# Strategic Petroleum Reserve

## Final Environmental Impact Statement for

## Kleer Mine

FES 77-2

September 1977

Federal Energy Administration

Strategic Petroleum Reserve Office

FEA/S-77/324

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

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

A. SUMMARY

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

Prepared By : The Strategic Petroleum Reserve Office
Federal Energy Administration, (CO-05-60472-00)
Washington, D.C. 20461
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1. Type of Action: (X) Administrative ( ) Legislative

2. Brief Description of the Proposed Action

A. The Federal Energy Administration (FEA) proposed to implement the Strategic Petroleum Reserve, Title I, Part B, of the Energy Policy and Conservation Act of 1975 (P.L. 94-163). The purpose of the Reserve is to mitigate the social and economic impacts of any future interruptions of petroleum imports to the United States of America. The Reserve will store 150 million barrels of oil by December of 1978 in the Early Storage Reserve (ESR), and 500 million barrels by 1982 under the entire program. Petroleum will be stored underground in conventional mines or solution-mined salt cavities, or aboveground in conventional tanks. Details of the Stategic Petroleum Reserve program are discussed in the Strategic Petroleum Reserve Final Environmental Impact Statement (FES-76-2). The present action is part of the ESR and proposes to store 30 million barrels of oil in a conventional salt mine located in Grand Saline, Texas. The storage of oil at Kleer Mine would be implemented at an existing underground salt mine presently owned and operated by the Morton Salt Company.

3. Summary of Environmental Impacts and Adverse Environmental Effects

This site-specific Environmental Impact Statement (EIS) has identified particularly sensitive environmental parameters that have been investigated in detail for the Kleer Mine, Texas Early Storage Reserve site. The most sensitive parameters to be affected by oil storage development at this site appear to be water quality, air quality, and socioeconomic factors. The significant adverse impacts to the physical environment that could result from the program include: degradation of surface water quality due to sedimentation from runoff and erosion during pipeline construction activities; a moderate increase in hydrocarbon emissions during transfer and temporary storage of oil in the Winnsboro storage tanks; locally significant increases in hydrocarbon emissions during transport of oil from the Gulf of Mexico to Winnsboro Terminal; and the potential for an increase in the frequency of oil spills along the transportation corridors. Changes in water quality would have a short-term impact on the aquatic organisms in local areas and could result in some minor sedimentation in downstream impoundments. Oil spill releases to land and water environments could cause localized losses to vegetation and fauna along the pipeline corridor and at the terminals. The maximum credible spill size is 60,000 barrels for tankers and 10,000 barrels from the pipeline system. A spill of this size could severely pollute several hundred acres, depending on location, but the probability of occurrence is extremely low. The most significant adverse socioeconomic impacts would be those related to the possible dislocation of a substantial number of Morton Salt Company employees if the salt mine were closed temporarily.

4. Alternatives Considered

Alternative Storage Sites

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

Nonstructural Alternatives

Structural Alternatives

- Alternative Storage Methods
- Alternative Mine Sites
- Alternative Shaft and Oil Recovery Systems
- Alternative Distribution Systems

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

Federal:

- Advisory Council on Historic Preservation
- Department of Agriculture
- Department of the Army
- Department of Transportation
- Department of the Treasury
- Environmental Protection Agency
- Nuclear Regulatory Commission

State:

- Sabine River Authority
- Texas Water Quality Board

Local:

No comments were received from local government agencies.

Others:

Southern Methodist University

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

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

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SECTION 1.0

## BACKGROUND

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

A final programmatic EIS (FES 76-2) addressing the effects of the SPR program as a whole was filed with the Council on Environmental Quality and made available to the public on December 17, 1976. That statement considers several different types of storage facilities, including the use of existing solution-mined cavities in salt formations and conventional mines, the construction of new solution-mined cavities and conventional mines, the use of existing and the construction of new conventional surface tankage, and the use of surplus tanker ships. The final programmatic EIS should be consulted for a description of each of these storage methods and the potential impacts which might result from its use. The programmatic EIS also assesses the cumulative impacts which could be expected from use of various combinations of the different facility types.

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

ESR storage sites to supply oil to refineries on the Gulf Coast, on the East Coast, and in the Caribbean. These five alternative sites include the West Hackberry salt dome (Cameron Parish, Louisisana), the Bayou Choctaw salt dome (Iberville Parish, Louisiana), the Bryan Mound salt dome (Brazoria County, Texas), the Cote Blanche salt mine (St. Mary Parish, Louisiana), and the Weeks Island salt mine (Iberia Parish, Louisiana). Environmental Impact Statements on all five alternative candidate sites (DES 76-4 through DES 76-8, September 1976) were filed with the Council on Environmental Quality and made available to the public on the same day so that the environmental impacts associated with the possible use of these sites could be compared with each other.

The other three candidate sites include the Kleer salt mine (Van Zandt County, Texas), the Central Rock limestone mine (Fayette County, Kentucky), and the Ironton limestone mine (Lawrence County, Ohio). Kleer mine would supply the refineries in the area served by the Texoma pipeline network. In addition the five sites listed above, because of their distribution flexibility, can also serve this inland market. The six sites therefore comprise a group of alternatives. Section 8.3.2 includes a more detailed discussion of the rationale supporting the selection of the six alternative sites in a brief summary of the impacts associated with each of the other five sites besides the Kleer mine. Central Rock and Ironton would serve the Capline-Ashland pipeline network and are therefore not alternatives for the Texoma market. This document has been filed with the Council on Environmental Quality and made available to the public. The draft EIS's on Central Rock (DES 76-9) and Ironton (DES 76-10) were filed with the Council on Environmental Quality in January 1977.

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

# SECTION 2.0

## DESCRIPTION OF THE PROPOSED ACTION

### 2.1 INTRODUCTION AND SUMMARY

Kleer Mine is located in 1 of 18 known salt domes within the west Gulf Coastal Plain. The mine is in northeast Texas, about 70 miles east of Dallas, near the town of Grand Saline (Figure 2.1-1). Morton Salt Company opened this 700-foot deep mine in 1930; today, it produces some 400 different salt products at a rate of 1000 to 1500 tons per day (250,000 tons annually).

The FEA is considering purchasing, contracting or leasing the existing underground cavern, together with sufficient surface area, for conversion of the cavern into a 30-million barrel (bbl) crude oil storage facility, to be part of the Early Storage Reserve (ESR) in the Strategic Petroleum Reserve (SPR) storage program. Morton's present underground mining activities can be relocated to another portion of the salt dome.

Major construction activities will include: sinking a production shaft and drilling an emergency exit and service shaft (hereinafter referred to as a service shaft) at the mine; converting the service shaft to a pump shaft at the existing mine; installing salt processing and handling facilities within the new mine and new conveyor system to carry the crushed and screened salt to the mill area; sealing the production shaft at the existing mine; installing a 42-mile long underground pipeline from the Winnsboro Terminal to the site, together with necessary pumps, manifolds, and metering equipment; installing an electrical power substation; and adding two 90,000-barrel storage tanks at the Winnsboro Terminal. Aerial photographs of the existing Kleer Mine and Winnsboro Terminal surface facilities are shown on Figures 2.1-2 and 2.1-3, respectively.

As discussed in section 2.3, the FEA is considering two possible methods or options for conversion of the existing mine to an oil storage facility. With the first option, conversion of the mine would be delayed for 40 weeks while the new mine is being developed, so that salt production would not be interrupted. If further development of the storage program strategy indicates an overriding need to expedite oil reserve buildup, mine conversion activities would begin concurrently with new mine development. This second option would result in placement of an additional 14 million barrels of oil in storage as of January 1, 1979, at the expense of a 40-week interruption of existing mine and plant operations. Both development options are addressed in the draft EIS.

Between 100 and 350 workers would be required during the 2-year construction period. Filling the mine with oil at 50,000 barrels per day (BPD) is expected to require 86 weeks; the 30 million barrels are assumed to be withdrawn at up to 200,000 BPD under emergency conditions. A trained operating crew of 8 to 10 employees must be available for call-up during emergencies after the initial fill. A permanent workforce of 3 or 4 (one per shift) would have routine security and maintenance duties.

Waste associated with mine conversion, construction, and operation would consist primarily of the overburden of salt removed in constructing the necessary shafts. All salt waste materials would be stabilized in the existing mine just prior to filling with crude; other overburden from shaft excavation (about 5000 cubic yards) would be placed in a small landfill at the site. Material excavated along the pipeline would be backfilled into the ditch. All other construction waste would be removed. Gaseous wastes would include engine exhausts and hydrocarbons vented and flared during cavern filling. Liquid wastes would include sanitary effluent disposed of in a septic tank and oily or briny water wastes treated off site by a commercial disposal company.

The mine conversion and new mine construction would be designed to comply with all Mining Enforcement and Safety Administration (MESA) and Occupational Safety and Health Administration (OSHA) requirements. The Grand Saline salt dome has been selected as a candidate for SPR storage, in part on the basis of its excellent geologic suitability for both mining and oil storage. The new mine workings would be located at least 300 feet from the oil storage cavern to provide sufficient clearance for safety considerations. Possible accident modes are recognized and accounted for in designing the storage and transportation facilities.

