche	18.8	2 lanes, 20 feet	960 - 4,130	1,486	9	31
Delcambre/Abbeville	14E to US 90	18.7	2-4 lanes, 24-48 feet	6,130 - 7,110	1,639 - 3,246	22	233
	US 90E to 83 (west access)	9.2	4 lanes, 48 feet	13,930 - 17,160	3,361	19	54
	83S to Cote Blanche	18.8	2 lanes, 20 feet	960 - 4,130	1,486	9	33

[1] Distance and accident data reflect estimates from mile marked information by the Louisiana Highway Safety Commission.

[2] Average number of vehicles travelling on road during 1990. Range is indicated where data for more than one point of the segment were available.

Source: Louisiana Department of Transportation, Lafayette Division, Average Daily Traffic maps, 1990. Department of Public Safety and Corrections, Louisiana Highway Safety Commission, Traffic Accident Statistics, 1990. Selected Highway Statistics, Louisiana Department of Transportation, Highway Needs Division, 1992.

5.4.9.5 Housing and Public Services

The following section describes the availability of housing in the Cote Blanche area and summarizes the education, health care, and public utility services that are available.

Housing

There are approximately 153,000 housing units in the Cote Blanche region. Of this total, about 135,000 or about 88 percent were occupied during 1990. The remaining units were vacant because they were being offered for rent or sale, used seasonally for vacation or second homes, or used for migratory workers. Of the occupied units, approximately 68 percent were owner-occupied and 32 percent were renter-occupied.

The number of units available for either rent or sale in the Cote Blanche region numbered 7,659 during 1990. Of this total, 5,601 were rental units and 2,058 were units for sale (Figure 5.4-8).

Lafayette parish accounted for over 52 percent of the total available housing in the region. In St Martin Parish, there were total of 17,592 housing units in 1990. Of this total, 307 were available for rent and 318 were up for sale. Of those units occupied during 1990, 67 percent were owner-occupied.

Health Care

St. Mary Parish has 45 physicians, or one for every 1,291 residents (Table 5.4-6). In its two hospitals, St. Mary Parish has 132 beds or one for every 440 residents. The closest hospital to the Cote Blanche site, Franklin Foundation Hospital (64 beds), is located within 15 miles from the site in Franklin. Health care facilities vary widely within the region, ranging from seven hospital facilities in Lafayette Parish, to zero facilities in St. Martin Parish. A total of 577 physicians were practicing medicine in the region during 1990, (one for every 668 residents) and there were 1,919 hospital beds (one for every 201 residents).

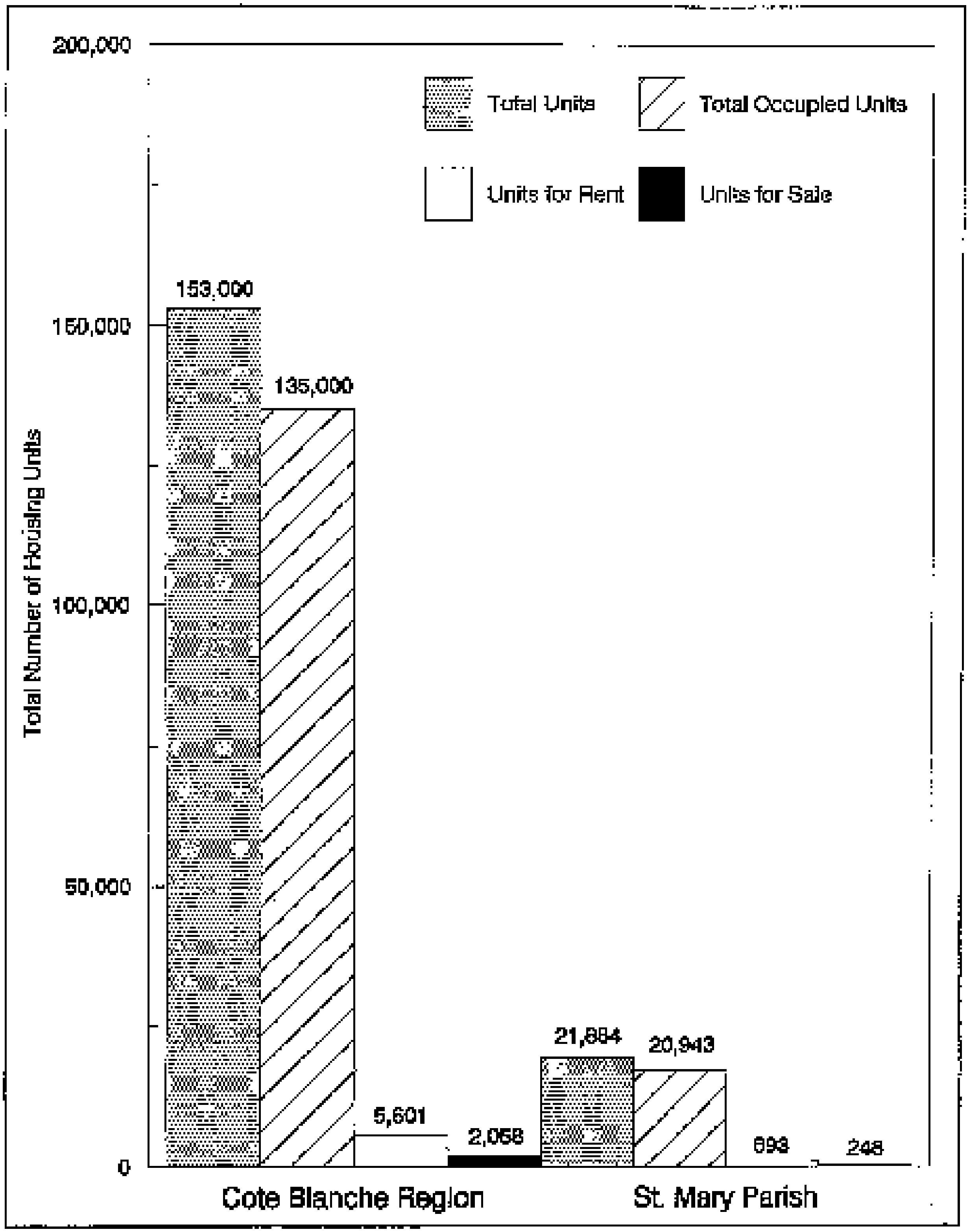
Education

During the 1989-1990 school year, there were 12,081 students in 31 public schools in St. Mary Parish (Table 5.4-7). An additional 1,118 attended six private schools. The five public secondary schools are located in Berwick, Centerville, Franklin, Morgan City, and Patterson. Estimated impacts of workers' children on the capacity of area schools is discussed in section 7.4.9.8.

Utilities

CLECO, one of four utility companies in the area, would provide electric power to Cote Blanche. The other three utility companies include GSU and two cooperatives, including the Teche Electric cooperative which serves Cypremort Point, and SLECO. Currently, CLECO has one 138 kV transmission line that runs north to south, ending at Route 83, just north of Cote Blanche. About two miles west of the CLECO line, GSU's 138 kV transmission line runs north to south along State Route 83 from New Iberia and services the DOE facility at Weeks Island. The GSU line to Weeks Island is looped two miles east and connected to the CLECO line.

Figure 5.4-8
Housing in the Cote Blanche Region, 1990



Source: U.S. Department of Commerce, Bureau of the Census, 1990.

Table 5.4-6
Health Care Facilities and Personnel, 1990

Parish or Parish	Hospitals	Hospital Beds	Residents per Bed	Physicians	Residents per Physician
St. Mary	2	132	440	45	1,291
Iberia	2	243	281	78	876
St. Martin	0	0	0	13	3,383
Vermilion	1	137	365	43	1,164
Lafayette	7	1,407	117	398	414
Region	12	1,919	201	577	668

Source: Louisiana Department of Health and Hospitals, Health Standards Division, 1991; State Board of Medical Examiners, 1991

GSU's Bayou Warehouse substation is located about five miles from Cote Blanche near Weeks Island, and has two transformers, each with a 25 MVA capacity.

5.4.9.6 Government Revenues and Expenditures

The Federal government spent over $840 million in the Cote Blanche region in 1990 (Table 5.4-8) or about $2,183 per capita. More than one-sixth of that spending, $147 million (over $2,537 per capita), was in St. Mary Parish. Local government expenditures in 1987 were almost $504 million with $97 million spent by governments within St. Mary Parish (Table 5.4-9).

The Cote Blanche site has an assessed value of about $13 per acre. In 1990, property taxes of 1.17 percent included a parish tax, a fire protection tax, a law enforcement tax and a mosquito control tax. Property tax paid on the 450-acre site in 1990 totalled approximately $70.

5.4.9.7 Emergency Response Capabilities

Police protection for St. Mary Parish is provided by the St. Mary Sheriff's Department located in the court house in Franklin. This sheriff's department employs 90 personnel, and uses 19 patrol cars and a total of 30 police vehicles. There are five municipal police departments and one Native American Reservation police department in St. Mary Parish. First response to the Cote Blanche site would come from the Baldwin Police Department about 10 to 15 minutes after first notification. No branches of the Louisiana State Police are located in St. Mary Parish.

Police services for Iberia Parish are provided by the Iberia Parish Sheriff's Department. The department is located at the court house in New Iberia, and four municipal police departments are provided in the following cities and towns: New Iberia, Jeanerette, Delcambre,

Table 5.4-7
St. Mary Parish Education Data, 1990

St. Mary Parish	Number of Schools	Number of Students	Average $/Student	Average Number of Students/Teacher
Public Primary (K-8)	26	9,127	$3,453	18
Secondary (9-12)	5	2,954	NA	17
Private (K-12)	6	1,118	NA	–

Source: 141st Annual Financial and Statistical Report. Session 1989-1990, Bulletin 1472. Louisiana Department of Education, Bureau of Education and Analytical Services.

and Loreauville. The New Iberia police department, located about 20 miles from the site, would be the first from Iberia Parish on the scene at Cote Blanche.

St. Mary Parish has a total of twelve fire departments, of which ten are volunteer departments and two are full-time. All St. Mary fire personnel have completed basic fire suppression training at the fire academy. At least one person at each of the twelve fire departments is familiar with hazmat training. St. Mary plans to have a fully operational hazmat team in the near future. The Franklin fire station is the nearest to the Cote Blanche site with an approximate response time of ten to 15 minutes.

Seven volunteer fire departments and one full-time fire department constitute Iberia Parish's firefighting capabilities. Fire suppression and hazardous materials training are required of all firefighters. Emergency medical training is required as well, and two of the nine fire departments provide ambulance and rescue service in addition to their other duties. Fire units can arrive at the Cote Blanche site approximately ten to 15 minutes after first notification.

There are seven independent ambulance and rescue units available for Cote Blanche from Acadian Ambulance Service in Lafayette and two ambulance units provided by the fire department in Iberia Parish. Each one of the units can provide advanced (or paramedic) life support with the nearest unit about 20 minutes away from the Cote Blanche site. The Franklin Foundation Hospital is within 15 miles of Cote Blanche as is the nearest medivac helicopter support available. A trauma center can be found in the city of Lafayette, approximately 30 miles away.

5.4.9.8 Land Use

The Cote Blanche salt dome is located in St. Mary Parish, Louisiana, on the northern edge of Cote Blanche Bay. Land is used in St. Mary Parish primarily for agriculture and forestry. The primary crops in the parish are sugarcane, soybeans, wheat, and freshwater fisheries. Most of the forest land in the parish is covered by bottomlands forest type.

Table 5.4-8
Federal Government Expenditures in the Cote Blanche Region, 1990
(Thousand Dollars)

Parish	**Expenditures**
St. Mary	147,341
Iberia	150,598
St. Martin	88,385
Vermilion	129,138
Lafayette	325,526
Total	**$840,988**

Source: Consolidated Federal Funds Report FY 1990. Department of Commerce.

Table 5.4-9
Local Government Expenditures in the Cote Blanche Region, 1987
(Thousand Dollars)

Parish	**Expenditures**
St. Mary	96,595
Iberia	94,078
St. Martin	43,485
Vermilion	73,736
Lafayette	195,929
Total	$503,823

Source: 1987 Census of Governments, Vol. 4, No. 3 and Vol. 4, No. 5, Bureau of Census, Department of Commerce.

Cote Blanche salt dome is about eleven miles south of Franklin, approximately 20 miles southeast of New Iberia, 30 miles from Morgan City, about twelve miles south-southeast of Lydia, and 95 miles west of New Orleans. The Cote Blanche salt dome is predominantly covered with an early stage, second growth deciduous forest. Other operations on the dome include rock salt production at Carey Salt Company's room-and-pillar cavern, located on the southwest corner of the dome, and oil and gas production at Shell Oil Company's facility also located on the southwest portion of the dome. Additionally, substantial hydrocarbon production has occurred on the north and south flanks of the dome.

Agricultural crop yields and values in St. Mary Parish are presented in Table 5.4-10. The 1990 sugar cane yield in St. Mary Parish was approximately 940,940 cwt (29 cwt/acre), and the gross farm value of the sugar cane exceeded $20 million.[239] Soybeans, wheat, nursery crops, and freshwater fisheries (catfish and crawfish farming) are the remaining important crops produced in St. Mary Parish.

The proposed Cote Blanche site contains no prime and unique farmland. The proposed pipeline right-of-way contains a total of 1.9 acres of prime and unique farmland, as identified by the U.S. Soil Conservation Service.[240]

In St. Mary Parish, 33.5 percent (139,400 acres) of the land is forested and the remaining 303,000 acres are designated as nonforest land use. Of that 33.5 percent of forested land, 6,100 acres (about 4.4 percent) are state-owned; 24,200 acres (about 17.5 percent) are owned by farmers; 54,500 acres (about 39 percent) are owned by cooperatives or corporations; and 163,600 acres (about 39 percent) are individually-owned forested properties.

Approximately 90,900 acres of the forested land in St. Mary Parish are sawtimber; 6,100 acres are poletimber; 12,100 acres are designated sapling-seedling stand-size class; and the 30,300 acres are considered nonstocked areas.[241] According to the Forest Service, in 1984, the average net annual growth of growing stock and sawtimber on timberland in St. Mary Parish was 5.0 million cubic feet for growing stock and 13.2 million board feet for sawtimber.

5.4.10 Ambient Noise

The primary activity near the proposed Cote Blanche SPR site is a room-and-pillar salt mine operated by the North American Salt Company. No sound monitoring data are available for this mine, but based on the available data from the Weeks Island SPR site, it can be assumed that the mining activity produces sound levels comparable to a suburban or an urban area (L_{dn} = 53 to 63 dBA) at 500 feet from the noise source. At 1,000 feet from the mine background noise levels (L_{dn}) are likely in the 50 to 58 dBA range. Because the island is very sparsely inhabited (i.e., only four residences or places of employment)[242,243] except for the mining activity, the overall L_{dn} measure for the entire salt dome is most likely comparable to a wooded residential or a suburban area (L_{dn} = 50 to 58 dBA). The nearest residence is approximately one-half mile from the proposed site. In addition, the proposed SPR expansion site is approximately one-half mile from the existing mining operation and would be expected to have ambient sound levels typical of the salt dome as a whole (L_{dn} = 50 to 58 dBA). (See Appendix H for information on methods for estimating noise levels.)

Table 5.4-10
St. Mary Parish Crop Production, 1990

Crop	Units of Measure	Yield Per Acre	Total Production	Gross Farm Value (dollars)
Freshwater Fisheries	Pounds		2,196,250	1,728,125
Nursery Crops	Wholesale			115,000
Soybeans	Bushels	35	24,640	154,000
Sugard Cane	cwt Raw Srg.	29	940,940	20,700,684
Wheat	Bushels	33	2,445	8,559

Source: Louisiana Agricultural Statistics Service

5.5 Richton (Capline Complex Site)

The Richton salt dome is one of the alternative sites proposed for expansion in the Capline Complex. Under this alternative, DOE would create up to 16 storage caverns with a storage capacity of up to 160 MMB. To accommodate oil fill and distribution, DOE has assessed various brine disposal and crude oil distribution alternatives, as detailed in section 3.5.

5.5.1 Geology

The proposed Richton site is located in Perry County, Mississippi, approximately 18 miles east of Hattiesburg and eleven miles north-northeast of New Augusta. The terrain surrounding the Richton salt dome is flat to gently rolling. The Leaf River, a major tributary of the Pascagoula River, passes approximately eight miles south of the proposed site.[244]

The predominant stratigraphic units overlying the dome are sedimentary formations of Pliocene, Miocene, and Oligocene age, extending to a depth of approximately 200 meters, immediately over the caprock of the dome. Alluvium, which consists primarily of fine-grained sand, silt and clay, and sandy gravel, is found in the stream valleys around the proposed site. The predominant formation immediately over the salt dome is the Citronelle Formation, which is of Pliocene age, has a maximum thickness of approximately 66 meters, and consists of gravelly, coarse-grained to fine-grained sand with lenses of silt, silty clay, and clay. The Hattiesburg and Catahoula formations are Miocene in age and consist of about 36 meters of very fine-grained to coarse-grained sand, clay, and chalky, sandy limestone. The Chickasawhay Formation, which is of Oligocene age, is 29 to 35 meters thick and consists of interbedded clay, fine-grained to medium-grained, and very sandy limestone that grades into limy sand.[245]

These same deposits make up the upper stratigraphic units off the edge of the salt dome. Other sedimentary deposits that are not found immediately above the salt dome, but can be found around the salt dome, are of middle Oligocene to Paleocene age and extend to a depth of more than 700 meters. These stratigraphic units lie beneath the units described above. From youngest to oldest, these deposits are the Lower Vicksburg Group (middle Oligocene), the Jackson Group (late Eocene), the Claiborne Group (Eocene), the Wilcox Group (Eocene-Paleocene), and the Midway Group (Paleocene). The Midway group, which extends to a depth of approximately 766 meters, overlies a sequence of Cretaceous and Jurassic sedimentary rocks with thicknesses of 3,000 to 5,800 meters.[245]

A cross-section of the Richton salt dome is provided as Figure 5.5-1. The Richton salt dome is a very large, oblong piercement dome. At the -670 meters contour the dome has approximate dimensions of about five miles (northwest to southeast) by nearly three miles (east to west). Elevations at the salt dome range from approximately 41 meters to approximately 65 meters above msl. The dome is mushroom-shaped with a large overhang on the western edge of the dome and a somewhat less well investigated overhang on the eastern edge. Sulfur exploration wells indicate that the shallowest salt is found at 155 meters below msl (220 meters bls). There are about 5,500 contiguous acres within the -600 meter contour that are potentially suitable for crude oil storage caverns. Although very little is known about possible anomalous zones within the salt column or overhangs on its periphery (i.e., either or both conditions may exist), there is probably sufficient capacity within the -600 meter contour for the development of a 160-million-barrel SPR site. However, the overhang geometry within the dome would need to be better defined and subsurface and seismic data would be needed in order to make a determination that construction of an SPR site at Richton is feasible.[247]

The top of the caprock lies at a depth of approximately 91 meters below msl. The caprock has an approximate thickness of 65 meters. There are a number of small fractures in the caprock that are typical of piercement domes. Most of these fractures are closed at present; however, sulfur exploration drilling and DOE boreholes in the caprock indicate that some of the fractures may be open.

A fault that is present only at depths below the Paleocene Midway Group, known as F-7, intersects the northwestern edge of the Richton dome. Development of the fault is thought to be the result of salt dome deformation, and movement along the fault is most likely created by the migration of the salt.[248]

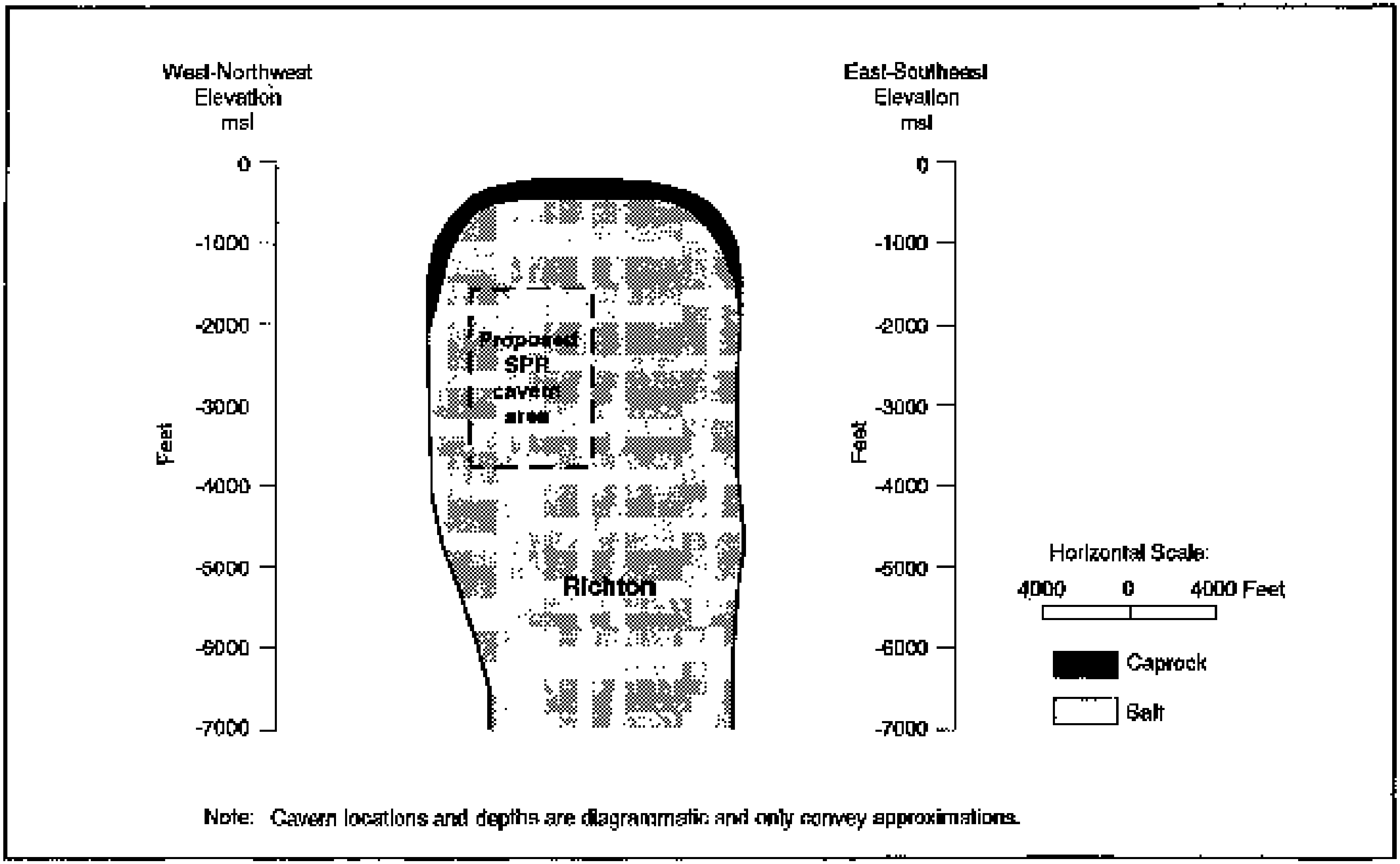
There are three oil distribution options under consideration for the Richton site. Under the first two, only pipelines would have to be constructed; under the third a bulk terminal would have to be constructed at the Mississippi Port of Pascagoula. The proposed Pascagoula Terminal would be located at the Jackson County Airport. The area is typical of the lower Mississippi River region with very little topographic relief and thick layers of sediment deposited within the floodplain. The land use around the proposed terminal site is largely industrial, with the most prominent industry being the Chevron refinery operated to the south of the proposed site.

Because any geologic impacts from construction and operation of pipelines and the Pascagoula Terminal would be limited to the surface and immediate subsurface soils, a discussion of the deeper geologic structure of the area is not warranted.

5.5.2 Hydrogeology

The aquifers in the immediate area of the Richton salt dome include the same units described in section 4.2.3, but only the Upper Aquifer lies directly above the salt dome. The Upper Claiborne and the Wilcox are pierced by the salt dome, but still exist immediately adjacent to the sides of the dome.[249] The units comprising the aquifers are uplifted in relation to their regional depths, but otherwise share similar characteristics as described for the region.[250] Table 5.5-1 summarizes key characteristics for each of these aquifers at the site.

Figure 5.5-1
Cross-Section of the Richton Salt Dome



Source: U.S. Department of Energy, Preliminary Site Geological Characterization for Strategic Petroleum Reserve (SPR) Expansion Candidates, Volume II, Sandia National Laboratories, Albuquerque, NM, March 1991.

Table 5.5-1
Site-Specific Characterization of Aquifers
Underlying the Richton Site

Aquifer	Depth of Aquifer (m bls)[a]	Overlying Soils/ Permeability (cm/sec)	Karst	Water Quality; Degree of Salinity[b]	Major Uses
Upper Aquifer	-1 to -345	Surface soils overlying: 1×10^{-2} to 1×10^{-7}; Aquifer sands: 7.7×10^{-2} to 2.7×10^{-4}, with average of 3.4×10^{-2}	None	Freshwater to Moderately Saline (brine adjacent to dome)	Residential, Municipal, Industrial, Agricultural
Upper Claiborne Aquifer	Dome pierces through; -460 to -615 adjacent to dome	Vicksburg-Jackson confining unit above: 1.7×10^{-7}; Aquifer sands: 1.7×10^{-6}	None	Moderately Saline to Brine	None
Wilcox Aquifer	Dome pierces through; -550 to -1610 adjacent to dome	Lower Claiborne confining unit above: 3.5×10^{-9}; Aquifer sands: 3.5×10^{-6} to 1.2×10^{-4}	None	Very Saline to Brine	None

a Meters Below Land Surface.
b Salinity determined by dissolved solids content, in ppt: Freshwater, Less than 1 ppt; Slightly saline, 1-3 ppt; Moderately saline, 3-10 ppt; Very saline, 10-35 ppt; Brine, More than 35 ppt.
Sources: US DOE, 1986; "Engineering Aspects of Karst", 1984; Davies and Moore, 1979; Back, W., 1988, PB-KBB, 1991; Newcome, Jr., 1967; Spiers and Gandl, 1980.

Surface soils at the site are dominated by two main soil association types. In upland areas, the Prentiss-Susquehanna-Benndale Association is the dominant surface soil. These moderately permeable surface soils are underlain by low permeability clayey soils. The other soil association prevalent in the area, the Prentiss-Bruno-Myatt, is developed in areas dominated by terraces and floodplains. Because the Bruno is a sandy soil and the Myatt is loamy, the soil association as a whole is moderately high to highly permeable.[251] There is no evidence of karst topography at the site.[252]

The Upper Aquifer begins just below the surface[253] and extends to a depth of 345 meters bls, just slightly above the domal caprock. The permeability of the aquifer sands is on the same scale as the regional permeability range (7.7×10^{-2} cm/sec to 2.7×10^{-4} cm/sec),[254] with the average permeability at over 200 sample wells being 3.4×10^{-2} cm/sec within the sands.[255] The aquifer contains abundant freshwater, which grades to moderately saline water with depth and to brine near the salt dome.[256]

Just off the side of the salt dome, the Upper Claiborne is characterized by a fairly low permeability (1×10^{-6} cm/sec)[257] and moderately saline water that grades to brine.[258] At a depth ranging from 460 to 615 meters bls, the Upper Claiborne is entirely below the base of the freshwater zone at the site, which lies at approximately 180 meters bls.[259]

The virtually confined Wilcox aquifer, where not pierced by the dome, extends from approximately 590 meters bls[260] to approximately 1,610 meters bls.[261] Only very saline water and brine exist in the Wilcox near the Richton dome.[262]

Groundwater flow direction at the Richton site is south or southeast in each unit. In the Upper Aquifer, groundwater flow at the site is almost directly to the south, following the downdip of the aquifer toward local discharge into the Leaf River and other streams,[263] and eventual discharge into the Gulf of Mexico.[264]

The Upper Aquifer is the only aquifer used within a 10-kilometer radius of the site. Eight wells in this area tap the Upper Aquifer for a variety of uses.[265] Both municipal and domestic wells are developed in the area, as well as some wells for agricultural and industrial purposes.[266]

At the proposed Pascagoula Terminal site in Jackson County, there is a water table aquifer located about 0.5 meters bls that is not used as a major source of freshwater. Below the water table aquifer, however, there are four fresh water-bearing aquifers that are used for both municipal and industrial water supplies. The Citronelle Aquifer occurs at about 8.5 meters bls, extends to a depth of approximately 60 meters bls, and is confined by impermeable clay layers. The Graham Ferry Aquifer starts at about 90 bls and extends to 120 meters bls. Beneath the Graham Ferry are two Pascagoula Aquifers that start at about 180 meters bls and 240 meters bls, respectively. Both of the Pascagoula Aquifers are approximately 30 meters thick each and are overlain by impermeable clay confining layers.[267] Major centers of groundwater pumpage in the area of the proposed terminal site are to the west in the city of Pascagoula, where wells are generally screened 40 to 115 meters bls in the Graham Ferry and Citronelle Aquifers.[268] The natural groundwater flow direction at the site is toward the southeast and Mississippi Sound, although pumpage has altered the flow direction somewhat toward Pascagoula.

5.5.3 Surface Water Environment

This section provides a baseline characterization of the water bodies possibly affected by development of the proposed Richton site. These waters are divided into: (1) the Gulf of Mexico in the vicinity of the proposed brine diffuser location; (2) the Leaf River and bodies of water that might be affected by its use as a raw water supply; and (3) inland water bodies including those within five miles of the proposed Richton site, those surrounding the proposed terminal in Pascagoula, and those crossed by the crude oil or brine disposal pipelines.

5.5.3.1 Gulf of Mexico

Figure 3.5-2 shows the proposed pipeline and diffuser location for the Richton site. The proposed pipeline route runs southwest from Pascagoula, Mississippi through Mississippi Sound to a diffuser approximately 14 miles off the coast. The proposed diffuser area lies at approximately 30°11'N and 88°27'W. This area is approximately three miles south of the east end of Horn Island (near Horn Island Pass) and the barrier island system that separates Mississippi Sound from the Gulf of Mexico.

The following sections briefly describe the baseline environmental conditions and existing oil and gas activities at the proposed Richton brine disposal site. Climatology and ecological conditions are described in sections 5.5.4 and 5.5.5, respectively, and a detailed discussion of the baseline environmental conditions of this site is included in Appendix L. The information presented here was gathered from existing sources containing data on the Mississippi Sound and offshore areas of the northern Gulf of Mexico.

Physical Conditions

The Mississippi-Alabama shelf is a triangular area extending seaward from the barrier islands.[269] The shelf is smooth in the area of the proposed diffuser site, where depths range from 40 to 50 feet.[270] An extensive sand sheet underlays the east Mississippi Sound offshore area, extending from the Chandeleur Islands east to the Alabama/Florida border.[271]

The proposed site is southwest of Horn Island Pass between Horn and Petit Bois Islands. Both islands are protected as part of the Gulf Islands National Seashore. The proposed site is 3.5 miles west of Horn Island Pass Channel, within a large Army Corps of Engineers dredged material disposal site,[272] and near two submarine natural gas pipelines. Additionally, a number of artificial reefs lie within ten miles of the proposed site.[273]

Weather in the northern Gulf of Mexico is strongly influenced by the Azores-Bermuda high pressure cell, which is strongest in summer.[274] Wind direction is variable throughout the year, but northerly winds predominate from September through February and southerly winds prevail for the rest of the year.[275]

Temperature and salinity in this area are affected by atmospheric conditions, river inflows, water circulation, and geology. Seasonal variation in meteorologic conditions strongly influences the water column, creating a well-mixed water column in winter and a partially-stratified water column in spring.[276] Surface water temperatures approximate air temperature, and near-bottom temperatures range from 63 to 84°F.[277] Salinities in this area vary dramatically with freshwater inputs and periodic intrusions of the Gulf Loop Current, and can range from eleven to 38 ppt.[278] To the east of the proposed diffuser, Horn Island Pass Channel allows colder, high-salinity, de-oxygenated Gulf waters to intrude upon Mississippi Sound.[279]

Currents are primarily wind-driven and are modified by the geology of the area. Surface circulation is dominated by longshore currents flowing west in winter; surface circulation reverses and flows east in spring. Recorded bottom currents, however, were independent of surface currents and were more likely to flow in the same general direction over time. In the area of the proposed diffuser, bottom currents flow primarily northeast. As tides enter the Mississippi Sound through Horn Island Pass, water below the barrier islands circulates clockwise east of Horn Island Pass, and counterclockwise west of this Pass.[280] The current speed most often ranges from 0.1 to 0.3 feet per second, but increases to between 0.3 and 0.7 feet per second about 15 percent of the time and increases to between 0.7 and 1 foot per second about 2 percent of the time.

Chemical Conditions

The Mississippi Sound and offshore areas are used extensively for marine transportation, dredged material disposal, and offshore oil and gas drilling, resulting in a complex chemical environment. Water-column and sediment chemistry are highly dependent on seasonal riverine discharge because rivers are a major source of nutrients, trace metals, hydrocarbons, synthetic organics, and radionuclides. Sediment contaminant levels fluctuate seasonally, perhaps due to dilution by biological mixing (i.e., the disturbance of sediments by benthic organisms), or from water-current transport.[281]

River outflows contribute nutrients and synthetic organic chemicals into the Gulf. Nutrient levels are characteristically low in open Gulf waters and increase in nearshore waters.[282] High levels of pesticides, polychlorinated biphenyls, and related organochlorines have been measured in the Mississippi River deltaic area and in coastal bays and estuaries of the Gulf.[283]

Petroleum exploration and production in the Gulf release trace metals, hydrocarbons, and radium. Iron and trace metal content of sediment vary considerably in the area of the proposed diffuser site, with shallow water sediment generally less contaminated with iron and trace metals than deep-water sediment.[284] Hydrocarbons are ubiquitous in Mississippi Sound offshore sediments, and higher levels of hydrocarbons are found in sediments along transects in the seaward direction, and near the Mississippi Delta.[285] Radium concentrations are sometimes higher in subsurface brines (i.e., brine produced from oil wells) than in the open Gulf.[286]

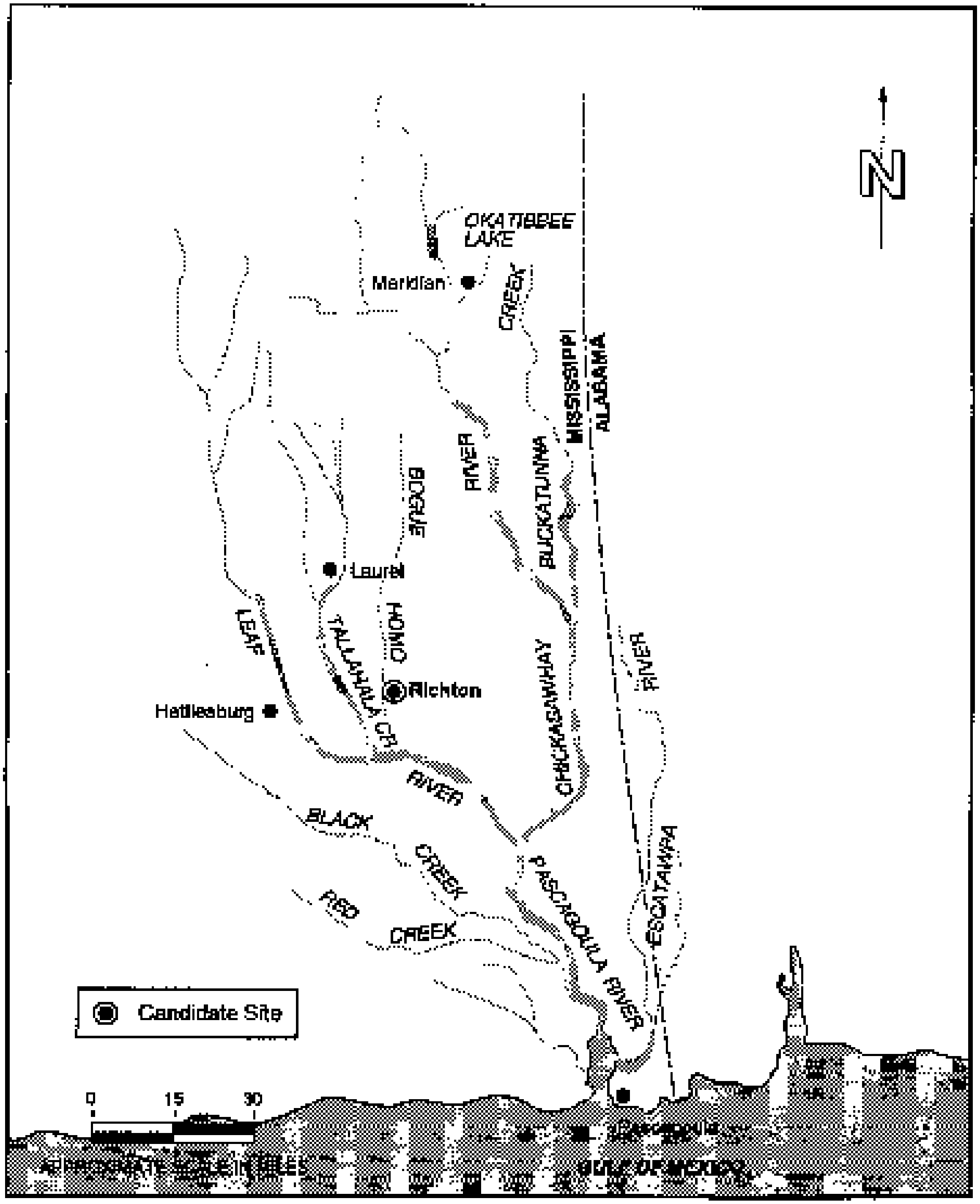
Oil and Gas Activities

Most of the over 25,000 oil wells drilled in the northern Gulf of Mexico since 1954 are situated off the coast of Louisiana.[287] There is presently no active oil or gas activity in the immediate vicinity of the proposed diffuser site, but there may be in the future. The proposed diffuser site lies within the Gulf of Mexico Central Planning area which has been considered for lease for petroleum exploration.[288] Additionally, two high pressure natural gas pipelines are buried east of the proposed diffuser.[289]

5.5.3.2 Leaf River and Connecting Waters

Raw water for development and operation of the Richton site would be obtained from the Leaf River, which flows in a generally southeasterly direction across southern Mississippi. The Leaf River is widely meandering, lying within a broad floodplain containing numerous oxbow lakes. Large sand deposits mark the banks at many points along the river. Major tributaries to the Leaf River are Tallahala Creek, Bogue Homo, and Thompson Creek, as shown in Figure 5.5-2. U.S. Geological Survey maps also show many other named and unnamed intermittent water courses intersecting the Leaf River. The river ends at its confluence with the Chickasawhay River where the Pascagoula River is formed.

Figure 5.5-2
The Leaf River System Near Richton Dome



The RWI structure for the Richton site would be located at the northern point of a prominent meander, about 450 feet downstream of the river's intersection with Bogue Homo (at 31°13'N and 89°00'W). The river in this area is a freshwater body, averaging 200 feet wide and eight feet deep. Characteristics of the surface water bodies intersecting the Leaf River in the vicinity of the proposed RWI structure are summarized in Table 5.5-2.

The land along the Leaf River in this vicinity is very lightly developed. The nearest of the few towns on the river is New Augusta at a distance of about four miles upstream of the proposed RWI. The only large town on the river is Hattiesburg, Mississippi at a distance of roughly 20 miles northwest of the proposed raw water intake structure. Although much of the land along the river near the proposed RWI structure is undeveloped forest or wetlands, some land is in residential, agricultural, and industrial use. No public water intakes, however, exist downstream of the proposed RWI structure.

The flow of the Leaf River is highly variable. From December 1983 to September 1991, the discharge of the Leaf River at New Augusta ranged from 590 to 74,000 cfs, with an average discharge of about 4,100 cfs.[290] The average yearly minimum discharge during this same period was 720 cfs, and the average yearly maximum discharge was 30,100 cfs.[291] Flow rates in the Leaf River and its tributaries peak between December and May, as severe floods may occur during these months.[292] There are no control structures on the river, and the only large commercial or industrial user is Mississippi Power Company, which in 1979 was permitted to divert up to 115.2 million gallons per day (mgd) (178 cfs) from the river at Hattiesburg for power generation. Most of the diverted water was returned to the river.[293]

In the past, industrial and municipal outfalls at Hattiesburg, upriver from the proposed RWI structure, were the major sources of pollution to the river. Data collected in the 1970s at the town of McLain, downstream of the proposed raw water intake, showed that criteria for phenols, pH, and fecal coliform bacteria were occasionally exceeded. Additionally, domestic water supply criteria for PCBs, iron, manganese, and several pesticides were frequently exceeded.[294] Currently, an important contamination of the Leaf River is the release of dioxin from the Leaf River Forest Products paper mill at the town of New Augusta. Although dioxin has not been detected in Leaf River water above the Mississippi standard of $1x10^{-9}$ mg/l,[295] bottom-feeding fish collected downriver of the mill's outfall showed whole-fish toxicity equivalent concentrations of 2,3,7,8-TCDD to be well above the FDA-consumption ban level. In March 1990, the Mississippi Department of Environmental Quality issued a commercial fishing ban and a fish consumption advisory for bottom-feeding fish in a 15.2-mile section of the river that includes the proposed RWI structure.[296] Since that time, the State has observed a steady decline in dioxin levels in fish tissues and has loosened the advisory to pertain only to fish over five pounds.[297] Otherwise, the State of Mississippi has classified the Leaf River as suitable for fishing and the propagation of aquatic life and wildlife, since at least the 1970s.

The Leaf River contains a fish community that is typical of southern freshwater rivers. At least 30 species have been collected from the river. Many of these belong to the two most abundant families, sunfish and minnows. The most popular sportfish in the area are channel catfish and bass. Wildlife likely to be found in the Leaf River corridor include white-tailed deer, raccoon, opossum, rabbits, a diversity of rodents, wild turkey, and migratory waterfowl.[298] Further characterization of the aquatic life and ecology of the area is provided in section 5.5.5.

Table 5.5-2
Characteristics of Surface Water Bodies Intersecting the Leaf River in the Vicinity of the Proposed Raw Water Intake at Richton

Surface Water System	Distance from RWI (miles)	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Tallahala Creek	3.9	70	8	1010 (225-2,190)	No downstream public intake	None	Fresh	Fish and wildlife
Gum Branch	2.5	3	0	Intermittent	No downstream public intake	None	Fresh	No known uses
Bogue Homo	0.1	80	2	770 (242-1,570)	No downstream public intake	None	Fresh	Recreation
McSwain Lake	1.8	350	6	Negligible	No downstream public intake	None	Fresh	Recreation
Horseshoe Bend Lake	7.5	100	Intermittent	Negligible	No downstream public intake	None	Fresh	No known uses
Coleman Creek	2.3	<50	Intermittent	Intermittent	No downstream public intake	None	Fresh	No known uses
Thompson Creek	7.3	50	2.5	263 (82.5-534)	No downstream public intake	None	Fresh	Recreation
American Legion Lake	8.2	100	2	Negligible	No downstream public intake	None	Fresh	Recreation
Lott Dead River	8.3	<50	3	None	No downstream public intake	None	Fresh	Recreation

5.5.3.3 Inland Water Bodies

For the purpose of this baseline characterization, inland water bodies potentially affected by the development of Richton have been organized into: (1) water bodies within a five-mile radius of the proposed site; (2) water bodies surrounding the proposed storage terminal at Pascagoula; and (3) water bodies crossed by crude oil and brine discharge pipelines.