For the purpose of this EIS, project development is assumed to follow standard industry practice, consistent with good engineering principles and a concern for environmental values. Wherever reasonable doubt exists about the ultimate performance characteristics or environmental effects of any phase of the project, a worst case analysis of potential impacts is provided.

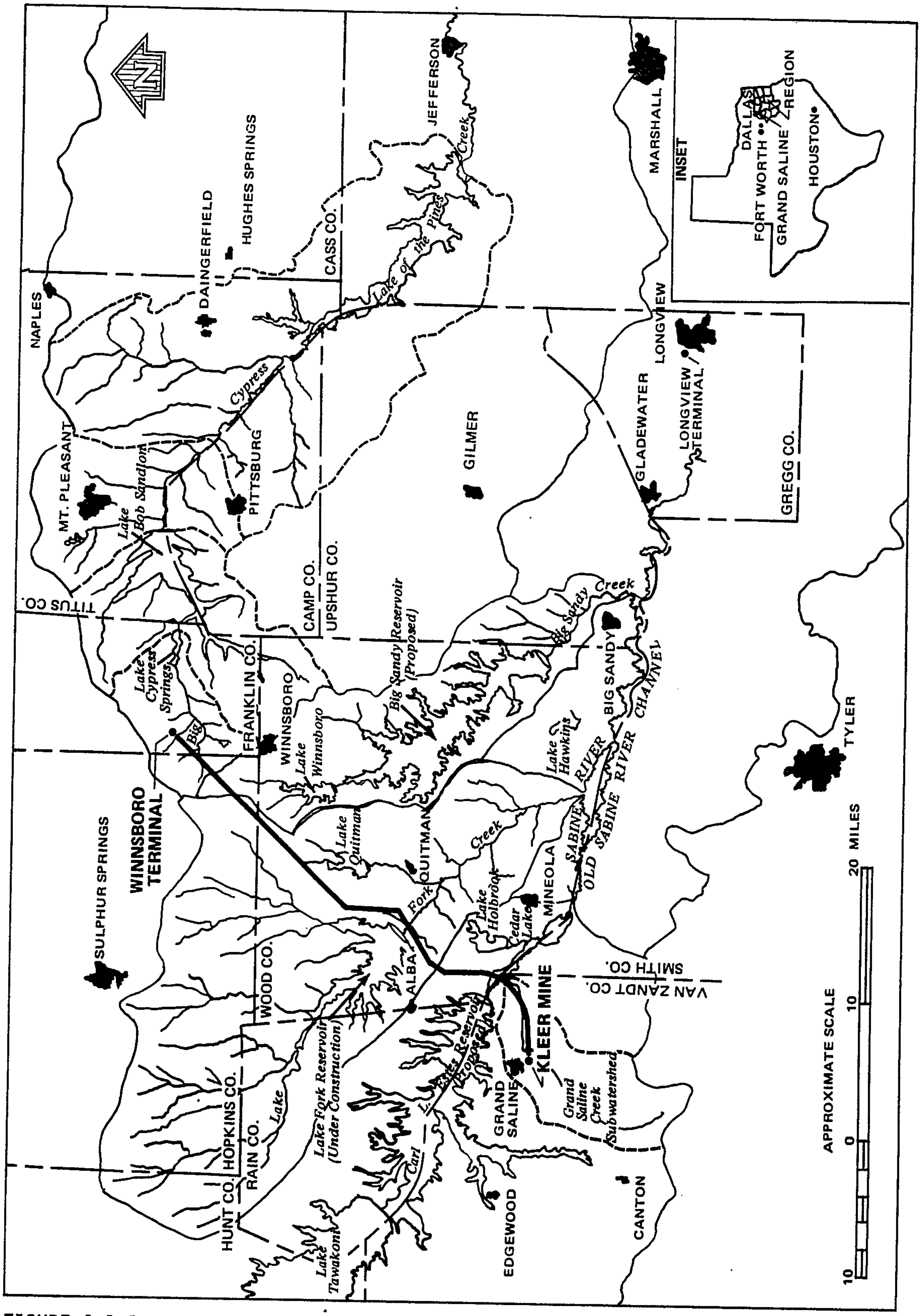
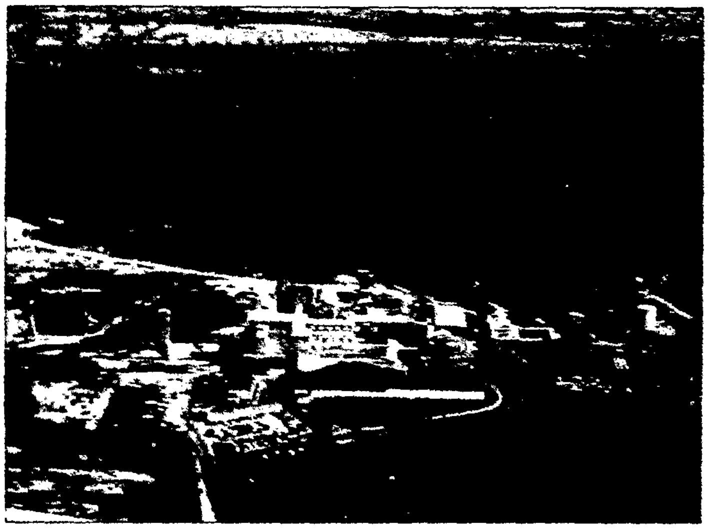
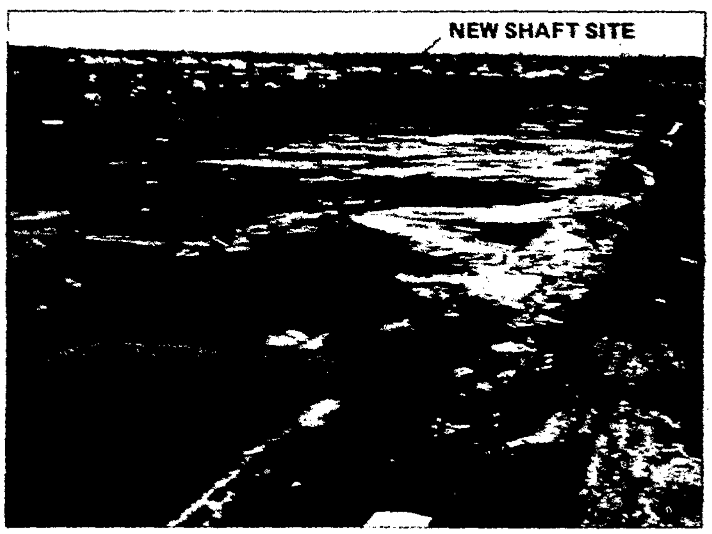



FIGURE 2.1-1 Location of the Kleer Mine

LOOKING WEST AT GRAND SALINE SALT MARSH



LOOKING EAST AT MORTON SALT COMPANY GRAND SALINE PLANT (KLEER MINE)



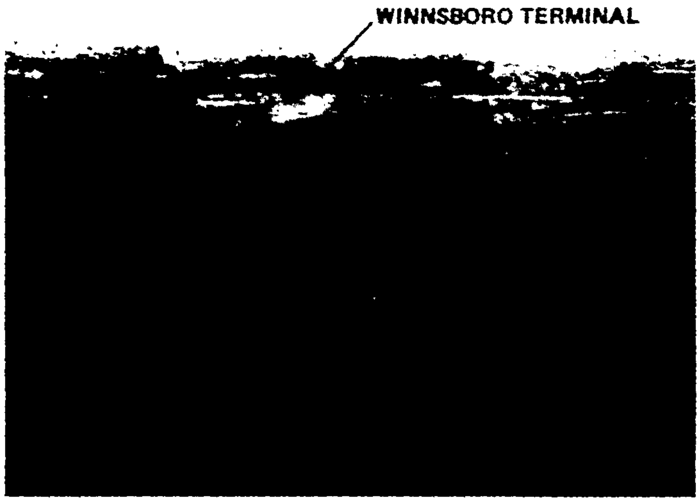

LOOKING NORTH FROM ABOVE EXISTING PLANT

PICTURES TAKEN JANUARY 30, 1976

BOTTOM PHOTO FROM LOWER ELEVATION THAN OTHERS

FIGURE 2.1-2 Aerial view of Kleer Mine surface facilities

LOOKING NE ALONG MOBIL PIPELINE




LOOKING EAST

LOOKING SW ALONG MOBIL PIPELINE

PICTURES TAKEN JANUARY 30, 1976

FIGURE 2.1-3 Aerial view of Winnsboro Terminal surface facilities

## 2.2 EXISTING MINE FACILITIES

The 700-foot-deep Kleer Mine has been owned and operated by Morton since 1930. Morton produces some 400 speciality salt products at 1000 to 1500 tons per day. Total potential crude oil storage volume is 30 million barrels.

Salt is mined underground by the room-and-pillar method. Two stages of crushing are done underground and further crushing and screening is done aboveground in the mill. In addition to dry mining, brine well No. 3 provides domestic quality salt to the mill.

### 2.2.1 Aboveground Facilities

Morton owns approximately 540 acres of surface and over 600 acres of mineral rights on the Grand Saline salt dome. Surface elevation is approximately 390 feet above mean sea level (MSL). Surface facilities include a processing and packaging plant, waste settling ponds, a hoist house, storage and warehouse buildings, a truck-loading dock, and an office building. See Figure 2.2-1 for surface facility layout.