Water Bodies Within Five Miles of the Proposed Site

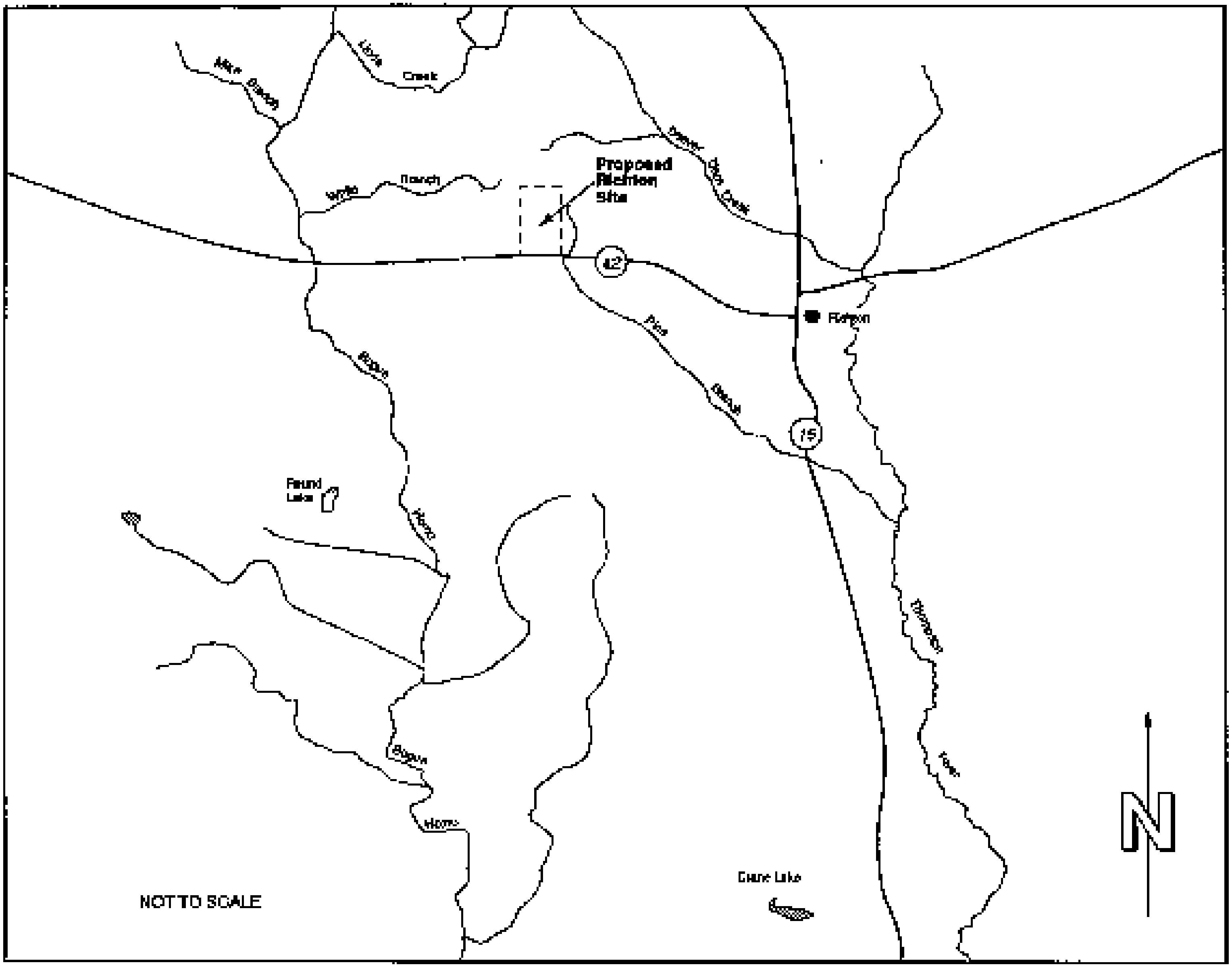
Richton is located in the Gulf Coastal Plain physiographic province of Mississippi, in the southern portion of the Pascagoula River Drainage Basin. This basin is the second largest in Mississippi, draining roughly 9,700 square miles of southeastern Mississippi and southwestern Alabama.[299] The region receives approximately 60 inches of rain annually,[300] and the water bodies in the area are fresh and generally classified as "Fish and Wildlife" waters or waters for recreational use.[301] Harpers Branch, an intermittent stream, runs from the center of the Richton site southeast and is the only water body located on the site property; however, 26 named water bodies and approximately 90 small, unnamed ponds are located within five miles of the proposed site.[302] Figure 5.5-3 shows the surface waters in the area surrounding the proposed site. Water bodies that are in the vicinity of the site are characterized in Table 5.5-3.

As shown in Table 5.5-3 all the waters in this area are fresh. The waters are principally used for recreation, although the actual uses of many of the waters are not known. Many of these water bodies are intermittent over much of their length, and most are rather small (less than ten feet wide). The most significant water bodies in the Richton area are Thompson Creek and Bogue Homo, east and west of the dome respectively, which drain the area over the dome into the Leaf River. The water bodies located closest to the proposed site are Harpers Branch, Pine Branch, White Branch, and Fox Branch Creek, which all drain into either Bogue Homo or Thompson Creek. No public water intakes exist within a five-mile radius of the Richton site.

Water Bodies Surrounding the Proposed Pascagoula Terminal

There are four major surface water systems in the vicinity of the proposed terminal site at the Jackson County Airport. Bangs Lake, the closest permanent water body, is an approximately 525-acre lake that is surrounded by extensive bands of salt marsh and wooded regions. The Bangs Lake area is ecologically significant and is presently protected as the Bangs Lake Wildlife Management Area and the Grand Bay National Wildlife Refuge (see section 5.5.5.2). The northern tip of Bangs Lake is about one mile southeast from the proposed terminal site. The Escatawpa River lies approximately 2.4 miles to the north of the proposed terminal, separated from the terminal by the population centers of Kreole and Moss Point. The Escatawpa River in this area is approximately 260 feet wide and 3.5 feet deep, and is used primarily for recreation. Krebs Lake, an embayment within the East Pascagoula River, is approximately three miles to the west of the proposed terminal and located on the opposite side of the city of Pascagoula. Finally, the northern tip of Bayou Casotte, near the point where it joins with the West Prong of Bayou Casotte, is about 1.7 miles south-southwest from the proposed terminal. Bayou Casotte is very heavily industrialized, supporting docks for the Chevron refinery and the Jackson County Port Authority. The approximately 100-acre Greenwood Island dredged material disposal area also is located on the west bank of the mouth of Bayou Casotte. In general, the Port of Pascagoula area, including Bayou Casotte, has one of the most severe water quality problems within the State of Mississippi. Bayou Casotte has been recognized as having both dissolved oxygen and bacteria

Figure 5.5-3
Water Bodies Within Five Miles of the Richton Salt Dome Site



Source: U.S. Geological Survey

Table 5.5-3
Characteristics of Surface Water Bodies Within Five Miles of the Proposed Site at Richton, Mississippi

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Bogue Homo	2.3	Leaf River, Pascagoula River	200	2	770 (242-1,570)	No downstream public intakes	None	Fresh	Recreation
Harpers Branch	0	Bogue Homo	5	1	Intermittent	No downstream public intakes	None	Fresh	No known uses
Sweetwater Creek	3.6	Bogue Homo	5	1	Negligible	No downstream public intakes	None	Fresh	No known uses
Holloman Pond	4.4	Bogue Homo	500	8	None	No downstream public intakes	None	Fresh	Recreation
Beaver Dam Creek	1.8	Thompson Creek	5	1	Negligible	No downstream public intakes	None	Fresh	No known uses
Fox Branch Creek	1.1	Beaver Dam Creek	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Pine Log Branch	4.6	Thompson Creek	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Thompson Creek	3.8	Pascagoula River	50	2.5	262 (82.5-534)	No downstream public intakes	None	Fresh	Recreation
Linda Creek	1.6	Bogue Homo	5	1	Negligible	No downstream public intakes	None	Fresh	No known uses
White Branch	1.6	Bogue Homo	5	1	Negligible	No downstream public intakes	None	Fresh	No known uses
Pine Branch	0.6	Thompson Creek	5	1	Negligible	No downstream public intakes	None	Fresh	No known uses
Reservoir (unnamed)	4.7	Grapevine Branch	1200	20	None	No downstream public intakes	None	Fresh	Recreation

Table 5.5-3 (Continued)
Characteristics of Surface Water Bodies Within Five Miles of the Proposed Site at Richton, Mississippi

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Buck Creek	2.7	Bogue Homo	10	2.5	45.9 (14.4-98.4)	No downstream public intakes	None	Fresh	Recreation
Grapevine Branch	3.1	Bogue Homo	10	2	Negligible	No downstream public intakes	None	Fresh	Recreation
Mill Creek (s.w. of site)	3.5	Bogue Homo	5	1	Negligible	No downstream public intakes	None	Fresh	No known uses
Flat Branch	4.1	Bogue Homo	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Nicholson Branch	3.5	Bogue Homo	5	1	Negligible	No downstream public intakes	None	Fresh	No known uses
Ready Branch	3.8	Underwood Branch	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Underwood Branch	3.7	Bogue Homo	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Allen Branch	2.9	Bogue Homo	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Big Thick Branch	3.0	Bogue Homo	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Mike Branch	2.9	Bogue Homo	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Round Lake	3.3	None	200	10	None	No downstream public intakes	None	Fresh	Recreation
Clear Lake	3.4	None	100	5	None	No downstream public intakes	None	Fresh	Recreation

Table 5.5-3 (Continued)
Characteristics of Surface Water Bodies Within Five Miles of the Proposed Site at Richton, Mississippi

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Bear Branch	4.5	Bogue Homo	10	1	Negligible	No downstream public intakes	None	Fresh	Recreation
Mill Creek (s. of site)	2.9	Bogue Homo	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
90 Unnamed Farm Ponds	>0.5	Various	up to 400 feet	up to 8 feet	None	No downstream public intakes	None	Fresh	Livestock Water; Fish Farming; Recreation

problems as a result of discharges from the Pascagoula/Bayou Casotte sewage treatment plant and other sources.[303]

Pipeline Crossings

One alternative crude oil distribution pipeline route would stretch from the Richton site 118 miles west to the Capline Liberty Station, in Amite County, Mississippi. Along this route the pipeline would traverse 23 water bodies, each of which is characterized in Table 5.5-4. Some of the more significant water bodies along this route would include: Bogue Homo, Leaf River, Black Creek, Pearl River, Bogue Chitto, Amite River, Tallahala Creek, and Tangipahoa River.

The proposed dual-purpose pipeline would run from the site to the 40-foot depth contour in the Gulf of Mexico, 96 miles away (the Gulf of Mexico in this area is characterized in section 5.5.3.1). For approximately the first six miles, this pipeline would share the ROW with the raw water pipeline, then it would follow another ROW to Pascagoula, and from there continue offshore. Twenty-four water bodies would be crossed along this route, each of which is characterized in Table 5.5-5. The most prominent inland water bodies crossed would include the Escatawpa River and the Chickasawhay River. Additionally, if the docks of Greenwood Island are used in Pascagoula, a 42-inch oil pipeline would be laid beneath Bayou Cassotte.

Another alternative crude oil distribution pipeline would run from the site at Richton 70 miles to Ten-Mile, Alabama, near Mobile. This pipeline would begin in the same southerly ROW as the proposed dual-purpose pipeline to Pascagoula, and turn east-southeast after crossing Big Creek in Mississippi. Along this route, the pipeline would follow all existing ROWs as described in Chapter 3 and would cross 25 water bodies, each of which is characterized in Table 5.5-6. Some significant water bodies along this route are the Escatawpa River and Big Creek. Although the pipeline would not cross Big Creek Lake, it would cross a number of creeks and branches at northern points that flow directly into Big Creek Lake. In addition to being a large lake used for recreation, Big Creek Lake is important because it serves as a source of drinking water for the City of Mobile. The closest the pipeline would come to the location of the municipal water intake on Big Creek Lake would be approximately ten miles upstream, at the point where it would cross Long Branch.

The blanket oil pipeline, which would be converted to a brine discharge pipeline after leaching is complete, would run 13.6 miles west-northwest from the Richton site. It would intersect the Hess 10-inch pipeline 10.6 miles from the site. Along this route, the pipeline would cross nine water bodies, of which five are intermittent streams (intermittent tributaries of Harpers Branch, Buck Creek, Driving Branch, Parker Branch, and McComb Branch). The four perennial streams that would be crossed by the pipeline are Harpers Branch, Bogue Homo, Tallahala Creek, and Buck Creek, each of which is characterized in Table 5.5-2 or Table 5.5-3.

5.5.4 Climate and Air Quality

The climate in the Richton area is significantly humid during most of the year, with relatively short, mild winters and long, warm summers.[304] The Gulf of Mexico has a moderating effect on the climate. Precipitation is greatest during the spring and winter months, decreasing during the summer and through the fall. Monthly mean temperature ranges from approximately 42°F in January to 82°F in July, and annual precipitation averages about 49

Table 5.5-4
Characteristics of Surface Waters Crossed by the Proposed Crude Oil Pipeline Route from Richton to the Liberty Terminal

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Average Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Uses	Water Type
Bogue Homo	Leaf River	130	2.5	770 (242-1,570)	No downstream public intakes	None	Recreation	Fresh
Reese Creek	Leaf River	10	5	98.5 (31-200)	No downstream public intakes	None	Recreation	Fresh
Wedgeworth Creek	Sims Lake	4	0.5	Negligible	No downstream public intakes	None	Recreation	Fresh
Leaf River	Pascagoula River	320	3.5	2,730 (860-5,560)	No downstream public intakes	None	Recreation	Fresh
Burketts Creek	Leaf River	5	1	Negligible	No downstream public intakes	None	Recreation	Fresh
Sandy Run	Black Creek	9	2.5	46.7 (22.4-86.1)	No downstream public intakes	None	Recreation	Fresh
Perkins Creek	Black Creek	8	2	36.6 (17.6-67.5)	No downstream public intakes	None	Recreation	Fresh
Black Creek	Pascagoula River	15	6.5	200 (96.2-369)	No downstream public intakes	None	Recreation	Fresh
Little Black Creek	Black Creek	5	1	Negligible	No downstream public intakes	None	Recreation	Fresh
Gully Creek	Lower Little Creek	10	3	53.4 (22-105)	No downstream public intakes	None	Recreation	Fresh
Cook Creek	Upper Little Creek	4	0.5	Negligible	No downstream public intakes	None	Recreation	Fresh
Brushy Creek	Upper Little Creek	4	.5	Negligible	No downstream public intakes	None	Recreation	Fresh

Table 5.5-4 (Continued)
Characteristics of Surface Waters Crossed by the Proposed Crude Oil Pipeline Route from Richton to the Liberty Terminal

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Average Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Uses	Water Type
Upper Little Creek	Pearl River	60	1.5	140 (28.8-287)	No downstream public intakes	None	Recreation	Fresh
Pearl River	Gulf of Mexico	270	9	7,330 (1,450-15,100)	No downstream public intakes	None	Small Boat Traffic; Recreation	Fresh
Silver Creek	Pearl River	5	1	Negligible	No downstream public intakes	None	Recreation	Fresh
Magees Creek	Bogue Chitto	15	7.5	236 (98.3-292)	No downstream public intakes	None	Small Boat Traffic; Recreation	Fresh
Bogue Chitto	Pearl River	110	3.5	861 (389-1,480)	No downstream public intakes	None	Recreation	Fresh
Little Tangipahoa River	Tangipahoa River	5	1	Negligible	No downstream public intakes	None	Recreation	Fresh
Tangipahoa River	Lake Pontchartrain	50	2	214 (105-341)	No downstream public intakes	None	No known uses	Fresh
Henley Creek	East Fork Amite River	10	4	75.1 (36.7-123)	No downstream public intakes	None	No known uses	Fresh
East Fork Amite River	Amite River	70	2.5	369 (180-606)	No downstream public intakes	None	Recreation	Fresh

Table 5.5-5
Characteristics of Surface Waters Crossed by Dual-Purpose Pipeline from Richton to Pascagoula

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Average Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Nicholson Branch	Bogue Homo	10	3	56 (29.3-90.1)	No downstream public intakes	None	Fresh	No known uses
Mill Creek	Bogue Homo	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Crane Creek	Thompson Creek	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Thompson Creek	Leaf River	50	2.5	262 (82.5-564)	No downstream public intakes	None	Fresh	Recreation
Gaines Creek	Leaf River	30	3	175 (55.2-357)	No downstream public intakes	None	Fresh	Recreation
McSwain Branch	Leaf River	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Atkinson Creek	Leaf River	10	4	75.1 (23.6-153)	No downstream public intakes	None	Fresh	Recreation
Courthouse Creek	Leaf River	5	1	Negligible	No downstream public intakes	None	Fresh	Recreation
Big Oktibee Creek	Leaf River	5	1	Negligible	No downstream public intakes	None	Fresh	Recreation
Hoy Creek	Leaf River	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Waterhole Branch Creek	Leaf River	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Chickasawhay River	Pascagoula River	250	6	4300 (1,280-8,630)	No downstream public intakes	None	Fresh	Recreation
Toms Creek	Pascagoula River	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses

Table 5.5-5 (Continued)
Characteristics of Surface Waters Crossed by Dual-Purpose Pipeline from Richton to Pascagoula

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Average Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Pree Creek	Pascagoula River	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Big Creek	Pascagoula River	10	3.5	68.4 (20.5-139)	No downstream public intakes	None	Fresh	Recreation
Tappley Branch Creek	Big Creek	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
White Creek	Plum Bluff Cutoff	10	2.5	49.1 (12.9-87.8)	No downstream public intakes	None	Fresh	Recreation
Indian Creek	Pascagoula River	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Big Cedar Creek	Pascagoula River	10	3.5	71.9 (21.5-147)	No downstream public intakes	None	Fresh	Recreation
Black Creek	Pascagoula River	3	0	Intermittent	No downstream public intakes	None	Fresh	No known uses
Black Creek Cooling Pond	Black Creek	4,000	3	None	No downstream public intakes	None	Fresh	Power Plant Cooling Water
Black Creek	Escatawpa River	10	3	56 (29.3-90.1)	No downstream public intakes	None	Fresh	Recreation
Escatawpa River	Pascagoula River	260	3.5	2,360 (1,210-3,800)	No downstream public intakes	None	Fresh	Recreation; Fish and Wildlife
Unnamed Canal	Escatawpa River	50	4	Controlled with Locks	No downstream public intakes	None	Fresh	Industrial, Water Supply
Mississippi Sound	Gulf of Mexico	46,000	15	None	No downstream public intakes	None	Salt	Commercial Traffic; Recreation; Commercial and Sport Fishery

Table 5.5-6
Surface Waters Crossed by Crude Oil Distribution Pipeline Route from Richton to Mobile, Alabama

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Average Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Uses	Water Type
Crane Creek	Thompson Creek	3	0	Intermittent	No downstream public intakes	None	No known uses	Fresh
Thompson Creek	Leaf River	60	2.5	262 (82.5-594)	No downstream public intakes	None	Recreation	Fresh
Atkinson Creek	Leaf River	10	4	75.1 (23.6-153)	No downstream public intakes	None	Recreation	Fresh
Courthouse Creek	Leaf River	5	1	Negligible	No downstream public intakes	None	Recreation	Fresh
Big Dialbee Creek	Leaf River	5	1	Negligible	No downstream public intakes	None	Recreation	Fresh
Holy Creek	Leaf River	3	0	Intermittent	No downstream public intakes	None	No known uses	Fresh
Waterhole Branch Creek	Leaf River	3	0	Intermittent	No downstream public intakes	None	No known uses	Fresh
Toms Creek	Pascagoula River	3	0	Intermittent	No downstream public intakes	None	No known uses	Fresh
Big Creek	Pascagoula River	10	3.5	68.4 (20.5-139)	No downstream public intakes	None	Recreation	Fresh
White Creek	Pascagoula River	10	2.5	43.1 (12.9-87.8)	No downstream public intakes	None	Recreation	Fresh
Indian Creek	Pascagoula River	3	0	Intermittent	No downstream public intakes	None	No known uses	Fresh
Big Cedar Creek	Pascagoula River	10	3.5	71.9 (21.5-147)	No downstream public intakes	None	Recreation	Fresh

Table 5.5-6 (Continued)
Surface Waters Crossed by Crude Oil Distribution Pipeline Route from Richton to Mobile, Alabama

Surface Water System	Connections	Width (ft)	Depth (ft)	Annual Average Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Uses	Water Type
Little Cedar Creek	Big Cedar Creek	5	1	Negligible	No downstream public intakes	None	Recreation	Fresh
Red Creek	Escatawpa River	5	1	Negligible	No downstream public intakes	None	Recreation	Fresh
Escatawpa River	Pascagoula River	110	4.5	1,181 (487-1,970)	No downstream public intakes	None	Recreation; Fish and Wildlife	Fresh
Flat Creek Pond (1 acre)	Escatawpa River	120	8	None	No downstream public intakes	None	Livestock water Recreation	Fresh
Boggy Branch	Big Creek Lake	3	0	Intermittent	53,000 feet	279,000	No known uses	Fresh
Long Branch	Big Creek Lake	5	1	Negligible	51,500 feet	279,000	Recreation	Fresh
Big Creek	Big Creek Lake	20	3.5	154 (81.8-226)	52,800 feet	279,000	Recreation	Fresh
Juniper Creek	Big Creek	5	1	Negligible	55,000 feet	279,000	Recreation	Fresh
Collins Creek	Big Creek Lake	5	1	Negligible	64,500 feet	279,000	Recreation	Fresh
Seabury Creek	Chickasaw Creek	5	1	Negligible	No downstream public intakes	None	Recreation	Fresh
Unnamed 9 acre Pond	Eightmile Creek	380	12	None	No downstream public intakes	None	Recreation	Fresh
Eightmile Creek	Chickasaw Creek	8	1.5	Negligible	No downstream public intakes	None	Recreation	Fresh
Toulmins Spring Branch	Threemile Creek	4	0.5	Negligible	No downstream public intakes	None	Recreation	Fresh

in/yr.[305] The Richton site is located in Perry County, an attainment/unclassified area for ozone.