Vehicle access to the mine is by a company-owned road from Texas State Highway 110. The plant is also served by a spur of the Texas and Pacific Railroad.

Process water is supplied from company-owned wells on the western flank of the salt dome and from on-site ponds; potable water and sewage treatment are provided by the municipal works. Available electric power supplied by the Southwestern Electric Power Company includes 12,470 volts to a surface substation and 2400 volts supplying the mine area.

### 2.2.2 Underground Facilities

The Grand Saline salt dome has the shape of a truncated cone. Although it extends downward 15,000 to 20,000 feet, it is only 8000 feet in diameter at the cap rock. The cap rock is composed of the less soluble residues left from the natural salt solutioning. The top of dome is 200 feet below the ground surface, but is topographically expressed by a circular, shallow depression partially covered by a salt marsh, directly above the dome; the marsh is the result of upward flow of ground water over the dome. Overlying the caprock is a horizontal sequence of sandy clays, clays, and silts, with some lignite that extends to the surface (see section 3.2 for more detail on salt dome structure).

Access to the mine is by two vertical shafts. Shaft No. 1, the production shaft, is 16 feet in diameter, 750 deep, and concrete-lined from top to bottom. Shaft No. 2, the service shaft, (also used as an emergency exit), is 12 feet in diameter, 700 feet deep, and concrete-lined to a depth of 460 feet.

The mine encompasses three different working elevations around one basic mine level. The central workings have an average floor elevation of 307 feet below MSL and were the first section mined. Room sizes in this section vary from 100 to 120 feet in height by 60 to 70 feet in width (Figures 2.2-2 and 2.2-3). The west section of the mine is located at 280 feet below MSL and has average room sizes of 65 to 75 feet in height by 60 feet in width. The east part of the mine is the newest section, with a planned floor elevation of 255 feet below MSL and planned room sizes of 100 feet in height by 60 feet in width. Present workings are 25 feet in height with floor elevation at 180 feet below MSL.

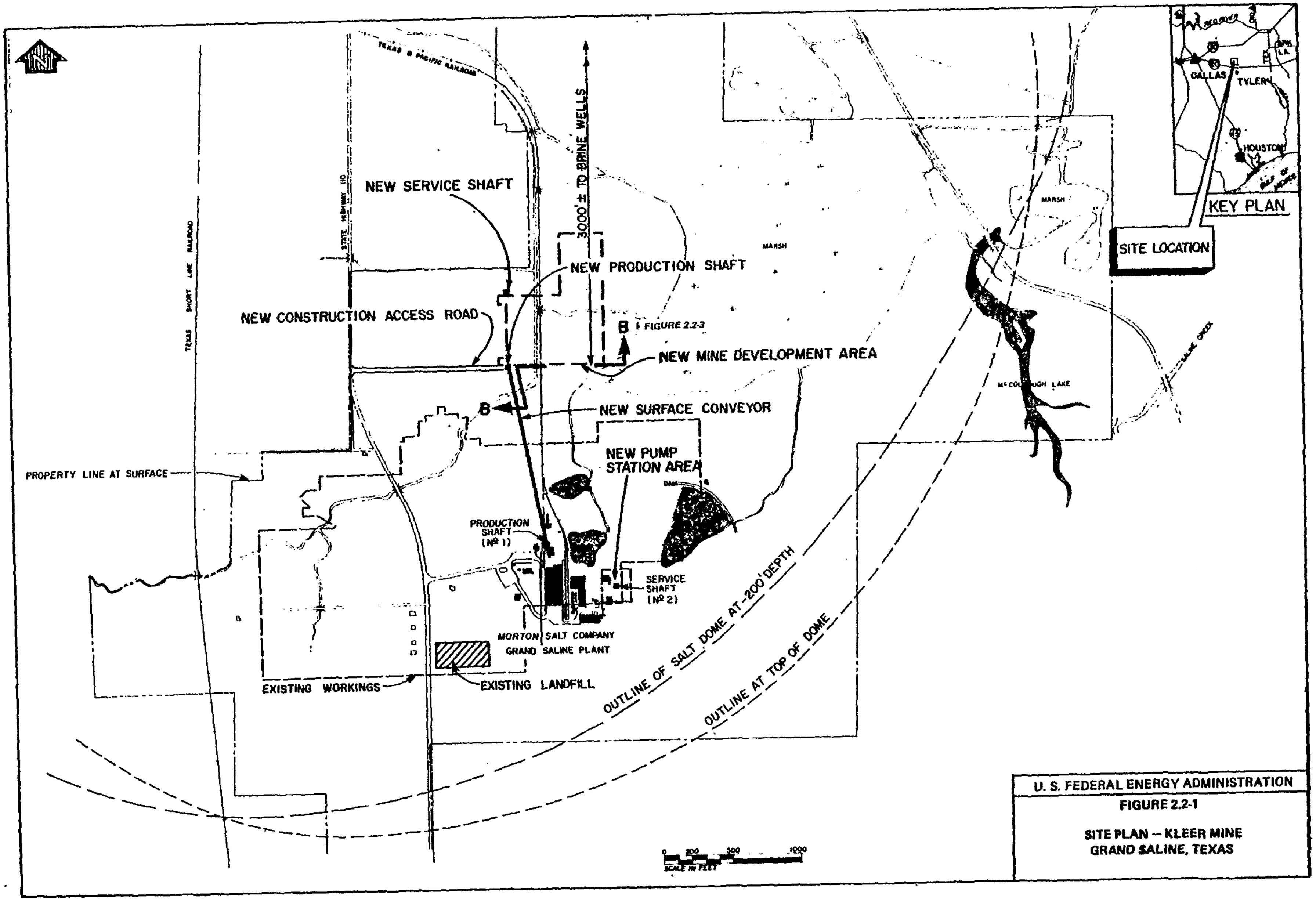
No floor heaves, rock falls, spalling, or fractures have been observed in the mine. No roof supports are used anywhere in the mine. The mine is dry in all sections, except for a few areas where condensation has collected and the No. 2 shaft area, which has very minor ground water leakage.

### 2.2.3 Mine Operation

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

After a 25-foot-high room is mined out, similar excavation is carried out on an additional 50-foot section below (benching). Holes are drilled vertically into the salt for this operation. Upon completion, the "room" is approximately 75 to 100 feet high and 50 to 70 feet wide.

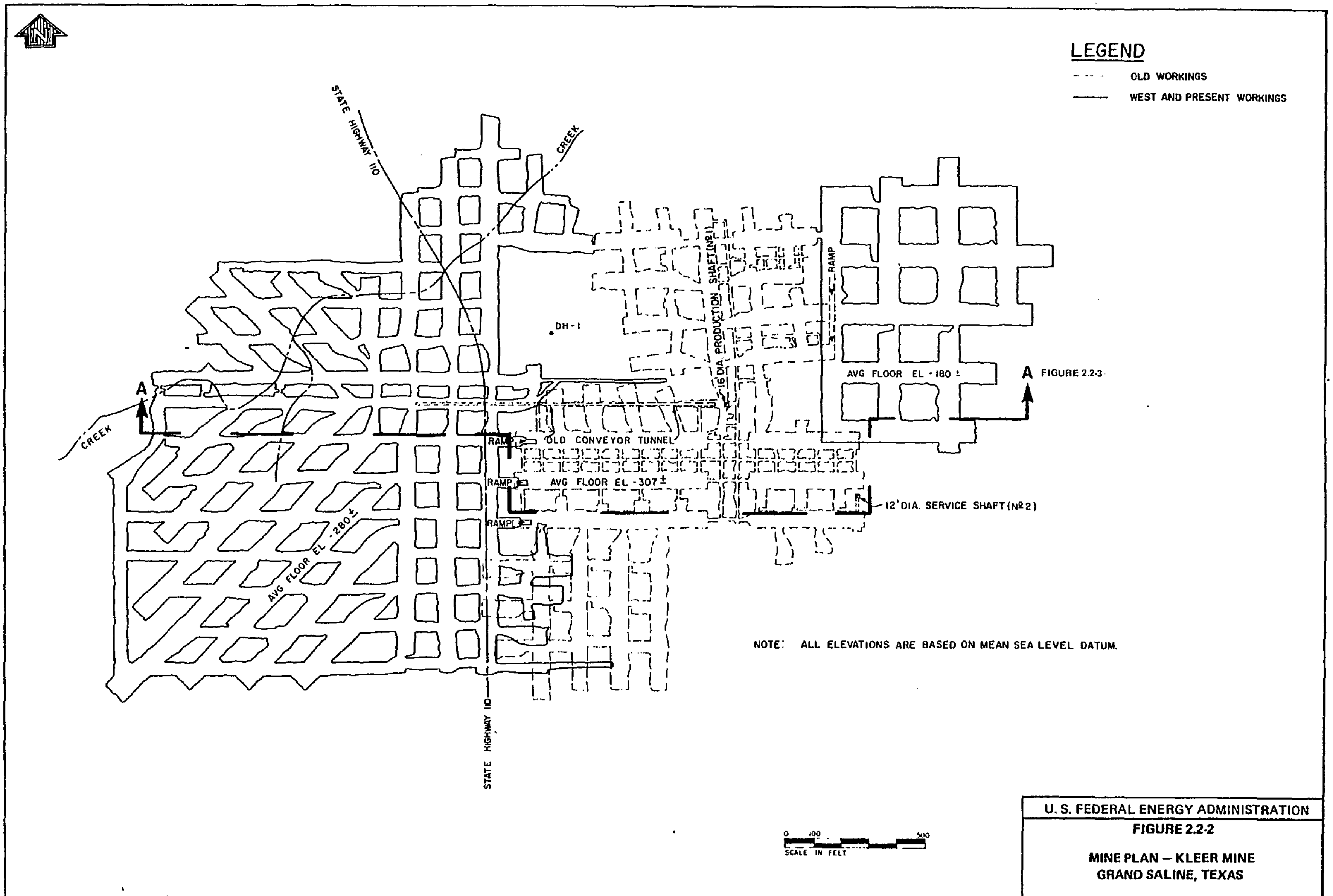
Approximately 17 underground workers normally work in two 8-hour shifts, 5 days a week. In addition, there are approximately 200 employees working a single shift, 5 days a week, in the processing plant aboveground.




U. S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.2-1

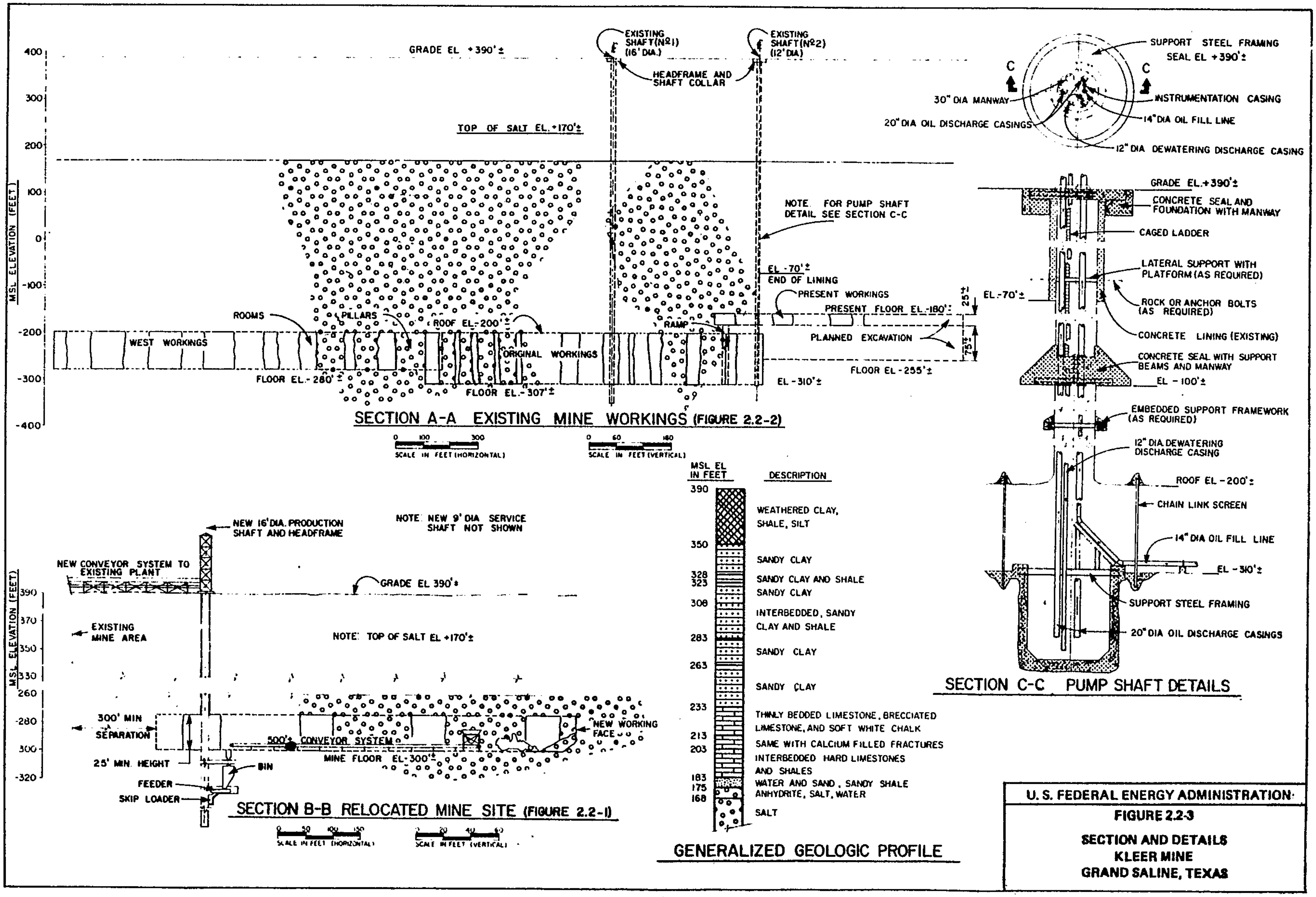
SITE PLAN – KLEER MINE
GRAND SALINE, TEXAS




U. S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.2-2

MINE PLAN – KLEER MINE
GRAND SALINE, TEXAS


GRADE EL +390'±
EXISTING SHAFT (Nº1) (16' DIA.)
EXISTING SHAFT (Nº2) (12' DIA.)
HEADFRAME AND SHAFT COLLAR
TOP OF SALT EL. +170'±
NOTE. FOR PUMP SHAFT DETAIL SEE SECTION C-C
EL -70'± END OF LINING
PRESENT WORKINGS
PRESENT FLOOR EL -180'±
PLANNED EXCAVATION
FLOOR EL -255'±
EL -310'±
ROOMS
PILLARS
ROOF EL -200'±
RAMP
WEST WORKINGS
ORIGINAL WORKINGS
FLOOR EL -280'±
FLOOR EL -307'±
MSL ELEVATION (FEET)
400
300
200
100
0
-100
-200
-300
-400
SECTION A-A EXISTING MINE WORKINGS (FIGURE 2.2-2)
SCALE IN FEET (HORIZONTAL)
SCALE IN FEET (VERTICAL)
SUPPORT STEEL FRAMING
SEAL EL +390'±
30" DIA MANWAY
INSTRUMENTATION CASING
20" DIA OIL DISCHARGE CASINGS
14" DIA OIL FILL LINE
12" DIA DEWATERING DISCHARGE CASING
GRADE EL +390'±
CONCRETE SEAL AND FOUNDATION WITH MANWAY
CAGED LADDER
LATERAL SUPPORT WITH PLATFORM (AS REQUIRED)
EL -70'±
ROCK OR ANCHOR BOLTS (AS REQUIRED)
CONCRETE LINING (EXISTING)
CONCRETE SEAL WITH SUPPORT BEAMS AND MANWAY
EL -100'±
EMBEDDED SUPPORT FRAMEWORK (AS REQUIRED)
12" DIA DEWATERING DISCHARGE CASING
ROOF EL -200'±
CHAIN LINK SCREEN
14" DIA OIL FILL LINE
EL -310'±
SUPPORT STEEL FRAMING
20" DIA OIL DISCHARGE CASINGS
SECTION C-C PUMP SHAFT DETAILS
NEW 16' DIA. PRODUCTION SHAFT AND HEADFRAME
NOTE: NEW 9' DIA SERVICE SHAFT NOT SHOWN
NEW CONVEYOR SYSTEM TO EXISTING PLANT
GRADE EL 390'±
EXISTING MINE AREA
NOTE: TOP OF SALT EL +170'±
300' MIN SEPARATION
25' MIN. HEIGHT
500'± CONVEYOR SYSTEM
MINE FLOOR EL -300'±
NEW WORKING FACE
BIN
FEEDER
SKIP LOADER
SECTION B-B RELOCATED MINE SITE (FIGURE 2.2-1)
MSL EL IN FEET
DESCRIPTION
390 WEATHERED CLAY, SHALE, SILT
350 SANDY CLAY
328 SANDY CLAY AND SHALE
323 SANDY CLAY
308 INTERBEDDED, SANDY CLAY AND SHALE
283 SANDY CLAY
263 SANDY CLAY
233 THINLY BEDDED LIMESTONE, BRECCIATED LIMESTONE, AND SOFT WHITE CHALK
213 SAME WITH CALCIUM FILLED FRACTURES
203 INTERBEDDED HARD LIMESTONES AND SHALES
183 WATER AND SAND, SANDY SHALE
175 ANHYDRITE, SALT, WATER
168 SALT
GENERALIZED GEOLOGIC PROFILE
U. S. FEDERAL ENERGY ADMINISTRATION
FIGURE 2.2-3
SECTION AND DETAILS
KLEER MINE
GRAND SALINE, TEXAS

## 2.3 MINE CONVERSION

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

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

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

Clearly, a naturally impermeable storage medium provides a simple direct means of assuring product containment. However, such impermeability is not essential if: 1) the permeable passages are saturated with water; 2) the hydrostatic head of that water exceeds the internal containment pressures of the cavern; 3) the resultant water inflow is sufficiently small to allow its periodic removal; and 4) the flows can be reduced by grouting. Given these conditions, the oil will float on a bed of inflowing water, preventing downward escape, while the hydrostatic pressures of the waters saturating the roof and sides prevent lateral migration of oil, as well as upward seepage of fumes. Worldwide experience shows that petroleum products can be successfully and economically stored under these conditions. Nevertheless, they commonly bear economic penalties that are not associated with storage in naturally impermeable media. These penalties are mostly composed of: 1) the costs of treating the water that, because of the head requirements, must necessarily flow into the storage area; and/or 2) the costs of artificially reducing the natural permeability by grouting in order to cut the costs of pumpage and treatment of water inflows. Experience suggests that such grouting may be economically justifiable if natural flow exceeds 400 to 700 cubic feet per day per 500,000 barrels of storage space. However, grouting itself is relatively expensive, and caverns mined in media with more than modest natural permeability, including sediments with intergranular permeabilities, are typically not considered for petroleum storage.