No air monitoring activities are carried out at the site, but the Mississippi Department of Environmental Quality's Bureau of Pollution Control maintains ozone monitoring stations in Lamar County (approximately 35 miles from the site) and at Pascagoula, the site of the dual-purpose pipeline termination. The NAAQS for ozone was not exceeded in 1989 or 1990 at either monitoring station.[306] The highest ozone measurements in 1989 were 0.079 ppm at the Lamar County Station and 0.097 ppm at Pascagoula. The highest ozone measurements in 1990 were 0.102 ppm at the Lamar County Station and 0.115 ppm at Pascagoula.[307]

5.5.5 Ecology

The following section describes the ecology of the Richton site, including vegetation, wildlife, and rare, threatened, and endangered species at the proposed site, the biological communities offshore in the Gulf of Mexico, and those that are expected to be encountered along proposed pipeline routes. The information presented here is from site visits conducted in November 1991 and April 1992, an aerial survey conducted in December 1991, information obtained from previous reports,[308] and information obtained from various federal and state agencies.

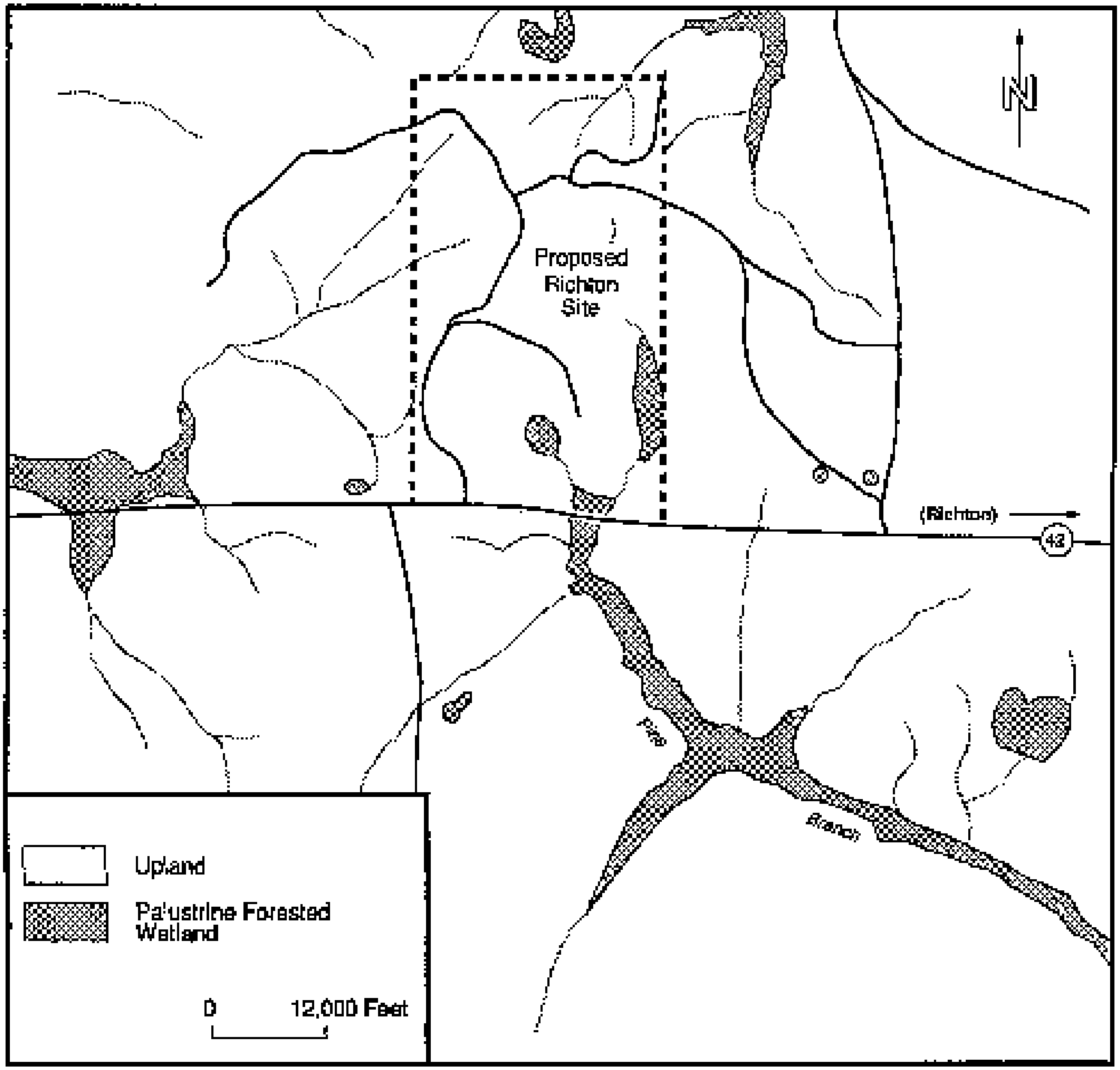
5.5.5.1 Ecosystems on the Proposed Site Location or Nearby

The Richton dome is located in a transition area between the outer coastal plain forest province and the southeastern mixed forest province.[309] The proposed site area is approximately two-thirds cutover/managed lands and one-third natural forest areas. Most of the central portion of the site has been timbered within the last six years and is currently managed primarily for timber production. Slash pine has been planted over the majority of this area, resulting in a large, even-aged timber stand. The planted pine are currently about 15 feet in height and about ten inches in diameter at breast height. In most areas, the planted pine stand is characterized by a relatively dense herbaceous-shrub layer. Lespedeza and blackberry are the dominant shrub species in these areas and occur along with a variety of grasses and forbes. Yaupon and sweetbay occur sporadically in the planted pine areas. Figure 5.5-4 shows wetland and upland areas at the proposed site and surrounding areas.

Vegetation

Natural vegetation in the eastern portion of the site is characterized by longleaf pine and slash pine forest. Other pine species occurring in the area include pond pine, loblolly pine, and shortleaf pine. Common hardwood species of the longleaf-slash pine forest overstory include post oak, blackjack oak, and southern red oak. Red maple, water oak, and sweet gum are common overstory species in some upland areas and along drainage ways. Yaupon, southern bayberry, sweetbay are common trees of the understory. Dogwood, American holly, and black cherry also occur in the understory. Herbaceous species are not generally abundant in forested areas due to a heavy cover of needle and leaf litter on the forest floor. Grasses and some other herbaceous species do occur sparsely in forested areas, although they are much more dense in less mature areas that have been cut over within the last ten years.

Figure 5.5-4
Wetlands and Upland Habitats: Proposed Richton Site



Source: National Wetland Inventory Map; Richton, MS Quadrangle

Small pockets of agricultural fields occur sporadically throughout the managed timber stand. Crops include rye, clover, corn, and soybean and are planted by the land owner as deer forage. An open field approximately one-half acre in size also occurs in the south central portion of the site, approximately 1,000 feet north of Route 42. The natural drainage of this area appears to have been altered artificially, thereby creating a somewhat marshy area. Cattails, rushes, and other herbaceous wetland species, as well as a variety of upland grasses and forbes occur in this area.

The extreme western boundary of the site is dominated by the longleaf-slash pine forest characteristic of the area. Longleaf pine is the dominant pine throughout this portion of the site, although slash pine also is common. The more mature pines along this strip of the proposed site are approximately 40 to 50 feet in height and approximately 20 to 35 inches in diameter at breast height. Oaks are the dominant hardwood tree species of the forest in this area. Red maple and water oak are common along the drainage ways. Yaupon, dogwood, and waxmyrtle are common understory species, with holly and sweetbay occurring less frequently. Grasses and some forbes comprise the sparse herbaceous layer of the forest floor.

Wetlands at the site were initially identified using a National Wetland Inventory map and were then field-verified during a site visit. The majority of the wetlands on the proposed site are associated with a tributary to Pine Branch. These are palustrine forested, broad-leaved deciduous and needle-leaved evergreen wetlands. The largest of these runs north to south along the eastern portion of the site. A palustrine forested (deciduous) and emergent wetland roughly 400 feet in diameter is located in the middle of the southern portion of the site. This wetland is also connected to the tributary of Pine Branch. The other small wetlands onsite are associated with intermittent streams or drainages, two of which drain to the southwest and three of which drain to the northeast. These are palustrine forested broad-leaved deciduous and needle-leaved evergreen wetlands.

No other standing water was observed at the site during a site visit in December 1991. An apparent seasonal drainage was observed in the eastern portion of the site. This drainage appears to flow south across the eastern portion of the site.

Terrestrial Wildlife

The proposed site area likely provides habitat for a variety of terrestrial wildlife species. Deer are common at the site and were observed along with numerous deer sign (tracks and rubbing trees) during a site visit in December 1991. Other mammalian species known or expected to occur on the site include armadillo, raccoon, gray squirrel, coyote, cottontail, and opossum. Bird species or their sign observed during the site visit include turkey, red-tailed hawk, mockingbird, blue jay, American crow, kestrel, and black vulture. Other common bird species likely include owls, woodpeckers, thrushes, vireos, and warblers. Reptiles and amphibians also are likely to occur throughout the site. Aquatic invertebrates and amphibians are likely inhabitants of the small pond observed in the southwestern portion of the site. It is not known if water in the pond is sufficient during summer months to support a fish community.

Aquatic Life

Several small ponds and intermittent creeks overly the Richton area. The major streams within two miles of the dome are Beaver Dam Creek, Pine Branch, and Harpers Branch.

Roughly four miles from the site there are two slightly larger creeks, Thompson and Bogue Homo Creeks. These creeks provide habitat for a wide variety of fish, mollusks, and other benthic invertebrates, as well transitory habitat for migratory waterfowl.

The fish species that inhabit these streams are, in general, the same ones that inhabit the bulk of the streams and ponds in the Pascagoula River Basin (Table 5.5-7). In addition to the fish species listed in Table 5.5-7, two other species, the Crystal darter and the Freckled darter, historically inhabited the area but are now Federally threatened and have not recently been identified in these waters. The Crystal darter is also listed as a State endangered species.[299]

The common mollusk species found in area waters are dependent on substrate and water flow. In the rivers and streams that have silt and or mud substrates, bivalves such as *Corbicula* and *Unio* are likely to be found. In the shallower, lotic (i.e., fast moving) streams, the common mollusk is the gastropod *Physa*.[300] Two other mollusk species that have historically inhabited waters in the Pascagoula basin, but are now State threatened species, are the mussels *Elliptio arcus* and *Obovaria unicolor*.[301] Other invertebrates that also are dependent on the sediment matrix are burrowing animals such as crayfish, oligochaetes, and some insect larvae.

Finally, in the area around Richton, especially along the banks of Beaver Dam Creek, there exist several freshwater marsh systems that provide habitat for many plant species adapted to the hydric sediment found there (see Table 5.5-8). In addition to these freshwater marshes in the dome vicinity, there are many estuaries in the area around the Pascagoula Terminal. These areas support plant and animal species that require salt water penetration from Mississippi Sound. These species include American alligator (Federally protected), rainbow snake, yellow-blotched sawback turtle, (both of which are State protected) and several species of catfish.[302] Due to the increased concentration of salt water that penetrates the Pascagoula River near the coast, the river itself provides habitat for the Atlantic sturgeon, a species protected at the State level. Estuaries also act as nurseries for many juvenile stages of species that, as adults, inhabit Mississippi Sound.

Threatened or Endangered Species

Based on information supplied by the Mississippi National Heritage Program (1991), four State endangered animal species are reported to occur within a one-mile radius of the Richton site. These are listed in Table 5.5-9. Although none of these species was observed during the site visit, three of the four could potentially inhabit the site: the eastern indigo snake, the black pine snake, and the gopher tortoise. In addition to these species, three other endangered or threatened species are listed in Perry County, in which the Richton site is located (Appendix D).

A fourth endangered species, the red-cockaded woodpecker, has very specific habitat requirements. It requires open pine woods with little understory, and nests mostly in aging long-leaf or loblolly pines roughly 60 to 100 years of age that are infested with red heart. The majority of the proposed Richton site is comprised of second- or third-growth pine forests less than ten years old. Many of the stands are dense, with considerable understory, and therefore, it is considered unlikely that the woodpecker nests at the proposed site.

Potential impacts on the federally-listed species are considered in the biological assessment in Appendix F.

Table 5.5-7
Fish Characteristic of the Pascagoula River Basin

American Eel	Blue Catfish
Chain Pickerel	Brindled Madtom
Mooneye	Speckled Madtom
Redfin Pickerel	Tadpole Madtom
Northern Hog Sucker	Freckled Madtom
Sharpfin Chubsucker	Balckspotted Topminnow
Blacktail Redhorse	Musquitofish
Smallmouth Buffalo	Brook Silverfish
Quillback	Banded Pygmy Sunfish
River Carpsucker	Longear Sunfish
Bullhead Minnow	Dollar Sunfish
Pugnose Minnow	Bluegill
Golden Shiner	Spotted Bass
Longnose Shiner	Largemouth Bass
Blacktail Shiner	Rock Bass
Common Shiner	Redear Sunfish
Weed Shiner	Black Banded Darter
Emerald Shiner	Speckled Darter
Cherryfin Shiner	Harlequin Darter
Silverjaw Minnow	Mud Darter
Speckled Chub	Gulf Darter
Silver Chub	Naked Sand Darter
Redeye Chub	Logperch
Bigeye Chub	Striped Mullet
Channel Catfish	Hogchoker

Source: Dames and Moore, 1979, p. 3-16.

5.5.5.2 Ecosystems Crossed by Pipelines and Near Proposed DOE Terminal

Development of the Richton site would necessitate construction of several pipelines, including an 82-mile, dual-purpose 42" brine/crude oil pipeline to Pascagoula and a 10-mile raw water intake pipeline to the Leaf River. Oil distribution alternatives include construction of a 118-mile, 36" crude oil fill and distribution pipeline to the Capline pipeline near Liberty, Mississippi, construction of a 70-mile 24" crude oil fill and distribution pipeline to Ten-Mile Terminal near Mobile, Alabama, and construction of a DOE terminal at the old Jackson County Airport site, and several connective pipelines associated with docks and refineries in the Pascagoula area. The pipeline routes are shown in Figures 3.5-2 and 3.5-5, and the ecological areas of interest along these pipelines are briefly discussed below. Several federally-listed threatened or endangered species have been identified as of concern by USFWS and potential impacts are assessed in Appendix F.

Table 5.5-8
Plant Species Typical of Freshwater Marsh Communities in Mississippi and Alabama

Anchistea virginica	milk weed	black gum
Batis maritima	groundsel-bush	regal fern
Boltonia asteroides	begger ticks	phragmites
Fimbristylis spadicea	cutgrass	marsh fleabane
Ludwigia sphaerocarpa	spike rush	pickerel weed
Prosperpinaca pectinata	square leaf spike rush	knotweed
Rubus betulifolius	spider lily	beak rush
	St. Johns wort	arrow head
	morning glory	lizard tail
	sea lavender	water parsnip
	loosestife	green briar
	wax myrtle	cattail
		wild rice

Source: Dames and Moore, 1979, p. 3-42.

Dual-Purpose Pipeline to Pascagoula

The dual-purpose pipeline proceeds south from the site for about six miles, crossing a hilly area which has numerous intermittent creeks that appear to drain to Bogue Homo to the west. The pipeline then proceeds east and then south along the existing Plantation pipeline ROW to Pascagoula. It crosses through small segments of palustrine forested, broad-leaf deciduous wetland as it travels roughly parallel to and east of the Leaf River. It crosses the Chickasawhay River just above its confluence with the Leaf River; below this confluence, the river is referred to as the Pascagoula River. The wetlands become more numerous and extensive near Pascagoula, where a transition occurs from palustrine forested to palustrine scrub-shrub, and finally to estuarine intertidal emergent wetlands. Before reaching the Bangs Lake area, the pipeline crosses to the west and parallels the road along the western border of the Chevron refinery, before the brine only segment proceeds out to the Mississippi Sound. Sixteen species of endangered or threatened species are listed in the four counties (Perry, Greene, George, and Jackson) in which the pipeline route is located (Appendix D).

Pascagoula Area

Development of the Pascagoula area could necessitate the construction of several connective pipelines that would attach to or run parallel to the dual-purpose 42" brine/crude oil pipeline. A 42" oil pipeline would be constructed going east from a meter located on the southern end of Greenwood Island, crossing first a small segment of estuarine intertidal emergent wetlands, then Bayou Casotte Channel, an impounded area supporting palustrine emergent wetlands, and finally developed upland areas before connecting to the 42" brine/crude oil pipeline at a point just south of the boundary of the Chevron Refinery. Two short spurs of 30" oil pipeline would be built from meter stations west of the refinery; these would attach to a 30" oil pipeline that would be built parallel to the 42" brine/crude oil pipeline as it runs along the

Table 5.5-9
Endangered and Threatened Species Within A One-Mile Radius of the Proposed Richton Site

Common Name	Status
Eastern indigo snake	FT, SE
Black pine snake	SE
Red-cockaded woodpecker	FE, SE
Gopher tortoise	FT, SE

Source:
Mississippi Natural Heritage Program (1991).
FT=Federal threatened
FE=Federal endangered
ST=State threatened
SE=State endangered

western boundary of the Chevron Refinery. Of these pipeline sections, the proposed southern meter hook-up would cross a section of palustrine scrub/shrub wetlands. The other two sections of 30" oil pipeline would be placed in developed upland sections of the Pascagoula area.

A 42" oil pipeline would connect to the 30" oil pipeline group and would run from the north-western corner of the Chevron Refinery east along the ROW established for the 42" brine/crude oil pipeline. This oil pipeline would parallel the brine/crude oil pipeline, proceeding north before entering the Bangs Lake area. A mile north of the Chevron Refinery, the 42" oil pipeline would proceed west in order to attach to the proposed DOE terminal. A 12" oil pipeline also would parallel this 42" oil pipeline from within the Chevron Refinery to the proposed terminal. The section of Pascagoula to be crossed by the 42" and 12" oil pipelines consists of palustrine forested wetlands (directly north of the Chevron site), and mainly palustrine emergent wetlands with a developed upland areas as the pipeline continues north to the terminal. The proposed DOE terminal would be located on a sixty acre upland portion of the old Jackson County airport area.

Fourteen endangered or threatened species are listed in Jackson County which includes the Pascagoula area (Appendix D). In the general Pascagoula area, the combination of vegetated wetlands and open waters provide optimum habitat for many commercially and ecologically important species. Aquatic and wetland areas provide important spawning, nursery, and feeding habitat for a major portion of the marine and freshwater finfish and shellfish species; vegetated areas support diverse wildlife species. Wetland areas also play an important role in assimilating pollutants (e.g., metals, PCBs, and pesticides) originating in the highly industrialized Port of Pascagoula. Within the Pascagoula area associated with the proposed SPR expansion, the undeveloped estuarine emergent and scrub/shrub wetlands located directly south of the Chevron Refinery have been identified as an area of special concern by the Mississippi Coastal Program Special Management Area Task Force.[314]

The Bangs Lake area to the east of the Pascagoula area is an estuarine system composed of three parts: the open water of the lake itself (approximately 525 acres); a surrounding broad belt of salt marsh (approximately 2,275 acres); and wooded regions to the north and west that drain into the estuary (approximately 1,300 acres). The open water of Bangs Lake is used by wildlife during fall waterfowl migrations. A total of 20 species have been identified in a waterfowl census, nearly all of which were wading and shorebirds. Bangs Lake also receives some pressure from sport fishing, contains 20 acres of public oyster reef, and appears to play an important role as a fish nursery and spawning area. The marsh surrounding the lake is a highly productive wildlife habitat. Extensive use is made of the marsh by wading and shorebirds, songbirds, hawks, nutria, muskrats, and rice rats. Vegetation is dominated by blackrush, although patches of saltmeadow cordgrass and saltwort-saltgrass occasionally occur. The wooded areas to the west and north have experienced varying degrees of disturbance, and now consist mainly of slash pine forests and pine savannahs.[315]

The Bangs Lake area has been described as a unique natural area within the Mississippi coastal zone and is presently protected as the Bangs Lake Wildlife Management Area and the Grand Bay National Wildlife Refuge. In addition, in accordance with a plan being advanced by a Mississippi Congressional representative and being supported by the Nature Conservancy, there is interest in acquiring additional protected land north of Bangs Lake and expanding the Grand Bay National Wildlife Refuge. The newly acquired area would be combined with the existing area to form the Grand Bay Bioreserve. The proposed dual-purpose pipeline bordering the Chevron Refinery in Pascagoula would effectively avoid all of these protected areas.

Brine Disposal Pipeline from Pascagoula to Gulf

As shown in Figure 3.5-2, the proposed brine disposal pipeline for the Richton site would leave the shore on the western side of Pt. aux Chenes, bear south-southwest across Mississippi Sound, and go through Horn Island Pass before ending at the diffuser in the Gulf of Mexico. The coastline of Pt. aux Chenes in the area traversed by the proposed pipeline is made up by exposed, narrow bands of salt marsh subject to ordinary tidal inundation with elevated lands located behind these bands. In some areas, a narrow sandy beach may occur between the bands of marsh and the elevated lands. Just offshore but to the east and north in Pt. aux Chenes Bay, there are extensive seagrass beds and associated algal communities. A common seagrass species that exists in Mississippi Sound is shoal grass. Seagrass beds also exist on the north side of Horn and Petit Bois Islands, within the Gulf Islands National Seashore. No seagrass beds, however, exist in Horn Island Pass or to the south of Horn and Petit Bois Islands in the vicinity of the proposed brine pipeline and diffuser. In addition, no oyster beds exist in the affected areas, either in the nearshore environment or farther offshore around the barrier island chain that separates Mississippi Sound from the Gulf of Mexico.[316] A great abundance of fish species, however, exists in the area, as commercial fisheries have long been an important part of the economy of coastal Mississippi. Menhaden and shrimp represent the most valuable fishery resources.[317]

Twenty-two endangered or threatened vertebrate species are listed in the eastern Gulf of Mexico (Appendix D). Species most likely to be found in nearshore areas include Atlantic, Gulf, and pallid sturgeons and Kemp's Ridley and loggerhead sea turtles. Waters off the Chandeleur Islands of Louisiana and Mississippi are important feeding grounds for Kemp's Ridley turtles; loggerhead turtles are known to breed on these islands. In addition, there is one sand beach location in Horn Island Pass that serves as a nesting area for the least tern, which has a threatened status.