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

Conversion of the existing Kleer Mine for crude oil storage primarily involves the removal of the existing service shaft equipment, conversion of the service shaft to a pump shaft, installation of oil pumps and casings, sealing of the production shaft, and construction of the necessary oil pipeline distribution facilities, including two 90,000 barrel storage tanks at Winnsboro terminal.

Option 1 for developing Kleer Mine oil storage capacity would avoid or minimize the disruption of salt mine production activities; for this option, mine conversion would be scheduled to phase smoothly with the new salt mine development. Cavern filling would begin about week 129, and 30 million barrels of oil would be in storage by about week 214. The corresponding schedule of construction activities is given on Figure 2.3-1; field construction manpower and payroll are given in Table 2.3-1.

The second option for developing Kleer Mine oil storage capacity would provide the most rapid means of getting oil into storage. For this option, mine conversion would begin concurrently with new mine development. Morton could continue using the existing production shaft until week 71. Production from the new mine would begin at approximately week 111, requiring shutdown of salt production for a period of approximately 40 weeks. The cavern filling operation would start during week 89, storing approximately 30 million barrels of oil by about week 174. The corresponding schedule of construction activities is given on Figure 2.3-2; construction employment manpower, and payroll are given in Table 2.3-1.

## 2.3.1 Underground

### 2.3.1.1 Pump System

Kleer Mine has an existing 12-foot diameter service shaft (shaft No. 2) and a 16-foot diameter production shaft (shaft No. 1). Since either shaft is suitable to accommodate the required pumping equipment, the 12-foot diameter service shaft would be converted to a pump shaft while salt production continued in shaft No. 1 -- either until the new mine is ready in Option 1, or until shutdown is required (when the shaft sealing operation is begun) in Option 2.

Pumping equipment would be installed in a pipe casting for protection and support, and to allow the pumps to be withdrawn for maintenance. Three 500-horsepower submersible oil booster pumps would be required for withdrawal of the oil from storage. No standby or backup pump units would be provided because of the anticipated short periods of operation required during emergency withdrawal of the oil, inherent pump reliability, and the assumption that repairs can be made to the pumps within a matter of days.

A cross section of the pump shaft system is provided on Figure 2.2-3. Major system components are: three 20-inch diameter oil pump (discharge) casings; a 12-inch diameter dewatering (or sludge) discharge casing; a small instrument casing; a 30-inch diameter manway opening; and a 14-inch diameter oil fill casing. The pump casing and tubing string would be supported at 2 points, with the majority of the weight carried at the surface by a concrete bulkhead seal supported on adjacent foundations around the shaft collar. Above the roof of the cavern, a second concrete bulkhead would be constructed to provide support for the lower casings.

The lower bulkhead would be keyed well into the rock to provide a vapor seal. Vapor pressures in the cavern are expected to be between 0.5 and 1.5 atmospheres. However, in accordance with conservative European design practices, the concrete bulkhead seal would be designed to withstand an overpressure of 10 atmospheres or 150 psi to account for possible abnormal conditions. The lower seal would be positioned above the roof of the cavern in order to provide support rock of adequate thickness below the concrete while minimizing the supported casing weight. The concrete bulkhead would provide the casings with a vapor seal. Immediately above the bulkhead, expansion joints would be installed to allow for temperature-induced movements in the upper casings.

To provide lateral support for the casings, steel beams coated with epoxy (concrete beams could be selected in the final design phase) would be installed at regular intervals. These lateral supports would also provide useful access platforms for monitoring the ground water conditions behind the shaft lining. A concrete bulkhead would be installed in the production shaft (after salt production is halted) at approximately the same position as the lower bulkhead in the pump shaft. A manhole and vent pipe, used for venting the cavern during filling, would be provided in the concrete bulkhead seal of the production shaft.

2.3.1.2 Mine Caverns

Although the mine was excavated at one general level, the floor of the mine is quite irregular in elevation; some of the tunnel floors are below the average floor elevation of the older workings. Therefore, extensive drainage channels, or some filling of cavities with brine, would be needed; for this purpose, a mine survey would be required during the final design phase. A sump would be excavated and lined directly below the pump shaft (Figure 2.2-3). A screen would be placed around the sump area to prevent debris from entering the sump. In addition, a concrete curb would be placed around the sump to contain the sludge and water that accumulate in the cavern.

Rock bolts and wire mesh would be used in the area above the sump pump and into the shaft between the roof of the mine and the lower concrete bulkhead to prevent any rubble from falling into the sump area. Any materials that would float into the sump area would be secured or stabilized rather than removed. No rock bolting, bulkheading, grouting, or other structural preparation of the walls or roof of the cavern would be required before oil storage. The mine is watertight, with no faults or joints that might affect the integrity of the storage system.

Materials in shop areas, wooden boxes and crates, and wood-frame type buildings located in the mine would have to be either removed or secured by fencing off a room. Since the production facilities are able to use the finer salt fractions, relatively little waste salt is stored at Kleer Mine compared to most other salt mines. Waste salt in areas where it might restrict oil flow or become dissolved and flow into the sump would be spread and either water or a gunite and water mixture would be sprayed on the material. The spray would crystallize the surface salt, forming chunks that would not dissolve easily. A survey would be required to locate these waste salt areas.

For the option of no salt mine shutdown, some provision for emergency access and ventilation would have to be made while the service shaft is being converted. A manhole is planned through the concrete bulkhead in the service shaft for service as an escapeway. Ventilation would be provided by channelling air around a partition in appropriate rooms. When the cavern conversion process has been completed, the production and service shafts would be sealed except for a vent pipe through the bulkhead in one shaft.

### 2.3.2 Aboveground

Only a minimum of surface grading would be necessary to prepare the aboveground area for oil storage. In the immediate vicinity of the pump shaft, approximately 1 acre would be required for a new pump station. A plan showing the proposed substation, powerhouse, manifolding, meter proving loop, and metering system is presented on Figure 2.3-3.

Electrical power would be provided from an existing 12,470-volt Southwestern Electric Power Company transmission line terminating at a surface substation. Minor modifications to the existing distribution system and installation of a new 5000-kva electrical substation and transformer would be adequate to provide the necessary power supply for oil transfer and storage operation.

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

Two main pipeline pump units would be placed in series; they are designed for a 200,000 BPD withdrawal rate. Approximately 147,000 BPD can be pumped with only one unit operating. The pumps selected are single-stage double volute horizontal split-case centrifugal units, with 1250-horsepower horizontal induction electric motor drivers. The pump speed would be nominally 3600 RPM. The station discharge pressure would be relatively low and an ANSI 300 class system design can be used.

The piping and instrument diagram shown on Figure 2.3-4 indicates the equipment arrangement, oil flow direction, and preliminary control and monitoring equipment required for cavern fill and withdrawal. The design of the storage cavern pumping facilities is based upon expected average rates of fill and withdrawal given in section 2.3.4. The preliminary design for all oil-handling and distribution facilities was based on ANSI B31.4, Liquid Petroleum Transport Systems, and other applicable codes or standards currently being used by the petroleum industry in the United States. The design of pipelines and all equipment was based on crude oil having the following characteristics:

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

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

Production in the existing mine would be terminated to allow for final oil filling preparations. Hoist equipment and headframes at the production shaft (No. 1) would be dismantled, and a portion of the old conveyor system would be removed. Most of the existing buildings and other facilities at the site would be retained for utilization with production at the new mine. It may be possible under Option 2 to move most of the underground and production shaft equipment to the new mine; a more detailed equipment evaluation and schedule would be needed to confirm the condition, cost savings, and effects on production schedule.

### 2.3.3 Pipeline and Terminal

Kleer Mine is near the heart of the declining east Texas oil production fields, which are crossed by numerous small and large diameter underground pipeline systems. Most of the production from this area is allocated to local refineries or to common carrier pipelines. It is not likely that large quantities of domestic production would be available for storage filling, unless some trade arrangements were made. Most of the lines in this area would not be affected by foreign crude oil curtailments.

The Texoma pipeline system passes to the east of the mine and would carry large quantities of foreign crude oil from Port Arthur, Texas, to the Cushing, Oklahoma, distribution area (Figure 2.3-5). Ultimately, the Texoma line is expected to handle up to 500,000 BPD of foreign oil. The Texoma line could utilize all of the planned Kleer Mine storage during a crude oil supply interruption and could also supply oil to fill the cavern. For these reasons, Texoma was selected as the primary fill and withdrawal system for the Kleer Mine storage cavern.

There are two possible locations for connection to the Texoma system. Longview Terminal, where domestic lines deliver to and receive from Texoma, is approximately 54 miles from Kleer Mine (Figures 2.1-1 and 2.3-5). About 630,000 barrels of tankage have been installed at Longview. At Winnsboro Terminal, located 42 miles from the mine, Texoma can deliver to and receive from a Mobil 20-inch pipeline system which is part of a major east-west network. Texoma has a 90,000-barrel storage tank and Mobil has a 250,000-barrel tank at Winnsboro Terminal (Figures 2.1-3 and 2.3-6).

Winnsboro Terminal was selected in preference to Longview because of the lower capital investments involved (shorter pipeline with terminals equal) and the better fit with programmatic distribution plans (see Section 8.0). Thus, a 42-mile bi-directional underground pipeline system from the cavern site to Winnsboro on the Texoma system is planned (Figure 2.1-1).

Oil would be delivered to the Winnsboro Terminal by tanker and pipeline from the Gulf of Mexico. Oil would be offloaded from VLCC's to 30,000 deadweight ton (DWT) tankers in the Gulf south of Sabine Lake on the Texas-Louisiana border. The tankers would transport the oil from the transfer point through Sabine Lake to Nederland, Texas on the Neches River, a total of approximately 95 miles. Oil would be pumped into temporary storage at the Texoma Terminal, then into the Texoma pipeline for transport to Winnsboro, Texas. The proposed route is shown on Figure 2.3-8. All facilities required to transport the oil currently exist and are in operation; thus no new construction is required.

Delivery from Winnsboro Terminal to refineries would be via the Texoma pipeline and connecting distribution system. The allocation of oil to markets has not been made, however, and therefore the analysis of impacts during withdrawal extends only to Winnsboro.

To meet the 5-month withdrawal time planned for the Kleer Mine, the design distribution rate is 200,000 BPD. Establishing a fill rate, which affects the design of the mainline pumps at the terminal, is difficult until the FEA can negotiate with the pipeline company for line space. Based on an initial contact, it appears that Texoma may be able to supply the 50,000 BPD needed for cavern fill without expansion (assuming 600 days for fill period). A plot of these estimated fill and withdrawal rates is given on Figure 2.3-7. The fill rate might be increased in the event of a trade/supply situation from Mobil through their 20-inch pipeline system at Winnsboro. Because the exact rates could not be ascertained, the spur pipeline was preliminarily designed for a conservative capacity of 100,000 BPD.

Pipeline terminal facilities would be integrated with existing facilities at Texoma's Winnsboro Terminal. A general arrangement plan at Winnsboro is shown on Figure 2.3-6. It is estimated that 2 additional 90,000-barrel storage tanks would be required during fill and withdrawal operations. There is adequate land available for this storage, mostly owned by Texoma; however, a small additional purchase (approximately 1 to 2 acres) would be required. Other terminal facilities can be located on Texoma's property.

Two horizontal split case booster pump units would be used to pump oil out of the storage tanks and provide adequate pressure to deliver oil to the storage cavern at up to 100,000 BPD. These units are driven by 200-horsepower horizontal induction electric motors operating at nominally 1800 RPM.

It may be possible to utilize Texoma's existing substation and transformer if adequate capacities are available and if an agreement can be established with the power company. The estimated costs include an independent powerhouse building and requisite equipment (1500 kva electrical substation and transformer).

A metering system would be required for product accounting and pipeline leakage detection. These meters would probably also be the point of custody transfer to and from the cavern storage system. Texoma's existing meter prover and sump tank system can be utilized.

The facility design provides a supervisory control leak detection system and capability for rapid, safe shutdown. The dispatcher may observe the operational status from a single control station and activate automatic valves or back-up manual valves. The preventive (mitigative) environmental protection measures listed in Section 5.2.2 have been incorporated in the facility design.

A modern supervisory control system would allow the dispatcher to observe the status of operations at the pump station and terminal, and to shut down the flow in the system if any potentially dangerous deviation in normal operating conditions occurs. One function of the system would be to detect leaks by accounting for all volumes that the system receives and delivers, and detecting the occurrence of losses due to pipeline leaks. The pump station would be equipped with control capabilities that allow independent operation. Protective devices installed in the station would permit independent station shutdown in the event of an equipment malfunction.

The amount of time required to completely stop flow through the system would depend upon the system configuration and the operating conditions at the time of shutdown. Instantaneous shutdown of the pump station can be achieved by the dispatcher utilizing the supervisory control system or by activation of one of the alarms listed below:

1. Temperature alarm.
2. Pressure alarm.
3. Excessive pump case temperature and pressure alarms.
4. Low station suction pressure alarm.
5. High station discharge pressure alarm.
6. Level indicator.
7. Pressure safety valve.
8. Electrical overload alarm.

A 22-inch O.D., 0.25-inch wall pipeline system was determined to be the most economic configuration for distribution from the Kleer storage cavern to Texoma's Winnsboro Terminal. The preliminary 42-mile pipeline route parallels the Mobil 20-inch pipeline route where possible (corresponding to the straight segment adjacent to the terminal, Figure 2.1-1). There is a 70-foot elevation increase between the Kleer Mine shaft collar and Winnsboro Terminal.

Right-of-way procurement for this line is not expected to be a significant problem. Some re-routing of the line may be required in the final design phase, at which time a survey and detailed construction specifications would be prepared.

Conventional pipeline laying techniques would be used wherever possible. A right-of-way width of approximately 125 feet is generally required. The right-of-way would be cleared, trees and brush piled to one side of the right-of-way, the small branches shredded to mulch, and the large trunks piled in rows. Initial grading would be confined to the leveling necessary for safe and efficient operation of trenching and pipelaying machinery.

Trench excavation would be confined to a strip slightly wider than the pipe diameter. The spoil would be deposited along one side of the trench and would be backfilled after the pipe is in place and has been pressure-tested. Excess spoil would be graded to form a small berm over the pipeline trench so that a ditch would not be created as settlement occurs in the backfill over the pipe. Conventional, modern, and safely operated equipment would perform the work of laying, welding and lowering the pipe in conformance with Department of Transportation (DOT) Codes 192.221 through 192.245. Welds would be inspected using X-ray systems.

Immediately after construction is completed in a given area, work would begin (weather permitting) to restore the area to a stable condition as close as practicable to its original, pre-construction condition. The amount of work required would vary with the terrain and the amount of disturbance.

In laying pipe across soft flood plain soils and across stream beds, it may be necessary to use special equipment to gain access. An hydraulic dredge would be required at major stream crossings (perhaps the Sabine River) to excavate a trench deep enough to bury the pipeline without danger of scouring or erosion. Dredged material would be carefully placed in a diked, temporary spoil containment area to minimize water quality impacts. Because of the increased potential for habitat and water quality disruption in flood plains, the pipeline route has been selected to avoid these areas to the maximum extent possible.

### 2.3.4 Operations

The maximum design fill rate is 100,000 BPD. The scheduled filling rate is 50,000 BPD over 600 days. The desired average withdrawal rate is 200,000 BPD over a period of 150 days (Figure 2.3-7).

The oil storage facility is assumed to be emptied and refilled once every 5 years to meet national emergency conditions. Crude oil stored at Kleer Mine is expected to have unlimited storage (or "shelf") life (Johansen, 1976).

To maintain a state of operational readiness, it would be necessary to maintain a trained stand-by crew available to carry out oil transfer activities. A total of 8 to 10 men should be sufficient; only 2 or 3 of these need be familiar enough with overall operations to act in a supervisory capacity. The others can probably be drawn in part from the existing salt mine work force and might be used during cavern filling as well. During standby storage periods, a total of 3 or 4 permanent full-time employees would be sufficient for security, routine maintenance and equipment monitoring at the mine, pipeline, and terminal facilities.

Pollution generated at the storage facility would be minor and local. A temporary flare system would be used during fill periods for combustion of hydrocarbon and hydrogen sulfide vapors vented from the cavern. The venting would prevent excessive buildup of vapor pressure within the cavern during fill. Approximately 75 pounds per day of hydrocarbons (at a 50,000 BPD fill rate) would be emitted during this period; flaring is a standard method of reducing concentrations of combustible gases and $H_2S$ in the mine vicinity. (Further discussion of vapor emission and flaring is found in Appendix E.) After the cavern is filled, the vent system would be sealed and the flare system removed. During standby storage, vapor pressures within the cavern would not exceed 1.5 atmospheres and no escape route for the vapor would exist.

Minor amounts of liquid wastes would be generated at the site. Sanitary sewage would be disposed of in the existing sewage treatment system. Only during fill and withdrawal would significant numbers of workers be present. No significant ground water seepage occurs in the existing mine, although there is minor seepage at the service shaft. If small amounts of ground water did gradually accumulate in the cavern, the water could be periodically pumped to the surface and transported to suitable facilities for removal of oil, gas, and salts.

Oil spillage is the most significant potential source of pollution at the storage facility. An oil spill contingency plan is described in Appendix H.

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

Water supply for domestic purposes would be tapped from the existing plant system. No other significant quantities of water would be required.