Crude Oil Pipelines

There are two major pipelines in addition to the dual-purpose pipeline to Pascagoula, which are part of the various crude oil distribution options being assessed for Richton: a pipeline to the Capline pipeline near Liberty, and a pipeline to the Ten-Mile Station in Mobile, Alabama. The ecological areas of interest crossed by these two alternative routes are discussed below.

Pipeline to Liberty. The pipeline to Liberty would proceed south from the site for a short distance, sharing the same ROW as for the dual-purpose pipeline, and would then branch off to the west. The pipeline would not cross through any wildlife refuges, but it would cross Percy Quinn State Park just north of Lake Tangipahoa, which may be an area of ecological interest. Fifteen species of endangered or threatened species are listed in the counties (Amite, Pike, Walthall, Marian, Lamar, Forest, and Perry) through which the pipeline would cross (Appendix D). At Liberty Station, a tank farm covering approximately 30 acres would be cleared and constructed at a location to be determined. A non-wetland area would be selected.

Pipeline to Mobile. The pipeline to Mobile would proceed south from the site, sharing the same ROW as the Pascagoula pipeline for approximately 36 miles, and then branching off to the east for the remaining 22 miles. This pipeline does not cross through any wildlife refuges, national or state parks, or any other areas of potential ecological concern. No areas of ecological concern have been identified along the proposed pipeline route by any Alabama state agencies.

Raw Water Pipeline to Leaf River

The ten mile raw water pipeline would proceed due south to the Leaf River. This area is primarily upland, and the area that would be crossed by the pipeline is fairly flat for the last two miles before reaching Leaf River. The De Soto National Forest is roughly two miles south of the RWI structure at the Leaf River. Seven endangered or threatened species are listed in Perry County, within which the RWI intake and pipeline route would be located (Appendix D).

Pipeline to Brine Injection Field and Hess 10-inch Oil Pipeline Connection

The 13.6-mile pipeline from the site to the brine injection field would proceed west from the site for a few miles, and then northwest, all within Perry County and Jones County. It would connect with the Hess 10-inch oil pipeline 10.6 miles from the site. The area that would be crossed is primarily upland, although the pipeline would cross numerous small tributaries, Tallahalla Creek, and the Bogue Homo River. The pipeline would not cross any wildlife refuges, national or state parks, or other similar areas of ecological concern.

5.5.5.3 Ecosystems Near the Brine Diffuser in the Gulf of Mexico

Over 900 species of diatoms and 400 species of dinoflagellates have been recorded in the Gulf, with the greatest diversity occurring near river discharges. Diatoms such as *Nitzschia seriata*, *Thalassiothrix frauenfeldii*, *Thalassionema nitzshioides*, and *Skeletonema costatum* are the most common phytoplankton; common dinoflagellates include *Ceratium*, *Glenodinium*, *Goniodoma*, and *Pyrocystis*. The dominant zooplankton are copepods.[318]

Benthic organisms would be most affected by brine disposal. The dominant macroinfaunal organisms at sampling stations in the Mississippi Sound offshore area are polychaetes.[308] An Army Corps of Engineers study has defined two benthic habitat types in this area: offshore mud bottom and offshore muddy sand. The mud bottom community is dominated by five polychaetes, one crustacean (*Oxyurostylis*), one sipunculid (*Golfingia*), and one nemtean (*Cerebratulus*). The muddy sand community occurs in deeper water and is dominated by six polychaetes and the sipunculid (*Golfingia*). Two molluscs (*Tellina* and *Turbonilla*) are common in this area.[309]

Nearshore areas are very important for fish. It has been estimated that 96 percent of fish caught south of the 72-foot contour line spend part of their life-cycle in nearshore environments.[310] MMS found 128 species of demersal (bottom-dwelling) fish representing 49 families in the Mississippi Sound offshore area, and found greater numbers and diversity of these fish at a site approximately ten miles from the proposed diffuser site, than at most other sites. Fish most commonly found at near the proposed diffuser area include *Bregmaceros atlanticus*, least puffer, blackcheek tonguefish, dwarf sand perch, and striped anchovy.[311]

A number of artificial reefs occur within approximately ten miles from the proposed diffuser site. These reefs provide habitat for fish species such as grouper, snapper, and triggerfish, which would not otherwise be found in this sandy-bottomed area.[312]

The proposed diffuser site may be an important area for shrimp.[313] Two commercially important species of shrimp (brown shrimp and white shrimp) are abundant in Mississippi Sound and the Gulf. Shrimp spawn in offshore waters from November to April (brown) and March to October (white). Postlarvae move to marshy bottom estuarine areas in February to April (brown) and May through October (white). Juveniles and adults migrate offshore from May to August (brown) and June to November (white).[314]

Twenty-two endangered or threatened vertebrate species are listed in the eastern Gulf of Mexico (Appendix D). However, only a few of these species are considered common to the area around the brine diffuser. Kemp's Ridley sea turtles may be found around oil rigs and banks, and the waters off the Chandeleur Islands are important feeding grounds for this species. Potential impacts are considered in the marine biological assessment in Appendix E.

5.5.6 Floodplains

An SPR site at Richton would cover approximately 300 acres at an elevation of 60 to 80 meters above msl. The proposed site at Richton is entirely outside any floodplains.[315] The proposed Richton site would, therefore, require no further floodplains assessment.

Any path chosen for crude oil fill/drawdown or brine disposal would cross a floodplain (most likely the Bogue Homo Creek and the Leaf River).[316] The proposed raw water intake structure location on the Leaf River is in a floodplain. In addition, the proposed tank farm located northeast of Pascagoula is also in a floodplain.[317]

5.5.7 Natural and Scenic Resources

The terrain in the area of the proposed Richton site is gently rolling in a rural setting, close to a National Forest and an undeveloped river. The restricted area has been cleared of forest vegetation during timber harvesting; this clear-cutting and the resulting barren landscape are common in the region. Visually, the dome is not unique compared to the surrounding area. The Leaf River is located approximately seven miles south of the proposed site.

A portion of De Soto National Forest containing the Chickasawhay Wildlife Management Area is located approximately three miles north of the dome. The De Soto National Forest, 3.5 miles from the center of the Richton site, is administered by the Forest Service. The Leaf Wilderness, comprising approximately 940 acres, is located in the De Soto National Forest. The Black Creek Wilderness, also located in the De Soto National Forest, comprises about 4,560 acres and is located approximately 13 miles west of the Leaf Wilderness. The Richton site is approximately 25 miles north of both the Leaf and Black Creek Wilderness Areas.

The proposed site does not contain land within the National Wildlife Refuge System. There are no designated, proposed, or potential National Park, National Recreation, National Historic or National Scenic Trails within a 20-mile radius of the Richton site.

5.5.8 Archaeological, Historical, and Cultural Resources

The proposed SPR site lies within the Pine Hills region, perhaps one of the least studied portions of Mississippi, in terms of cultural resources. No cultural resource investigations are known to have been conducted within the dome area or the immediate vicinity. No sites are listed in, nominated for, or evaluated as eligible for inclusion in the National Register of Historic Places. Three archaeological resource sites in the project vicinity (Site 22PE552, Site PE599, and Site PE593) are on file in the State of Mississippi Department of Archives and History, Division of Historic Preservation. The State knows very little about one site (PE599). A second site has been dated to about 300-900 AD, and may be eligible for the National Register of Historic Places (22PE552). The last site (PE593) is severely eroded, and is not eligible for the Register. These sites are more than one mile to the north and west of the proposed site.[329]

There is potential for some archaeological, cultural, and historic resources in the dome area, although various physical and cultural factors suggest that this potential is low. Because of previous plowing and logging activities in the area, it is doubtful that undisturbed archaeological resources would be found on the land surface; however, buried remains are possible.[330]

Several known or unrecorded sites may occur near the proposed pipeline routes. Of these, the sites that appear to be closest to the proposed ROW are near Ragland, Mississippi (Site 598, Site FO607), near Okahola, Mississippi (Site LM519), and near Merrill, Mississippi (Site PE513, Site PE514).[331]

5.5.9 Socioeconomics

The Richton salt dome is located in Perry County in southeastern Mississippi. SPR development is likely to affect an eight county region around Richton consisting of Perry, Forrest, Jones, Lamar, Wayne, Greene, George, and Stone Counties. The largest city in the region, Hattiesburg, is located in Forrest County about 25 miles west of the site. Forrest and Lamar Counties are west of the site, Jones County is to the north, Wayne and Greene are to the east, and Stone and George Counties are to the south of the site.

5.5.9.1 History and Cultural Patterns

The Choctaw Tribe occupied this area of southeastern Mississippi when the Spaniard, Hernando de Soto, first arrived in 1540. In the two centuries that followed, European influence included French, English, and Spanish control of the region until 1798, when the area became recognized as the Mississippi Territory under the newly formed United States. Scottish settlers arrived from the mid-Atlantic states and spread their Gaelic language and culture to southeastern Mississippi. Gaelic influence dominated the culture until the 1820s, when large numbers of English-speaking settlers entered the area. Throughout this period, the number of Choctaws lessened dramatically as a result of European settlement; the tribe ceded its land to the U.S. in 1805 and, by 1840, had almost completely resettled in Oklahoma.

Mississippi was admitted to the union in 1817; three years later Perry County, originally part of Washington County, was formed. Africans and African-Americans were brought to Mississippi as slaves to work on the growing number of cotton plantations arising in the early 1800s. Settlers in the Piney Woods region, however, were not successful producing cotton in the area and instead turned to cattle grazing and small farming.

After the Civil War, lumber production replaced farming as the major industry, and production peaked between 1904 and 1915. Several towns were formed during this boom in the forestry industry; one of which was the village of Rich's Mill. In 1902, Rich's Mill changed its name to Richton after relocating closer to a railroad line south of Laurel. After a 25-year decline, the timber industry strengthened once again, and diversified its products to include particle board, plywood, and paper. Today, production of wood and wood products remains the leading industry in the region.

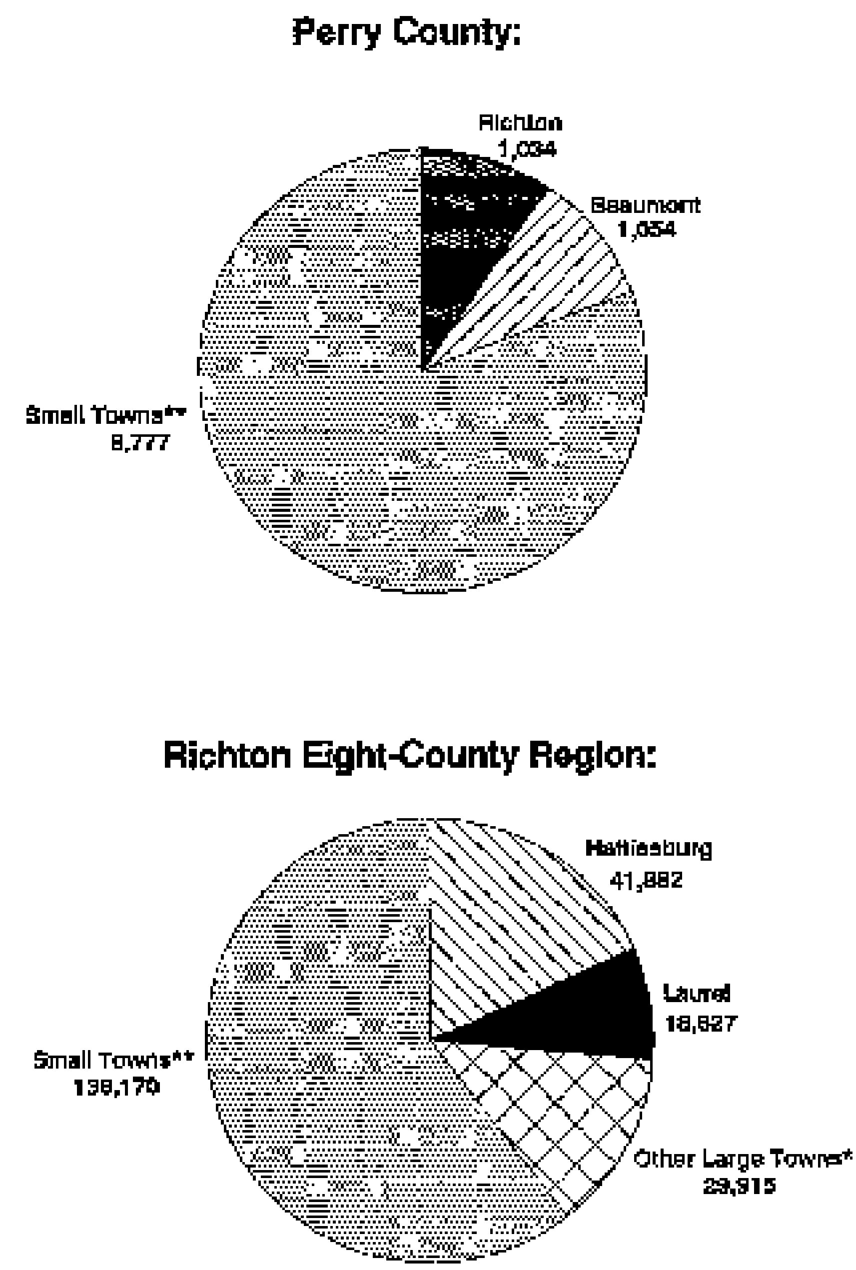
The Choctaw Native American Tribe is located in Philadelphia, Mississippi. The tribe has 21,000 acres spread over seven counties in Mississippi. The major portion of the land is located in Philadelphia, some 80 miles northwest of the Richton site. The portion of tribal land closest to the proposed site is located along the Pearl River, in Jones County. This land is 25 miles northeast of the site, but the Native Americans are not expected to be concerned with SPR development.

5.5.9.2 Population

The population within the Richton region grew from 215,590 to 228,794 people during the 1980s, an increase of six percent. Most of the population growth occurred in small towns and rural areas rather than in cities and large towns. For example, during the last decade, the population decreased in about 75 percent of the towns with populations greater than 1,000. Figure 5.5-5 illustrates the population distribution for Perry County and for the entire Richton region.

Although most of the region experienced greater population growth in the 1970s, Perry County actually grew at a slightly faster rate in the 1980s, increasing by ten percent compared to the nine percent growth during the 1970s. The county, however, remains primarily rural; the two largest towns in Perry County, Beaumont and Richton, each have a population of about 1,050. Richton lies in the north-central section of the county, and Beaumont is located about 15 miles to the south. New Augusta, the Perry County seat of government, has a population of fewer than 700. None of Perry County's population is urban.[332]

Figure 5.5-5
Population Distribution in Perry County and the Richton Region, 1990



* Towns with populations between 1,000 and 10,000 residents
** Towns and unincorporated areas with populations less than 1,000 residents

Source: STF-1A, Selected Highlights of the 1990 Census, Table 1.
U.S. Department of Commerce, Bureau of Census.

Forrest and Jones Counties contain four of the five largest cities and towns in the eight-county region. Hattiesburg, located in Forrest County about 25 miles west of the Richton site, is the largest city in the region with a population of 41,882, and is one of the few cities in the region to experience growth in the 1980s. Petal, a town of almost 8,000 people, is located east of Hattiesburg, but within the same urban area.

The population of Jones County has remained at about 62,000 since the end of the 1970s. Laurel, located approximately 25 miles north of Richton in Jones County, has a population of 18,827 and is the second largest city in the region. Together, the Forest and Jones Counties account for over half the population in the entire eight-county region.

Lamar County, with a population of 30,400, has sustained population growth over the last two decades, doubling in size since 1970. George and Stone Counties, located to the south of the Richton salt dome, have grown about ten percent in the last decade. The populations of Wayne and Greene Counties, east of the proposed site, grew two and four percent, respectively, in the 1980s.

5.5.9.3 Economic Activities

The work force in the Richton region in 1990 consisted of about 97,510 workers, of which approximately 3.5 percent, or 3,410 workers, were employed in Perry County. With the exception of 1990, total employment for Perry County has generally declined since 1985.[333]

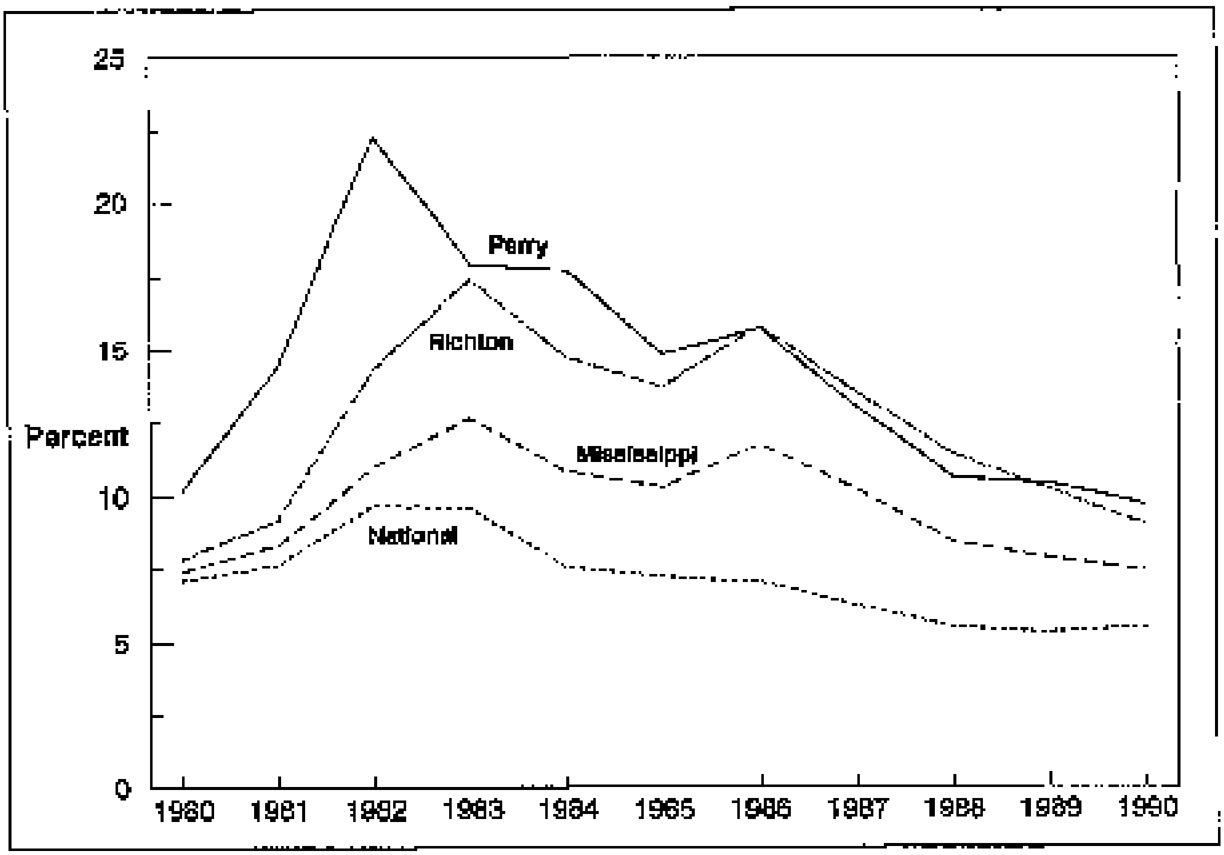
The decline in total employment for Perry County mirrors the trend for the Perry County work force over the same time period. The Perry County work force rose from a low of 3,050 in 1981 to a peak of 4,340 workers in 1984. With the exception of a sharp increase in 1990, the work force has since declined.[334]

The unemployment rate for Perry County declined to a low of 9.7 percent in 1990, but remained above the state's average unemployment rate of 7.4 percent and the national rate of 5.5 percent for 1990. Nonetheless, this represents a significant improvement from the county's worst unemployment rate of 22.3 percent in 1982. The Perry County unemployment rate for the years 1980 through 1990 is compared to the national and state unemployment rates for the same time period in Figure 5.5-6.

Since 1984, the per capita income for Perry County has lagged behind the national figure by approximately 40 percent. Although per capita income grew in Perry County from $8,538 in 1984 to $10,476 in 1989, a 22.7 percent increase, the national per capita income average grew from $13,116 to $17,592 during the same period, a 34 percent increase.

Forestry and the manufacture of wood products have are the dominant industries in the Richton region; particularly in Perry County, where the town of New Augusta has been the regional center of commercial timber activity for many years. The oil and gas industry, centered in the town of Laurel in Jones County, is another important industry in the region. The oil and gas industry experienced strong growth in the late 1970s, followed by significant retrenchment in the 1980s. However, the industry is currently showing modest growth and has provided new employment opportunities for workers in the region. In addition, food and poultry processing, as well as metal-working, have been identified as strong growth industries for the region.[335]

Figure 5.5-6
Unemployment Rate in the Richton Region, 1980-1990



Source: Mississippi Employment Annual Average Data, 1980-1990. Mississippi Employment Security Commission.

Approximately 40 percent of Perry County's workers are employed by establishments outside the county. Commuting pattern data for 1990 indicate that many workers from the Perry County travel to Forrest County to work for such major employers as the University of Southern Mississippi and the Forrest General Hospital, the region's major medical center. Forrest County has experienced significant economic growth over the past ten years.