### 2.3.5 Termination and Abandonment

For the purpose of analysis of environmental effects (particularly those related to oil spill potential), it is necessary to assign a useful life to the SPR storage facilities. There are two aspects to the definition of useful life which are appropriate for Kleer Mine. The first aspect is the engineering life of the facilities. For the caverns themselves, this may be almost indefinitely long; for pipelines, pump stations, storage tanks and other major hardware components it may be 20 to 30 years, possibly longer with proper maintenance. The second aspect is determined by need for the facility as protection against the effects of an oil supply interruption. Although foreign oil will remain an important source of energy for the nation through at least the year 2010, its percentage of U.S. consumption is expected to peak around 1990 (U.S. Dept. of Transportation, 1976) and decline steadily thereafter (as the nation develops alternative energy sources such as coal, nuclear power, and solar energy). Therefore, the incentive for arbitrary supply control (and thus, for protection against such control) as an economic strategy will begin to diminish in the 1990's. The volume of oil needed in storage could be reduced correspondingly.

The assignment of benefit life to strategic storage is speculative because there are many political uncertainties which will affect the development of the world petroleum market. In ascribing benefits to the storage project, the conservative stance is to set an economic life intermediate between the peak oil import period and the engineering life of new oil import and handling facilities. This would be about the year 2000, or a 22-year project life beginning 1978. For purposes of analysis, it will be assumed that 5 oil supply interruptions will occur during this period. Termination might initially consist of pumping oil out of storage and maintaining the facilities in case future needs arise. Eventually, it is expected that oil storage will no longer be in the national interest and operations will be terminated.

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

### 2.3.6 Costs

Table 2.3-2 summarizes the costs estimated for mine conversion, excluding acquisition and abandonment of the mine site. Capital costs, expressed in 1976 dollars, regionally adjusted, and not including interest or escalation during construction, are $0.47 per barrel, or $13,933 million (independent of mine development option). Operating costs, including labor required for inspection of the mine shafts and all oil distribution facilities, maintenance, taxes, insurance, and power, are estimated to be $277,700 per year for static storage, plus an additional $7,300 per month for filling, and $19,000 per month for withdrawal. These costs do not include transport of oil by tanker to Texoma Terminal or by pipeline to Winnsboro.

TABLE 2.3-1 Estimate of employment and earnings, mine conversion and replacement mine construction, Kleer Mine site

Option 1: No interruption of salt mining

| Week | | Average No. of Workers per Week | Average Annual Wage | Total Earnings | Number of Workers by Place of Permanent Residence: Within Local Commuting Area | Number of Workers by Place of Permanent Residence: Commuting from Dallas-Ft. Worth Area | Earnings by Place of Permanent Residence: Within Local Commuting Area | Earnings by Place of Permanent Residence: Commuting from Dallas-Ft. Worth Area |
|---|---|---|---|---|---|---|---|---|
| 47-97 (50 weeks) | Specialists (25%) | 65 | $ 22,000 | $ 1,430,000 | -- | (100%) 65 | $ -- | $ 1,430,000 |
| | Skilled (35%) | 85 | 18,000 | 1,530,000 | (60%) 51 | (40%) 34 | 918,000 | 612,000 |
| | Nonskilled (40%) | 100 | 12,000 | 1,350,000 | (100%) 100 | -- -- | 1,350,000 | -- |
| | Total | 250 | | $ 4,310,000 | 151 | 99 | $ 2,268,000 | $ 2,042,000 |
| 98-120 (22 weeks) | Specialists | 75 | $ 22,000 | $ 726,000 | -- | (100%) 75 | $ -- | $ 726,000 |
| | Skilled | 105 | 18,000 | 831,600 | (60%) 63 | (40%) 42 | 488,960 | 332,640 |
| | Nonskilled | 120 | 12,000 | 712,800 | (100%) 120 | -- -- | 712,800 | -- |
| | Total | 300 | | 2,270,400 | 183 | 117 | 1,201,760 | 1,058,640 |
| 120-140 (20 weeks) | Specialists | 25 | $ 22,000 | $ 220,000 | -- | (100%) 25 | $ -- | $ 220,000 |
| | Skilled | 35 | 18,000 | 252,000 | (60%) 21 | (40%) 14 | 151,200 | 100,800 |
| | Nonskilled | 40 | 12,000 | 216,000 | (100%) 40 | -- | 216,000 | -- |
| | Total | 100 | | $ 688,000 | 61 | 39 | 367,200 | 320,800 |
| | | | | $ 7,268,400 | | | $ 3,836,960 | $ 3,421,440 |

Option 2: Expedite reserve build-up

| Week | | Average No. of Workers per Week | Average Annual Wage | Total Earnings | Number of Workers by Place of Permanent Residence: Within Local Commuting Area | Number of Workers by Place of Permanent Residence: Commuting from Dallas-Ft. Worth Area | Earnings by Place of Permanent Residence: Within Local Commuting Area | Earnings by Place of Permanent Residence: Commuting from Dallas-Ft. Worth Area |
|---|---|---|---|---|---|---|---|---|
| 47-111 (64 weeks) | Specialists | 90 | $ 22,000 | $ 2,436,900 | -- | (100%) 90 | $ -- | $ 2,436,900 |
| | Skilled | 125 | 18,000 | 2,769,200 | (60%) 75 | (40%) 50 | 1,661,500 | 1,107,700 |
| | Nonskilled | 140 | 12,000 | 2,067,700 | (100%) 140 | -- -- | 2,067,700 | -- |
| | Total | 355 | | $ 7,273,800 | 215 | 140 | $ 3,729,200 | $ 3,544,600 |

TABLE 2.3-2 Cost summary for Kleer Mine project

Capital Costs[a]

| | Amount (Thousands of Dollars) | Amount (Dollars per Barrel) |
|---|---|---|
| Mine Conversion | | |
| Underground | 2,562 | 0.09 |
| Aboveground | 11,371 | 0.38 |
| TOTAL | 13,933 | 0.47 |
| New Mine Development | 15,693 | 0.52 |
| TOTAL PROJECT | 29,626 | 0.99 |

Operating and Maintenance Costs[b,e]

| | Yearly Expenses | Additional Monthly Expenses | |
|---|---|---|---|
| | Static Storage | Filling | Withdrawal |
| Mine Inspection and Maintenance | $ 37,000 | $ -- | $ -- |
| Power[c] | 46,700 | 1,400 | 10,100 |
| System Operations Personnel | 20,800 | 5,000 | 6,600 |
| Ad Valorem Taxes[d] | 96,000 | -- | -- |
| Insurance | 48,200 | -- | -- |
| Other Expenses | 29,000 | 900 | 2,300 |
| TOTAL | $ 277,700 | $ 7,300 | $ 19,000 |
| Cost (cents/barrel) | 1.12 | 0.02 | 0.06 |

[a]Not including site acquisition and abandonment, and purchase of oil. Costs are not affected by development option.

[b]Does not include any amount for product loss or depreciation, or for new mine operation.

[c]Power costs are based upon Large Lighting and Power Service rates from Southwestern Electric Power Company.

[d]Ad valorem tax is applicable only if the facility is privately owned.

[e]Does not include marine oil transport.