The commuter data also indicate that a significant number of workers travel south, presumably to work in the shipbuilding industry in Pascagoula, to work at the State's primary international port, or in the production of electric transformers at the Gulf Port.[336]

Significant industrial operations within Perry County include a sand and gravel company, a pole and piling company, a concrete operation, a tank company, and one manufacturing operation. In addition, there are three wood-related operations: Hood Industries, a plywood manufacturing plant; American Wood, a wood-block flooring manufacturer; and Leaf River Forest Products, a pulping and lumber operation.

Total earnings for the Richton region in fiscal year 1989 were $1.7 billion, or about $17,500 per worker, with the highest earnings found in the government and manufacturing sectors. Total earnings for Perry County in fiscal year 1989 were $66 million, or about $19,000 per worker, with the highest earnings found in the manufacturing sector. Summaries of earnings and employment levels by industrial sector for both the eight-county region and Perry County are found in Figures 5.5-7 and 5.5-8, respectively.

5.5.9.4 Transportation

The Richton's site location in southeastern Mississippi is roughly central to four cities: New Orleans, Louisiana, about 140 miles to the southwest; Mobile, Alabama, 75 miles to the southeast; and Jackson and Meridian, Mississippi, 90 miles to the northwest and about 60 miles to the northeast, respectively. For a map of the transportation systems in the Richton region, see Figure 5.5-9. Interstate 59 is the major highway in the area, running north to south and connecting Meridian with New Orleans. Both Hattiesburg and Laurel, the two largest cities in the Richton region, are located along Interstate 59. State Route 11 parallels Interstate 59 and provides another route between Hattiesburg and Laurel.

The salt dome lies two to three miles west of the town of Richton and borders the northern portion of Route 42's ROW. State Route 42 connects Hattiesburg to Richton running through the towns of Petal and Runnelstown. Route 42's road surface consists of asphalt with a gravel base. Currently, no paved access road exists to the site. Route 15 completes the triangle by connecting Richton with Laurel.

Route U.S. 98 runs from Hattiesburg to Mobile and bisects Perry County south of Richton. The southern portion of De Soto National Forest lies in the county's southern half, while most of the towns in the county are located north of U.S. 98. The town of Beaumont is 15 miles south of the site at the intersection of U.S. 98 and Route 15. New Augusta, located seven to ten miles west of Beaumont on U.S. 98, lacks a direct major route to the site. The case of Waynesboro is similar; this town of 5,100 lies on the opposite side of De Soto National Forest (northern portion) without a state route connecting the two points. Table 5.5-10 summarizes road characteristics and traffic statistics for potential routes from these towns and cities to the Richton site. Cities and towns of origin reflect areas of heaviest density within a 30-mile radius of the

Figure 5.5-7
Perry County Industry Earnings and Workforce, 1989

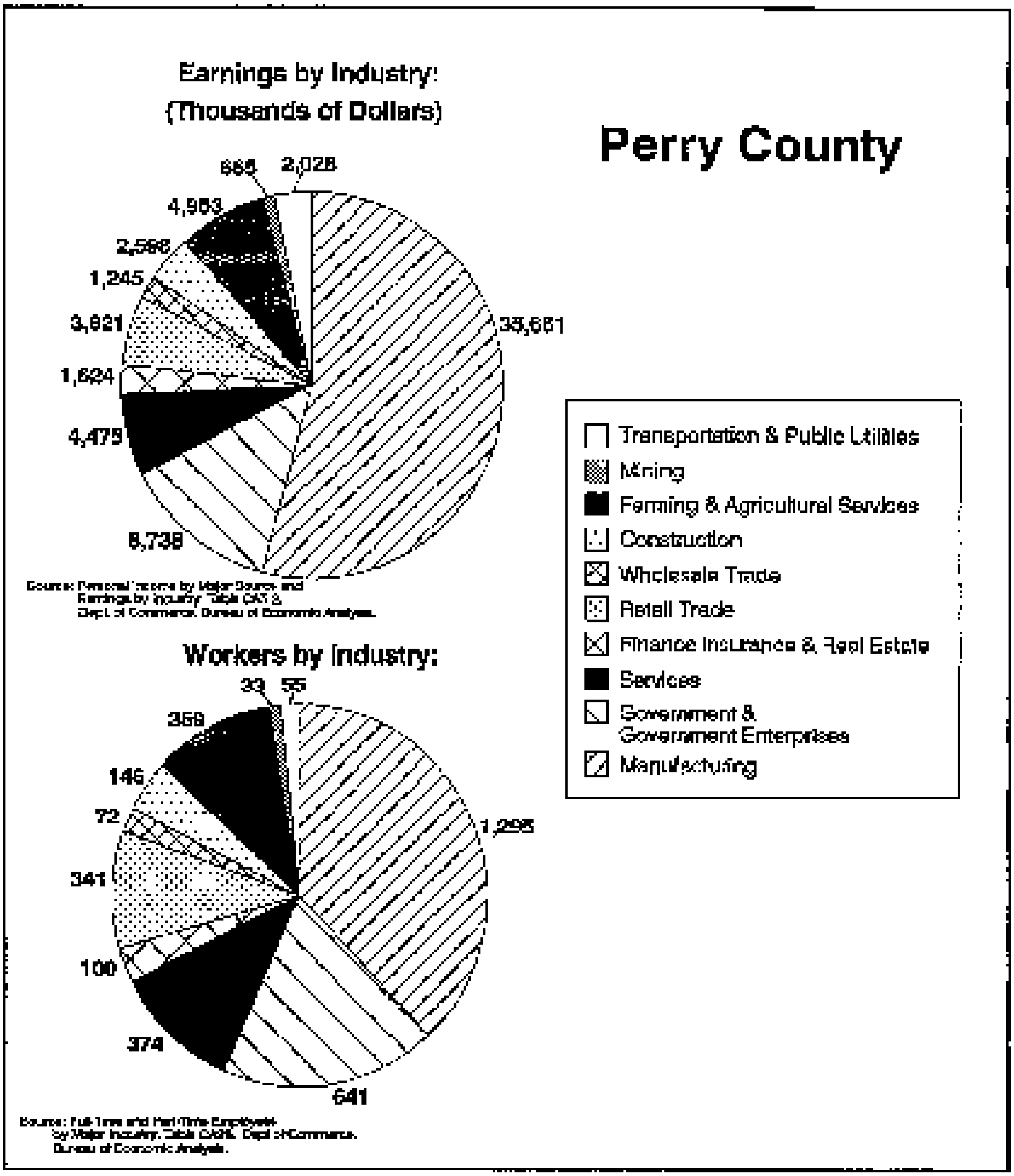


Figure 5.5-8
Richton Eight-County Region Industry Earnings and Workforce, 1989

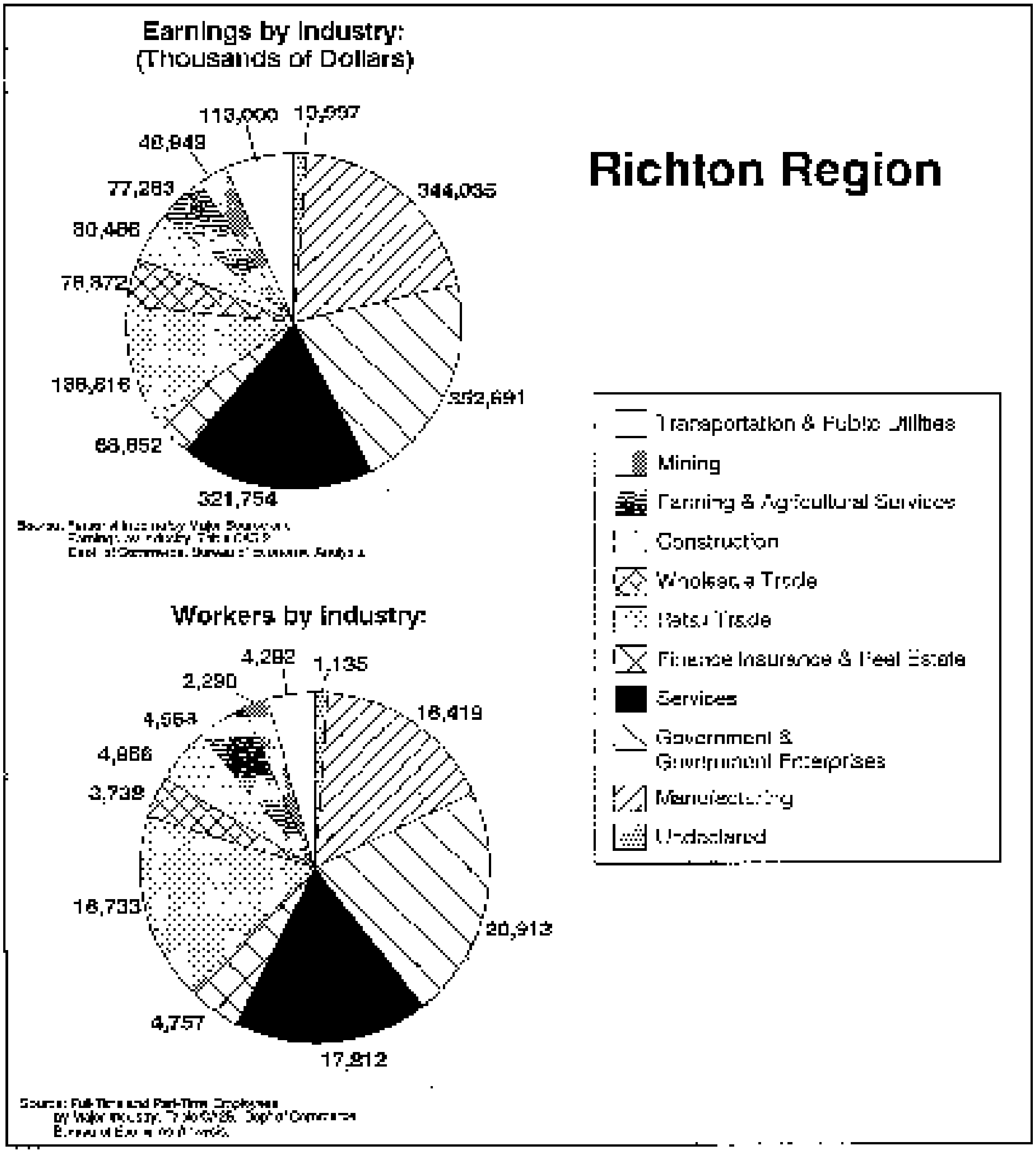


Figure 5.5-9
Transportation Systems in the Richton Region

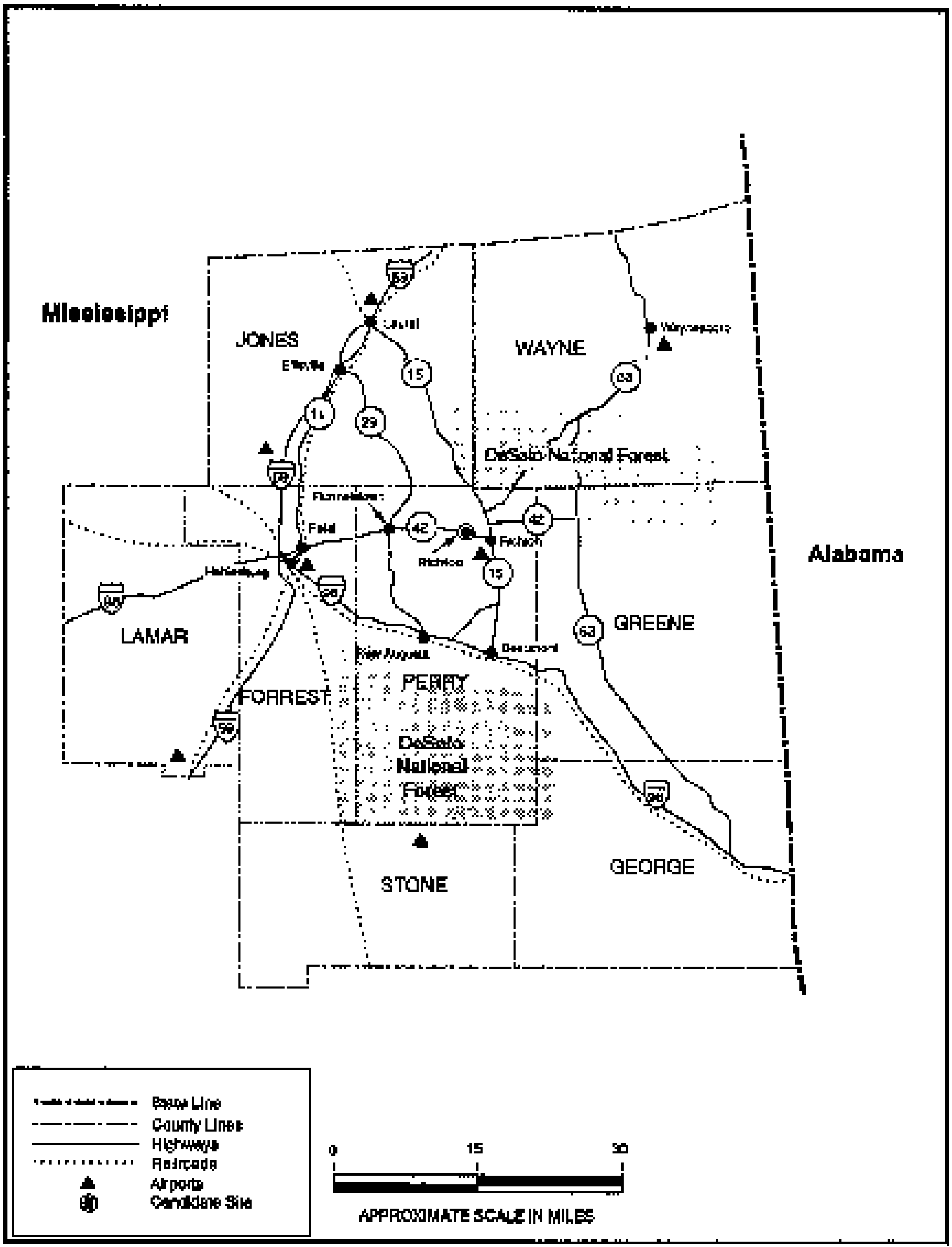


Table 5.5-10
Road Characteristics and Traffic Statistics for Likely Commuting Routes to Richton

City/Town of Origin	Route(s)	Distance (miles)	No. of Lanes, Road Width	Daily Vehicle Counts[a] (1990)	Vehicle Capacity	% of Trucks	Number of Accidents (1990)
Richton	Route 42W to site	1.9	2 lanes, 20 feet	2,260	1,473	13	NA
Hattiesburg/Petal/ Runnelstown	Route 11N to 42 Route 42E to site	0.4 18.6	4 lanes, 48 feet 2 lanes, 20-22 feet	6,100 2,260 - 15,630	2,660 1,435 - 1,921	4 9 - 14	NA
Laurel	15S to 42 42W to site	25.5 1.9	2 lanes, 24 feet 2 lanes, 20 feet	1,660 - 6,980 2,260	1,768 1,473	10 13	NA
Beaumont	15N to 42 42W to site	12.3 1.9	2 lanes, 24 feet 2 lanes, 20 feet	1,400 - 2,800 2,260	1,526 1,473	16 13	NA
New Augusta	US 98E to Wingate Road Wingate Road N to 15 15N to 42 42W to site	2.2 6.6 1.9	2 lanes, 24 feet 2 lanes, 20 feet 2 lanes, 24 feet 2 lanes, 20 feet	5,090 400 - 450 1,400 - 1,920 2,260	1,532 NA 1,526 1,473	18 NA 16 13	NA
Waynesboro	63S to DeSoto National Forest Access Road to 15 15S to 42 42W to site	11.2 13.2 NA 1.9	2 lanes, 20 feet 2 lanes, 20 feet 2 lanes, 24 feet 2 lanes, 20 feet	510 - 6,350 360 - 600 2,610 - 6,980 2,260	1,716 NA 1,768 1,475	8 NA 10 13	NA
Ellisville	29S to 42 42E to site	19.2 8.7	2 lanes, 22 feet 2 lanes, 20 feet	950 - 3,150 2,260 - 2,470	1,750 1,435	10 14	NA

NA = Data were not available from Mississippi State Highway Department.

[a] Average number of vehicles traveling on road during 1990. Range is indicated where data for more than one point of the segment were available.

Source: Average Daily Traffic Flow for 1990. Mississippi Department of Highways. Selected Roadway Information. Mississippi Department of Highways, Highway Planning Division, 1992.

Richton site. Commuter routes in the table were chosen based on minimizing the distance between the town of origin and the site.

All of the roads specified as likely commuting routes, with the exception of a number of posted limit bridges, have been designed to carry a legal gross load of 80,000 pounds. Sixteen bridges have weight limits posted lower than 80,000 pounds along these routes. Rather than classifying the condition of each bridge structure, the Mississippi State Highway Department reduces the legal gross load on posted limits for each bridge. The nearest bridge structure to the site, with a posted limit of 52,000 pounds, is located on Route 42 over the Bogue Homo Creek approximately five miles west of the town of Richton. The lowest posted limit of the sixteen bridges is 15,700 pounds for a structure located on Route 15 over the Leaf River about a mile north of Beaumont. Construction will begin in 1993 to replace five bridges at Bogue Homo Creek on Highway 15 between Laurel and Richton.

There are no major navigable waterways within the eight-county region surrounding the Richton site. The ICW is 100 miles south of Richton near Pascagoula and Gulfport, two international port cities with ocean vessel and barge port capabilities. Almost 16,000 vessels travelled on the ICW between Mobile, AL, and the Mississippi River in 1989.[337] The Mississippi River runs along the western border of the state, and branches at Vicksburg into the Yazoo River. Both of these rivers serve barge and related traffic. The Tennessee-Tombigbee Waterway serves the northeast portion of the state and feeds into the Tennessee River.[338]

One commercial airport and six smaller airstrips serve the eight-county region surrounding the Richton site. Pine Belt Regional Airport is located approximately halfway between Hattiesburg and Laurel off of Interstate 59 (about 35 miles away). This airport has a 6,500-foot by 150-foot runway and provides daily commuter flights to Atlanta and Memphis. In addition to Pine Belt Regional Airport, there are municipal airports in Hattiesburg and in Laurel, and an attended airstrip in Wayne County. There are three smaller unattended airstrips located in the region, including a 3,000-foot airstrip in Richton.[339]

There is no rail service within the town of Richton; an abandoned rail line runs south from Laurel through Richton. Three rail lines, all of which intersect in Hattiesburg, do provide rail service to the region. The Illinois Central Gulf (ICG) railroad runs daily northwest-southeast from Jackson through Hattiesburg to Mobile, Alabama; in Perry County, the ICG runs along U.S. 98 through both New Augusta and Beaumont. The Norfolk Southern System follows a northeast-southwest route from Meridian, Mississippi to New Orleans, Louisiana, crossing the ICG in Hattiesburg. Midsouth Rail provides rail service from Hattiesburg to Gulfport on the coast.[340]

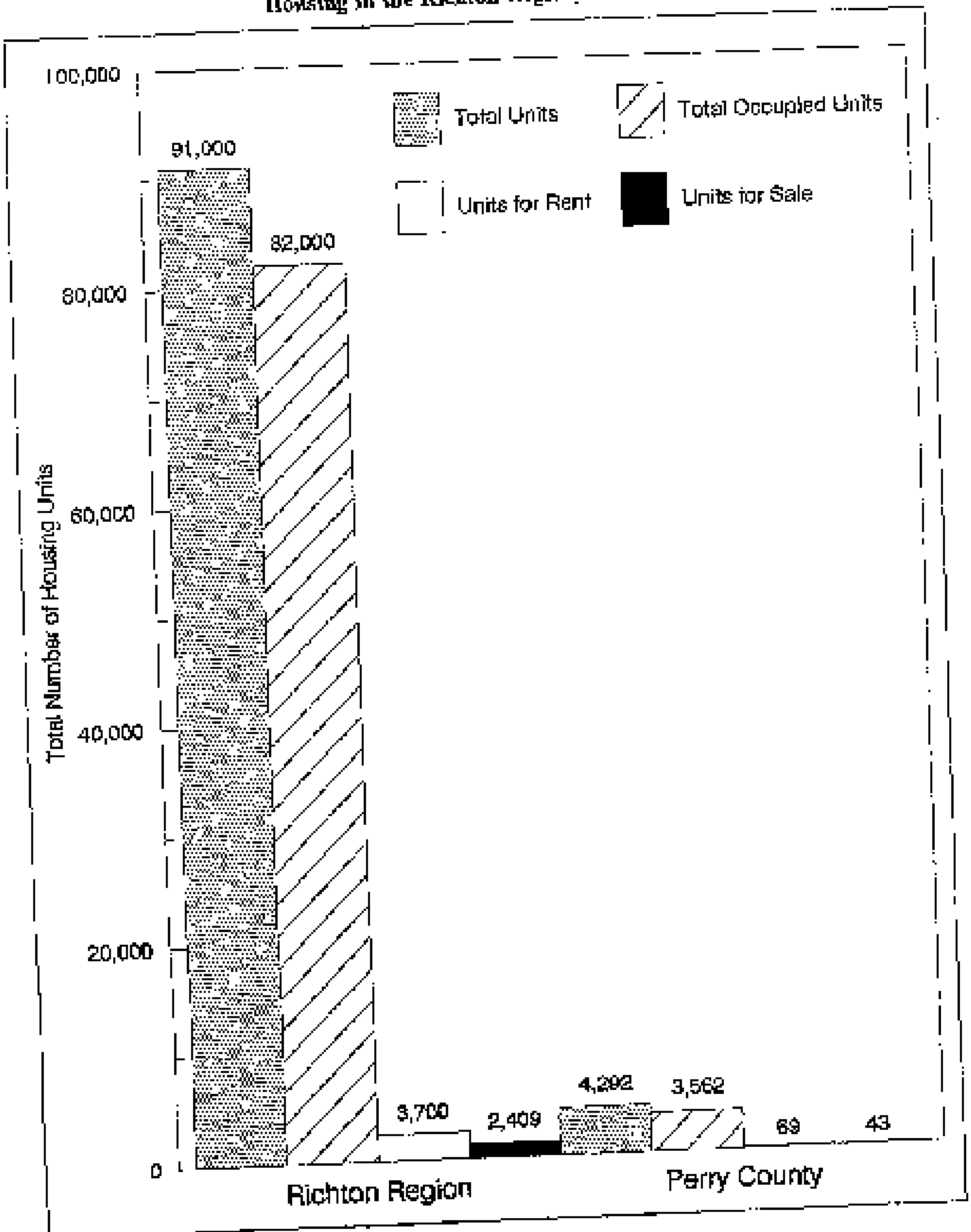
Between eight and twelve motor freight carriers provide services to the Richton area and to Perry County. Although no municipal bus lines are available in Richton, one commercial bus line does service the area.

5.5.9.5 Housing and Public Services

Housing

There are approximately 91,000 housing units in the Richton region. Of this total, about 82,000 or about 90 percent, were occupied during 1990 (Figure 5.5-10). The remaining units were

Figure 5.5-10
Housing in the Richton Region, 1990



Source: U.S. Department of Commerce, Bureau of the Census, 1990.

vacant because they were being offered for rent or sale, used seasonally for vacation or second homes, or used for migratory workers. Of the occupied units, approximately 73 percent were owner-occupied and 27 percent were renter-occupied.

The number of units available for either rent or sale in the Richton region numbered 3,700 during 1990. Of this total, 2,409 were rental units and 1,291 were units for sale. Forest and Jones Counties accounted for over 68 percent of the total available housing in the region. In Perry County, there were total of 4,292 housing units in 1990. Of this total, 69 were available for rent and 43 were up for sale. Of those units occupied during 1990, 83 percent were owner-occupied.

Health Care

Although the State Department of Health has the statutory responsibility for the general health of the state's population, the State Health Plan explicitly notes that Mississippi lacks a central supervisory agency dedicated to the coordination of state health care issues.[341] The public health programs of the Mississippi Department of Health are instead implemented through a network of local county health supervisors, who are in turn supervised by professional staff in each of nine regional offices.

Although Mississippi meets the minimum national standards for adequate health manpower (3,500 persons per primary care physician), there is a significant maldistribution of physicians in the region. Forty-four of the state's 82 counties are designated as primary medical care shortage areas. For example, although there are 165 physicians and 45 dentists in Forrest County, Greene County has only one physician and one dentist.[342]

In total, there are 275 physicians, 92 dentists, and 1,508 registered nurses in the eight-county region (Table 5.5-11). Perry County has one physician, one dentist, and 25 registered nurses. The eight hospitals located in the eight-county area have a total of 1,206 beds, or one bed for every 190 residents. The 22-bed Perry County General Hospital is located in the town of Richton.[343]

Education

Perry County has three elementary schools, one public high school, and one vocational school. The average number of dollars spent per public school student in the county is $3,440, and the average number of students per teacher is 16.[344] Public elementary school enrollment in Perry County has increased since 1985, when enrollment was 738 students, to 1,110 students enrolled in 1991. In contrast, enrollment in public secondary schools over the same time period has decreased from 1,123 students enrolled in 1985, to 964 enrolled in 1991. Total public elementary school enrollment for the Richton region was 20,718 in 1991, and total secondary enrollment in 1991 for the area was 13,361.

Although there are no non-public schools in Perry County, approximately 1,700 students enrolled in non-public schools (private or Catholic) in other counties within the Richton region.[345] Because the state does not track non-public schools that are not members of the private school association, this non-public school enrollment figure may be somewhat underinclusive. Estimated impacts on area school capacity by an influx of workers' children are discussed in section 7.5.9.8.

Table 5.5-11
Health Care Facilities and Personnel, 1990

County	Hospitals	Hospital Beds	Residents/Bed	Physicians	Residents/ Physician
Perry	1	22	494	1	10,865
Forrest	1	503	136	178	384
Lamar	2	224	136	4	7,606
Jones	1	275	226	67	926
Green	0	N/A	N/A	1	10,220
George	1	53	315	6	2,779
Wayne	1	80	244	11	1,774
Stook	1	49	219	7	1,536

Source: Mississippi State Department of Health, *Directory of Mississippi Health Facilities*, Health Facilities Licensure and Certification Division, Jackson, MS, June 1991.

Utilities

Electrical power to Richton is currently supplied by Southern Mississippi Electric Power Association (SMEPA), a rural electric generation and transmission cooperative, and distributed through Dixie EPA, one of SMEPA's eleven distribution members. Also supplying electricity to the area, the Mississippi Power Company services approximately 23 counties in Southeast Mississippi, but does not currently have a transmission line near Richton. Of SMEPA's transmission lines, two run close to the site. One is a 161 kV transmission line that runs northwest to southeast and cuts across the western portion of the salt dome. The second line, a 69 kV transmission line, is located south of the first line and follows a roughly parallel path. The electrical power substation nearest to the site is the West Richton substation on State Route 42 about 2-3 miles west of the site and approximately half the distance between the towns of Richton and Runnelstown. The 161 kV and 69 kV lines are linked to the West Richton substation and a transformer (7.5 MVA capacity) drops the voltage to 12 kV for distribution in the area.

5.5.9.6 Revenues and Expenditures

The Federal government spent approximately 523 million dollars in the eight-county area in 1988 (Table 5.5-12), with Jones and Forrest counties receiving the most funding (158.2 and 173.1 million dollars, respectively). Green county received the least funding (20.9 million dollars). A breakdown of Federal expenditures by Agency in the eight-county area shows that the Federal Department of Health and Human Services was the major source of Federal funding in each of the counties in the eight-county area. Other Federal agencies that provided significant funding for these counties are the Federal Departments of Agriculture, Defense, Education, and the Veterans Administration. In 1988, Federal government expenditures in Perry County totalled 23 million dollars.

Table 5.5-12
Federal Government Expenditures in Richton Region, 1988
(millions of $)

County	Expenditures
Perry	23
Lamar	43.1
Forrest	173.1
Jones	20.9
Green	158.2
George	37
Wayne	38.9
Stone	28.9
Total	523.1

Source: Mississippi Institutions of Higher Learning, *County Data Bank*, Jackson, MS, November 6, 1991.

Local government expenditures in fiscal year 1989 for the Richton region were approximately 46 million dollars (Table 5.5-13). The highest expenditures were in Forrest and Jones Counties (13.7 and 11.2 million dollars, respectively), and the per county average expenditure was approximately 5.76 million dollars. Expenditures in Perry County for fiscal year 1989 totalled 3.86 million dollars.

5.5.9.7 Emergency Response Capabilities

Police, fire, and ambulance services for Perry County were evaluated for local emergency response capabilities in the Richton region. The Richton police department employs five officers, with one officer on duty at any given time. The police department, located about a mile from the proposed site, has two patrol cars.

In the event of a major emergency, additional police aid to Richton would come from a number of other sources. The Perry County Sheriff's Department in New Augusta is staffed by the sheriff, one part-time, and three full-time officers. Five patrol cars are available from the sheriff's department to respond to Richton by any of three routes in approximately 15-18 minutes. All officers have received law enforcement training, but none are certified in hazardous materials training. Further assistance would come from municipal police departments located in New Augusta and Beaumont, each having one on-call officer on staff. Police response from outside the county would most likely originate from the Mississippi State Highway Patrol Substation

Table 5.5-13
Local Government Expenditures in the Richton Region, 1988
(thousands of $)

County	Expenditures
Perry	3,861
Lamar	5,296
Forrest	13,775
Jones	2,930
Green	11,249
George	3,203
Wayne	3,758
Stone	2,249
Total	46,321

Source: State of Mississippi, *Counties in Profile 1990*, Office of the State Auditor, Jackson, MS, 1990.

located in Hattiesburg. The substation has 28 uniformed, enforcement personnel and an approximate response time of 15 minutes to the Richton site moving east along Route 42. Two Mississippi Highway patrol officers, one stationed in Perry County and the other living within the Richton town limits, could also lend support.

A total of 80 personnel and 16 vehicles constitute the six fire departments in Perry County. Richton has the largest department with 20 active volunteer personnel. Response time to the salt dome for the Richton department would be about four to five minutes, including notification of firefighters through a paging system. The department has two pumper vehicles with both water and foam capabilities (for oil and gasoline fires), one water tanker primarily for rural fires, and one rescue van staffed by one emergency medical technician (EMT) and five responders. Rescue personnel are not trained in advanced life support and must coordinate their response closely with the paramedic ambulance unit available from Perry County General Hospital.

Other fire departments in the county are located in Runnelstown, Beaumont, New Augusta, and Janice. A private fire brigade is employed by the Georgia-Pacific Leaf River Paper facility. The Richton fire department has a mutual aid agreement with each of these Perry County fire departments. The closest departments to Richton are Runnelstown, located ten miles west of the site, and Beaumont, twelve miles to the southeast. All fire personnel have received training at the firefighting academy, and 75 percent of the Richton fire personnel have also received hazardous materials training provided each year in Hattiesburg. The emergency management agency in Perry County is currently coordinating hazmat teams composed of three certified personnel in each of the five municipal fire departments within Perry County.

Perry County General Hospital, located in Richton and the nearest hospital to the proposed site, has one ambulance available for emergency response. The total staff consists of three full-time and six part-time licensed paramedics, with one paramedic and one driver on duty at any given time. A private ambulance service 25 miles west in Hattiesburg provides additional service to the county as needed, and has about five vehicles including the nearest medivac helicopter. Limited trauma facilities are available at Forrest General Hospital in Hattiesburg. Once stabilized, trauma cases are usually flown to a more extensive trauma unit in Mobile, Alabama.

5.5.9.8 Land Use

The Richton salt dome is located in Perry County, Mississippi in the southeast portion of the Mississippi salt dome basin. Land is used in Perry County primarily for agriculture and forestry. The primary crops in the county are corn, sorghum, soybeans, and wheat (Table 5.5-14). Most of the forest land in this area is covered by longleaf slash pine and hardwood trees. Approximately 46 percent of the forest land in Perry County lies within De Soto National Forest.[346]

Richton salt dome is about 18 miles east of Hattiesburg and approximately two miles west of the town of Richton. Three farm dwellings are located within the dome area, one immediately north of the proposed SPR facility area and two others within approximately 1,500 yards of that area. Numerous single family dwellings are located within the eastern portion of the dome area, west of the town of Richton. The density of these dwellings declines substantially along the county road proceeding from Richton to the proposed SPR site. According to 1983 census data, Perry County has a total population of 10,100 and Hattiesburg, the nearest major urban center to the Richton salt dome, has a population of 40,740. Richton Dome is predominantly covered with mixed evergreen forest in the northern portion (4,733 acres), agricultural land (1,085 acres) in the southern portion of the dome, and barren land (eleven acres) in the eastern portion of the dome. Other uses on the dome include a large orchard adjacent to Piney Creek in the southern area and the town of Richton on the southeastern flank of the dome.

The major land resources areas in Perry County consist of Lower Coastal Plain Silty Uplands in the northern three-quarters of the county and in the southwestern portion of the county and Coastal Flatwoods Alluvium in the lower southeast portion of the county.

In Perry County, 84 percent of the land is forested. Approximately one-half of the forested land contains sawtimber, one-fifth poletimber, and the remainder considered nonstocked areas (i.e., saplings and seedlings). Sawtimber is defined as live trees that are of commercial species, contain at least a twelve-foot saw log, and meet regional specifications for freedom from defect. Softwoods must be at least nine inches in diameter at breast height and hardwoods at least eleven inches. Poletimber is defined as growing-stock trees of commercial species at least five inches in diameter at breast height, but smaller than sawtimber size. Nonstocked areas are classified as areas with timberland less than 16.7 percent stocked. According to the Forest Service, in 1978, the average annual net growth of sawtimber on timberland in Perry County was 155 board feet per acre for sawtimber.

Table 5.5-14
Perry County Crop Production, 1989

Crop	Planted All Purposes (Acres)	Harvested (Acres)	Yield Per Acre (Bushels)	Production (Bushels)
Corn	800	600	59.0	35,400
Sorghum	NA	NA	NA	NA
Soybeans	4,000	3,800	21.6	430,000
Wheat	3,000	2,500	42.0	105,000

NA indicates no data available for that year.
Source: Knight, D. and H. McWilliams, Mississippi Agricultural Statistics Service-Fact Finding For Mississippi Agriculture, cooperative function of Mississippi Department of Agriculture and Commerce & U.S. Department of Agriculture, Supplement 25. 1989-1990.

The proposed Richton site contains approximately 4.2 acres of prime and unique farmland. The proposed pipeline right-of-way to Pascagoula contains a total of 907.4 acres of prime and unique farmland, as identified by the U.S. Soil Conservation Service. This includes 83.2 acres in Amite County, 59.3 acres in Forrest County, 92 acres in George County, no acres in Greene County, 90 acres in Jackson County, 82.2 acres in Lamar County, 95.1 acres in Marion County, 95.5 acres in Perry County, 180.6 acres in Pike County, and 129.5 acres in Walthall County.[347]

The proposed pipeline right-of-way to Mobile, Alabama contains a total of 119.5 acres of prime and unique farmland, as identified by the U.S. Soil Conservation Service. This includes 69 acres in George County, Mississippi, and 50.5 acres in Mobile County, Alabama.[348]

The town of Richton, located at the southeastern edge of the dome area, and approximately two miles from the proposed SPR site, comprises approximately one square mile of land. Of this total area, 42 percent is in residential, commercial, transportation, and industrial land uses; the remaining area within the corporate limits is undeveloped. The areas of Richton adjacent to the proposed SPR storage site are primarily zoned residential.

Other land uses include two state highways (Mississippi State Highways 15 and 42) and two utility corridors which cross the dome. A portion of De Soto National Forest containing the Chickasawhay Wildlife Management Area is located approximately three miles north of the dome area. The De Soto National Forest, 3.5 miles from the center of the Richton Dome site, is administered by the Forest Service. The Leaf Wilderness, Federally designate under the Wilderness Act (16 USC Sections 1131-1136), comprises approximately 940 acres and is located in the De Soto National Forest. The Black Creek Wilderness, also Federally designated as a wilderness area under the Wilderness Act, was established simultaneously with the Leaf Wilderness, and is also located in the De Soto National Forest. The Black Creek Wilderness comprises about 4,560 acres and is located approximately 13 miles west of the Leaf Wilderness. The proposed Richton Dome SPR site is approximately 25 miles north of both the Leaf and Black Creek Wilderness Areas.

Camp Shelby Military Reservation is located about ten miles south of the dome in De Soto National Forest. Camp Shelby is a state-owned training site for the National Guard

Reserves and has been designated a U.S. Army Forces Command Mobilization Station in case of national emergency or war. Camp Shelby is operated by the Mississippi National Guard under a special-use permit granted by the U. S. Forest Service. The facility occupies approximately 135,670 acres within Forrest and Perry Counties. The Mississippi National Guard has permission under this special-use permit to use portions of the Camp Shelby field training area as a bomb-firing range and tank field. The Camp averages 8,900 troops during the annual training period (May-August). During peak periods usage reaches 18,000 troops. The Camp is used for training 50 weekends each year and four full months during the summer.[349] Major access routes to the Camp Shelby facilities are U.S. Highway 98 and U.S. Highway 49, with Mississippi State Highway 29 as another access route. Training activities at the site are not expected to have any effect on the development and operation of the Richton site.

5.5.10 Ambient Noise

The area near the proposed Richton site is wooded with only a sparse human population (i.e., fewer than 20 people per square mile). Although no actual sound monitoring has been performed at Richton, the ambient noise levels can be estimated based on the land use at the site. Land use is more urban on the southeast edge of the dome near the town of Richton. Mississippi State Highway 42 passes less than a mile to the south of the proposed site and would be expected to contribute significantly to the ambient noise level at the site. Because of the close proximity of State Highway 42, noise levels at the site are believed to exceed 45 dBA.[350] As of 1965, there were approximately 27 residences or places of business within the 5000-foot radius impact zone. The nearest residence is approximately one-half mile from the proposed site. Background noise levels within the impact zone are expected to be roughly comparable to a suburban area (i.e., 53 to 58 dBA).[351,352,353] (See Appendix H for information on methods used for estimating noise levels.)

There are several oil distribution options proposed for the Richton site. One possible option would involve the construction of a storage terminal to serve the proposed Greenwood Island Docks, which would serve as a loading and unloading area to support a proposed DOE terminal at the abandoned Jackson County Airport site. Land use in the area around the proposed site is primarily industrial and is dominated by a Chevron refinery, which lies just to the south of the proposed site. U.S. Interstate 90 passes less than one mile to the northwest of the proposed site and the nearest residence or place of business is approximately one-half mile from the proposed site. Based on the existing activity surrounding the proposed site (i.e., industrial activity and Interstate 90), sound levels are likely comparable to an urban to a noisy urban area (i.e., 58 to 68 dBA).

5.6 St. James Terminal (Capline Complex Distribution Enhancement)

Under a 180-day drawdown criterion, crude oil distribution enhancement for the Capline Complex would require expansion of the St. James Terminal to accommodate the increased drawdown requirements. DOE would construct up to two new docks, install custody transfer meters, and up to two new oil storage tanks.

5.6.1 Geology

The proposed St. James Terminal expansion site is located in St. James Parish on the west side of the Mississippi River, approximately two miles north of the town of St. James on Highway

18, and about halfway between Baton Rouge and New Orleans. The area immediately adjacent to the site is characterized by fresh water wetlands and by agricultural land uses.

The area is typical of the lower Mississippi River region with very little topographic relief and thick layers of sediment deposited within the floodplain. The land use around the St. James Terminal is largely agricultural with the primary crops being sugar cane and tobacco.

Geologic impacts from the St. James Terminal would be limited to the surface and immediate subsurface soils. The St. James Terminal, like the coastal storage sites, is seismically located in an area that has an expectation of only minor earthquake damage.[354] Several minor earthquakes have occurred in Louisiana, but all of these had a magnitude of less than 5.5 on the Richter scale at their epicenters and none of the epicenters was near the St. James Terminal.[355]

5.6.2 Hydrogeology

The hydrogeologic characteristics in the vicinity of the St. James Terminal closely match the hydrogeologic characteristics for much of the Parish (see section 4.2.3). The principle characteristics of the aquifers in the immediate vicinity of the site are summarized in Table 5.6-1 below. The main difference between these site-specific characteristics and the regional characteristics summarized in section 4.2.4 is that the Mississippi River Alluvial (MRA) aquifer does not lie immediately beneath the site; instead a 30-meter silty clay loam and clay loam confining bed exists below the site.[356] Very low permeability Sharkey Association soils are present at the surface of the terminal site, and these soils continue vertically to the Gramercy and other underlying aquifers.[357]

Thick surface and subsurface clays inhibit direct vertical permeability from the land surface to the Gramercy and the semiconfined and confined lower aquifers at the site. (Because no site-specific permeability data are available, parish-wide permeabilities for the clay layers and aquifer sands are assumed.) The horizontal directional flow of groundwater is dependent upon the seasonal changes of the Mississippi River stage. Flow is toward St. James Bayou to the west during the high stage in the spring, and toward the Mississippi to the east in the fall.[358] Although recharge originates in part from natural levees just to the north and near the river,[359] most recharge comes from the downgradient flow of the Mississippi during high stage.

There are 51 groundwater wells within a three-mile radius of the St. James Terminal site, 33 of which are on the western side of the Mississippi River (the same side as the terminal site). Wells on the opposite side of the river are not included in this characterization because groundwater in those wells could not be influenced by any contamination near or on the St. James Terminal site; any contaminant releases to groundwater would be carried away by the river instead of crossing over into the groundwater on the other side of the river. Of these 33 wells, 26 tap the Gramercy, four tap the MRA, and three tap the Norco.[360]

Of the 26 wells developed in the Gramercy aquifer, eleven have unknown/undocumented uses. Among those wells with documented uses, six are industrial, four are rig wells, three are fire wells, one is an irrigation well, and one serves as a domestic (single home) supply well. These wells range in depth from 60 to 112 meters bls.[361]

Table 5.6-1
Characterization of Aquifers Underlying the St. James Terminal Site

Underlying Aquifer	Depth to Top of Aquifer (m bls)[a]	Overlying Soils/ Permeability (cm/sec)	Karst	Water Quality; Degree of Salinity[b]	Major Uses
Mississippi River Alluvial (and associated shallow sands): Not under site, but in vicinity	0 to -40	Not immediately under site. Surface soils: 1.4×10^{-4} to 1×10^{-7}; Aquifer sands: 7.0×10^{-3}	None	Freshwater to Slightly Saline	Irrig.
Gramercy	-55 to -75	Clays under site: 1.4×10^{-5} to 1×10^{-7}; Discontinuous clay beds: 1×10^{-4} to 1×10^{-7}; Aquifer sands: 3.5×10^{-2} to 8.8×10^{-2}	None	Freshwater to Slightly Saline	Industry, Rig, Fire, Domestic
Norco	-65 to -145	Discontinuous clay beds: 1×10^{-4} to 1×10^{-7}; Aquifer sands: 7.4×10^{-2}	None	Freshwater to Slightly Saline	Domestic
Gonzales-New Orleans	-130 to -220	Aquiclude overlying; Sands: 4.2×10^{-2}	None	Slightly Saline to Brine	None

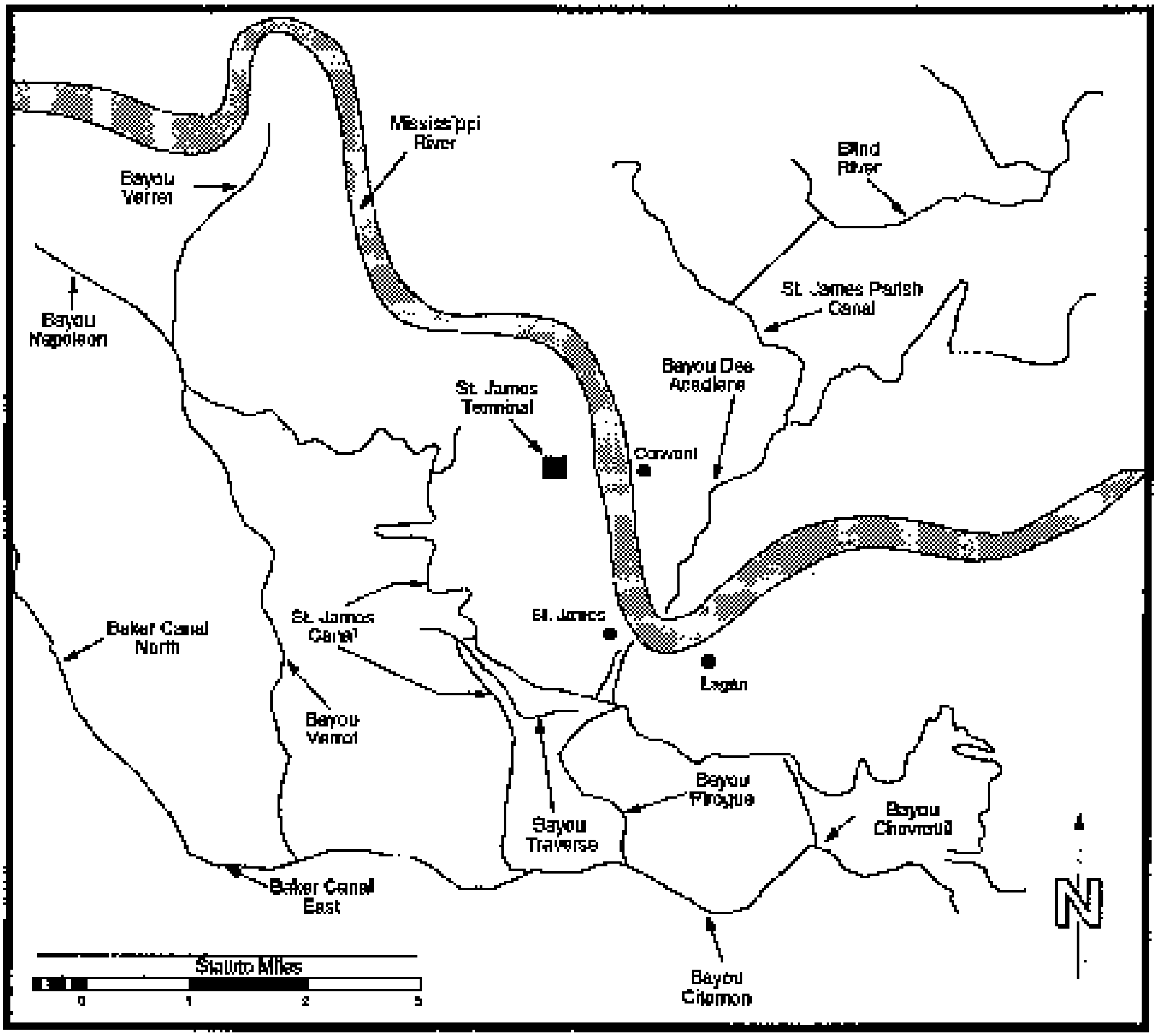
a Meters Below Land Surface.
b Salinity determined by dissolved solids content, in ppt. Freshwater, Less than 1 ppt; Slightly saline, 1-3 ppt; Moderately saline, 3-10 ppt; Very saline, 10-35 ppt; Brine, More than 35 ppt.
Source: SPR Library Document Number 95; USGS Water Resources Technical Report No. 24 (USGS (b)); USGS Water Supply Paper 2220; "Soil Survey: St. James and St. John the Baptist Parishes, Louisiana"; Jerry Daigle: "Engineering Aspects of Karst"; USGS(b).

Among the four MRA wells, one serves as an irrigation water source while the other three have unknown uses. These wells range in depth from 44 to 68 meters bls. The three Norco wells include two that are used for domestic purposes and one that has an unknown use. These wells tap the Norco at depths of 143, 123, and 170 meters bls.[362,363]

5.6.3 Surface Water Environment

St. James Terminal is located in the Mississippi River delta plain, approximately 45 miles southeast of Baton Rouge. The terminal lies in the upper reaches of Louisiana's Mississippi River Basin, on the west bank of the river (see Figure 5.6-1). In the vicinity of the terminal site, this narrow basin is bounded by the Barataria Basin to the west and the Lake Pontchartrain Basin

Figure 5.6-1
Water Bodies Within Five Miles of the St. James Terminal, Louisiana



to the east. The Mississippi River itself is bordered by man-made levees. Between 1951 and 1988, an average of 60 inches of precipitation fell annually at Donaldsonville, LA, about eight miles northwest of the terminal.[364] Although the site topography is very flat, stormwater that does runoff from the site drains either toward the Mississippi River to the east or toward the St. James Canal to the west.

The hydrology of the Mississippi River system has been significantly altered in an attempt to reduce the risk of flooding and the resulting loss of land and increased salinity of adjacent wetlands.[365] Water quality in the basin has been adversely affected by pesticides, priority and non-priority organics, siltation, pathogens, and suspended solids. Suspected sources of this contamination include numerous industrial and municipal discharges, agriculture, urban runoff, land disposal of wastes, hydromodification, miscellaneous material spills, in-place contaminants, and heavy barge and ship traffic from the Gulf of Mexico and New Orleans.[366] The major water quality problems in the upper portion of the basin, where the terminal is located, are fecal coliform and turbidity.[367] In this area, the Mississippi River is the main source of drinking water for most of the river parishes.[368]

Within five miles of the proposed St. James expansion there are only eight water bodies. Key characteristics of each of these waters are summarized in Table 5.6-2. As shown, the water bodies in the vicinity of the St. James Terminal are predominately freshwater systems. Saltwater intrusion, however, may occur during some portion of the year as a result of low flows. Designated uses for these water bodies include primary contact recreation, secondary contact recreation, and agriculture,[369] although designated water uses are only partially attained over much of the Mississippi River Basin due to the water quality problems described above.[370] The only water body that is presently used as a public water supply source in the area is the Mississippi River. The nearest downstream public intake on the Mississippi, however, is at least ten miles from the proposed new docks at St. James. There is a public intake that serves about 700 people in Convent directly across the Mississippi River from the existing terminal site, but this intake is approximately a half-mile upstream of the proposed new docks.

5.6.4 Climate and Air Quality

The climate around St. James Terminal is largely influenced by the warm waters of the Gulf of Mexico that moderate the temperature. The area is very moist; the average precipitation is 54 in/yr.[371] Because the site is located further from the coast than are the Louisiana salt dome sites, annual precipitation rate is slightly lower. Additionally, the inland location of the site slightly decreases the probability of flooding and wind damage caused by tropical storms. The air temperature averages 74°F, but ranges from 85°F in the summer months to 60°F in the winter; the highest and lowest temperatures recorded are 100°F and 30°F, respectively.[372]

St. James Terminal is located in a nonattainment area for ozone. The terminal does not maintain an ozone monitoring station; however, the Louisiana DEQ maintains an ozone monitoring station in Convent, which is one mile east of the terminal, across the Mississippi River. The ozone level did not exceed the NAAQS in either 1988 or 1989.[373] The highest ozone measurement during 1989 was 0.119 ppm, recorded on August 15, 1989.[374] The highest recorded ozone measurement during 1988 was 0.089 ppm, recorded on October 11, 1988.[375]

Table 5.6-2
Characteristics of Surface Water Bodies Within Five Miles of the Proposed Expansion at St. James Terminal, Louisiana

Surface Water System	Distance from Site (miles)	Connections	Width (ft)	Depth (ft)	Annual Ave. Flow & Monthly Range (cfs)	Downstream Distance to Nearest Public Intake (miles)	Number of Persons Served by Intake	Water Type	Uses
Mississippi River	0.8	Gulf of Mexico	2,600	40	468,000 (793,000-211, 000)	None[a]	None	Fresh	Drinking, commercial traffic, contact recreation, fish & wildlife prop.
Bayou des Acadiens	2.3	St. James Parish Canal, Blind River	10	2	Storm Drain	None	None	Fresh	Agriculture
St. James Parish Canal	4.7	Blind River, Pipeline Canal	60	6	84.8 (36.9-145)	None	None	Fresh	Agriculture, small boat and barge traffic
Batres Community Drainage Canal	4.7	St. James Canal, Bayou Chevreuil, Bayou Citamon	10	2	Storm Drain	None	None	Fresh	Agriculture
St. James Canal	1.6	Bayou Verret, Bayou Traverse, Bayou Citamon, Cutgrass Cracks, Bayou Chevreuil	80	6	71.1 (32.2-122)	None	None	Fresh	Agriculture, small boat and barge traffic
Bayou Verret	4.2	St. James Canal, Baker Canal East, Bayou Citamon	60	2	148 (66.9-253)	None	None	Fresh	Contact recreation, fish & wildlife prop., agriculture
Bayou Traverse	2.7	St. James Canal	12	2	71.1 (32.2-122)	None	None	Fresh	Agriculture
Bayou Pirogue	4.2	Bayou Citamon	10	2	Storm Drain	None	None	Fresh	Agriculture

[a] No public intakes within 10 miles downstream.

5.6.5 Ecology

The following sections describes the ecology of the St. James Terminal area, including the vegetation and wildlife, and also identifies rare, threatened, and endangered species that may occur.

5.6.5.1 Vegetation

The proposed tank expansion would occur within the current St. James Terminal facility. The vegetation in this area is currently maintained by DOE and consists of rye grass, white clover, and Bermuda grass. The area surrounding the facility is primarily agricultural: sugar cane cultivation and pasture/cattle grazing. Natural pasture species common to the area include bluestem, Indian grass, dallisgrass, and switchgrass.

There are no wetlands within the storage tank facility; however, the area adjacent to the dock facility, located on the west bank of the Mississippi River, includes man-made, freshwater wetlands (or depressions) created by excavation for levee construction along the river. This area is often inundated during high water periods. Plants that occur in these wetlands are duckweed, pennywort, mud plantain, white water lilies, and water lettuce. Willows are the dominant canopy species along the edge of these wetlands and the riverbank. Other canopy species observed in the dock facility area are water oak, white oak, hickory, and Chinese tallow tree. The riverbank understory consisted mostly of overgrown shrubs and herbaceous vegetation. Common species occurring are shining sumac, yaupon, honeysuckle, bur reed, and Virginia creeper.

The Mississippi River near the St. James Terminal is wide and deep, and has a large flow and steady currents. Establishment of permanent beds of aquatic vegetation is prevented because of steep banks and the fluctuating water level of the river in this area.

5.6.5.2 Terrestrial Wildlife

Bird species observed during the site visit are mourning doves, mockingbird, white ibis, egrets, blackbirds, and an unidentified hawk. Wood ducks can be found in the wetland when the water level is sufficient. Raccoon and swamp rabbit tracks were observed along the riverbank and the edge of the freshwater wetlands. Beavers can be found in the dock area when the water level is high, however, none were observed during the site visit. Other mammals which are likely inhabitants are nutria, river otters, and squirrels. Reptiles observed were several species of lizards and two species of turtles (snapper and soft-shell).

5.6.5.3 Aquatic Life

Several man-made, freshwater wetlands contain sufficient water to support populations of aquatic invertebrates and possibly some freshwater fish species such as catfish and river bass. The aquatic biological community of the lower Mississippi River is composed principally of nongame fish of little commercial or recreational value.

Although the Mississippi River is the largest and closest of the water bodies in the vicinity of the St. James Terminal expansion, several bayous and canals are found south and west of the site. All surface waters in this part of Louisiana are fresh. Vegetation found in most freshwater habitats in this region are vascular hydrophytes and algal species; however, the fluctuating water level and steep banks of the Mississippi River prevent macrophyte survival over most of its length.[365] The most prominent benthic organisms in the area include various species of crayfish and mollusks,[366] but the Mississippi River has never supported a substantial benthic community due to its high sediment load. The fish species that typically inhabit the fresh water areas of southern Louisiana include crappie, catfish, various species of sunfish, largemouth bass, gar, gizzard shad, and suckers.[367] Fish species typically encountered in the Mississippi River in the vicinity of St. James Terminal are those that can tolerate the chronically turbid conditions, and include: blue catfish, channel catfish, gar, and buffalo.[368]

5.6.5.4 Threatened or Endangered Species

Based on information supplied by the U.S Fish and Wildlife Service in Louisiana and the Louisiana Department of Wildlife and Fisheries, there are no endangered plant or animal species occurring at or within a one-mile radius of the St. James Terminal. One endangered or threatened species is listed in St. James Parish, in which the St. James Terminal is located (Appendix D).

5.6.6 Floodplains

Under a 180-day drawdown criterion, the crude oil distribution alternatives for Weeks Island, Cote Blanche, and Richton could require construction of up to two new docks and up to two new tanks at St. James. Because of its location on the Mississippi River, the terminal is in a floodplain area. Each dock would be about seven meters above msl. Adding two new docks will require dredging of up to one million cubic yards of spoil per dock.

5.6.7 Natural and Scenic Resources

The area surrounding the St. James Terminal is a relatively industrial and developed area without unique natural or scenic features. The Louisiana Natural Heritage Program conducted a data base search of the project area and found no rare, threatened, or endangered species or critical habitat in the area.

5.6.8 Archaeological, Historical, and Cultural Resources

DOE contacted the Louisiana Department of Culture, Recreation, and Tourism for information on culturally important resources in the area and vicinity of the proposed St. James Terminal expansion. In response, the State of Louisiana performed a file search and determined that there are no recorded archeological or historical sites located within the proposed St. James Terminal project area.

5.6.9 Socioeconomics

The DOE terminal at St. James is located in southern Louisiana near the center of a 90-mile corridor along the Mississippi River between New Orleans and Baton Rouge. Originally homeland to the Ouma and Chitmacha Indians, the land was later settled by Germans and Acadians, who landed in Convent, and fished and trapped along the Blind River. A few miles inland from the Mississippi River are Grand Pointe, an original Acadian settlement still in existence, and a few of the remaining plantation homes that were once the mainstay of the local economy. The proposed expansion site is located in the town of St. James. Because of the limited nature of the proposed expansion at the St. James facility, a summary of the socioeconomic conditions in St. James Parish is presented below.

5.6.9.1 Summary of Socioeconomic Conditions

The only Native American Reservations in Louisiana are the Coushatta and the Chitimacha (see section 5.3.9.1), neither of which are in the vicinity of St. James.

Population trends for St. James Parish showed an increase from 21,495 in 1980 to a peak of 22,200 in 1986. Since 1986, however, population has steadily dropped to the 1990 level of 20,879. Three major towns located approximately ten miles east of the town of St. James are North Vacherie (population 2,354), Lutcher (population 3,907), and Gramercy (population 2,412). Because St. James is an unincorporated area there are no confirmed population estimates for it.

Housing costs in St. James Parish are below national averages, with an average cost of $55,000 for a single family dwelling. New home prices range from $50,000 to $90,000, with an estimated cost of 35 dollars/square foot. In 1990 there were 6,934 total housing units in St. James Parish, of which 502 were vacant.

St. James Parish has eight elementary schools, two junior high schools, and two senior high schools. Total enrollment for the Parish in 1989 exceeded 4,500, with an average student/teacher ratio of approximately 17:1. St. James Parish has one parochial school (K-8), and one private school (preK-12) is located in the neighboring St. John the Baptist Parish. Additionally, two vocational schools are located approximately 35 miles from the DOE facility.

The St. James Parish Sheriff's Department is staffed by 100 employees, and has 38 patrol cars and two boats. A Sheriff's Department substation is located in the town of Vacherie, approximately 15 miles north of the DOE facility. Fire protection for the Parish is provided by six volunteer departments with a total of 329 fire-fighters and 20 pumper trucks. A St. James Fire Department building is located approximately two and a half miles from the DOE facility. Ambulance service is provided by the Acadian Ambulance Inc. and Air Med Services. Additionally, the St. James Parish Emergency Operations Center monitors weather patterns, stores information on potential hazards, generates digitized regional maps, and notifies emergency personnel.

Health care facilities in St. James Parish include two major hospicals with a total of 143 beds, or approximately 146 residents/bed. Also located in St. James Parish are a 40-bed mental health facility, a 128-bed long-term health care residence, and two health units providing basic health care services (immunizations, child care, laboratory services, etc.). There are twelve licensed physicians and one dentist in St. James Parish.

Major transportation routes running close to the site and connecting Baton Rouge to New Orleans are Interstate 10 and U.S. 61. To access the site from Baton Rouge, travellers would take route 10 west, to route 22 south, to route 70 south, to Highway 18, the major off-site route for the St. James Terminal. From New Orleans, travellers would take route 61 east to access Highway 18. A series of shell and paved roads running east and west from Highway 18 provide access to other local industrial facilities and farms. Most of these roads are private and are not normally used for SPR purposes except in emergencies. The northwest running Texas and Pacific Railroad passes immediately west of the site.

The St. James Parish economy was once dominated by agricultural interests, which have recently been supplanted by a significant industrial concentration. St. James Parish has two major industrial parks, and a 2,000-acre site currently under development. Petroleum, chemicals, sugar, and aluminum, as well as trapping and commercial catfish and crawfish production are significant industries in the Parish. Industrial trends in St. James Parish reflect those in the corridor between New Orleans and Baton Rouge, in which over 50 major facilities produce 20 percent of all U.S. chemicals and refine ten percent of U.S. gasoline. The influence of such industry is also reflected by St. James Parish's largest employers: Star Enterprise (Texaco)(723 employees), Kaiser Aluminum (over 500 employees), and the Occidental and LaRoche chemical companies (each with approximately 250 employees).

Agriculture, however, is still a significant economic force in the parish. Soybeans are the largest income-producing crop, followed by cotton, rice, and sugar cane. Colonial Sugars, Inc. is the oldest industry in the parish, begun in 1896, and currently employing 350 workers. St. James Parish is also the world's sole producer of the rare and intoxicating perique tobacco. Total crop production for the Parish in 1990 had a gross farm market value of about $12,738,000. Additionally, several historical and archeological sites have spawned a tourism industry in the Parish.

The St. James labor force stood at 9,325 in 1990, reversing a decreasing trend in labor force participation since 1987. Manufacturing is the largest employment sector in the county, with 3,359 employees, followed by the transportation/utilities industry (886 employees), and the retail industry (706 employees). The St. James Parish unemployment rate has decreased from a 1988 high of 15.7 percent (in contrast to the 1988 Louisiana and national averages of 10.6 percent and 5.5 percent, respectively), to the 1990 level of 8.6 percent (6.2 percent for Louisiana and 5.5 percent nationally). Total earnings for St. James Parish in 1989 were roughly 204.5 million dollars. This translates to a 1989 per capita income figure for St. James Parish of 12,873 dollars, as compared with per capita personal income figures of 12,923 dollars and 17,592 dollars, for the State of Louisiana and the entire U.S., respectively.

5.6.9.2 Land Use

The St. James Terminal is a DOE-owned facility located in St. James Parish, approximately 40 miles west of New Orleans and 35 miles southeast of Baton Rouge, on the west bank of the Mississippi River. The main terminal site occupies approximately 105 acres of land acquired from a private landowner. The dock facility located on the Mississippi River, about two miles southeast of the main terminal, occupies an additional 48 acres, and is connected to the main terminal by two 42-inch pipelines.

The area immediately adjacent to the main terminal is either industrial land or farmland. St. James Terminal is situated in a mostly rural area; sugar cane cultivation and cattle grazing are the dominant land-use activities in the surrounding area. The land area adjacent to the dock facility is a freshwater, man-made ravine. St. James Parish has a total population of about 21,400 and the only two incorporated towns in the Parish are Lutcher and Gramercy, with a total combined population of about 6,300.

The major land resources area in St. James Parish consists of Southern Mississippi Valley Alluvium. Southern Mississippi Valley Silty Uplands are considered the area that poses the risk for the highest soil erosion rates.[380]

In St. James Parish, about 48 percent (79,300 acres) of the land is forested and the remaining 83,100 acres are designated as nonforest land use. Of that 48 percent of forested land, 52,900 acres (about 70 percent) are owned by cooperatives or corporations; and 26,400 acres (about 30 percent) are individually-owned forested properties.

Approximately 72,700 acres of the forested land in St. James Parish are sawtimber and 6,600 acres are poletimber.[381] According to the Forest Service, in 1984, the average net annual growth of growing stock and sawtimber on timberland in St. James Parish was 3.1 million cubic feet for growing stock and 16.8 million board feet for sawtimber.

5.6.10 Ambient Noise

The existing activity around the proposed expansion site for the St. James Terminal includes agricultural and industrial land use and the existing St. James Terminal. Ambient sound level studies conducted when the terminal was in a "shut down" mode have shown sound levels to vary widely depending upon where the sound level reading was taken. Sound levels measured around the site ranged from 52 dBA to 68 dBA.[382] It is important to note, however, that the higher readings are from sound sources outside the St. James complex (e.g., the 68 dBA reading was due to a nearby tractor). As of 1981, there were over 100 residences or places of business within the 5,000-foot impact zone at St. James Terminal that experience background noise levels (L_{dn}) of up to 68 dBA. The nearest of these residences is approximately one-fourth of a mile from the proposed site.[383,384,385] Ambient sound levels 500 feet from the terminal, when the terminal is in an operational mode, would likely be lower than the high level reading presented above (i.e., the L_{dn} would likely be less than 68 dBA, or comparable to an urban or a noisy urban area) based on sound level readings of pump noise taken at the Big Hill site and on the existing land uses around the St. James Terminal site. (See Appendix H for information on estimating noise levels.)

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Mr. J.T. Monroe, District Conservationist, Purvis, MS.
Mr. J.J. Smith, District Conservationist, Columbia, MS.
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