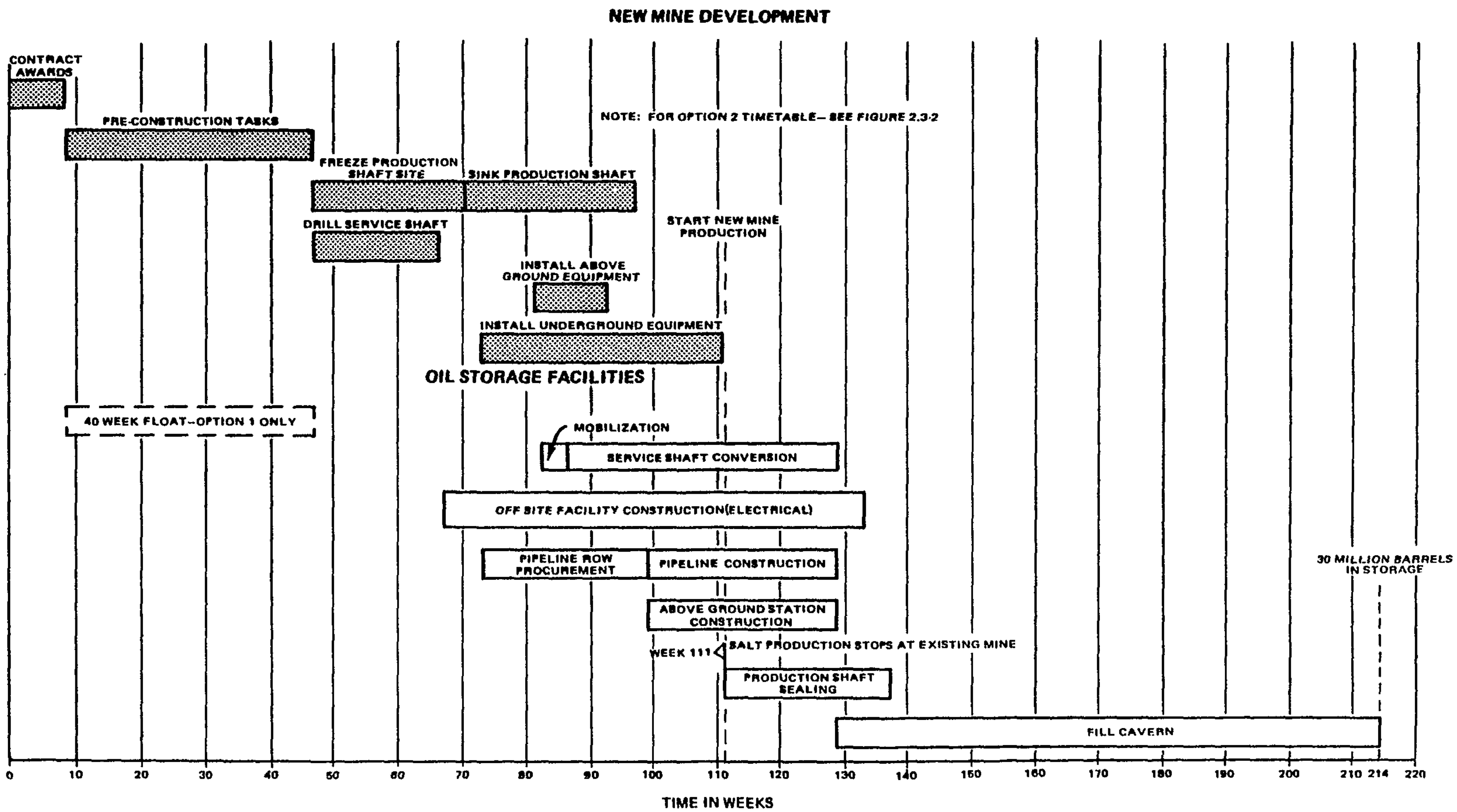



Figure 2.3-1 Construction schedule for Option 1: no interruption of mining

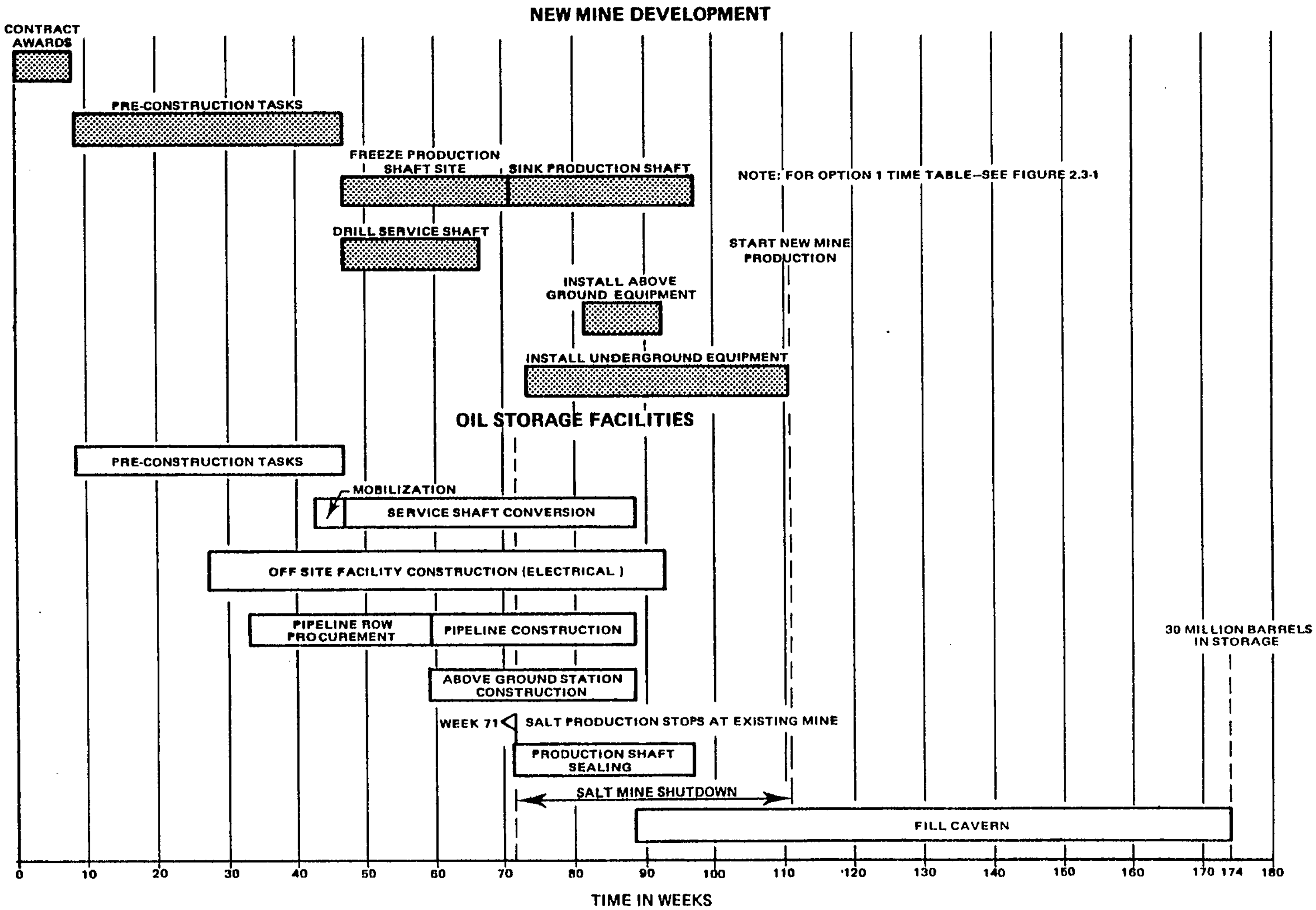
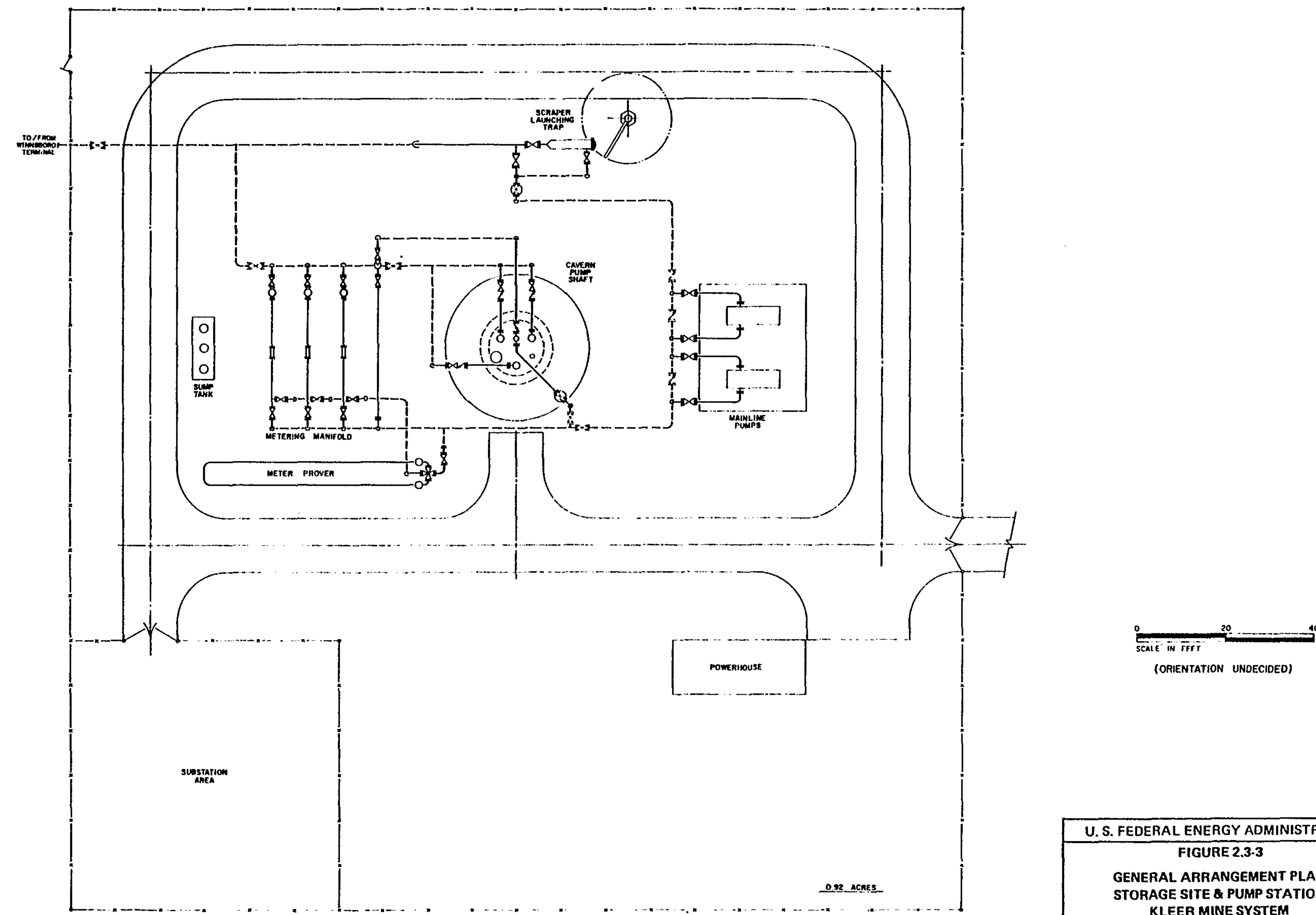


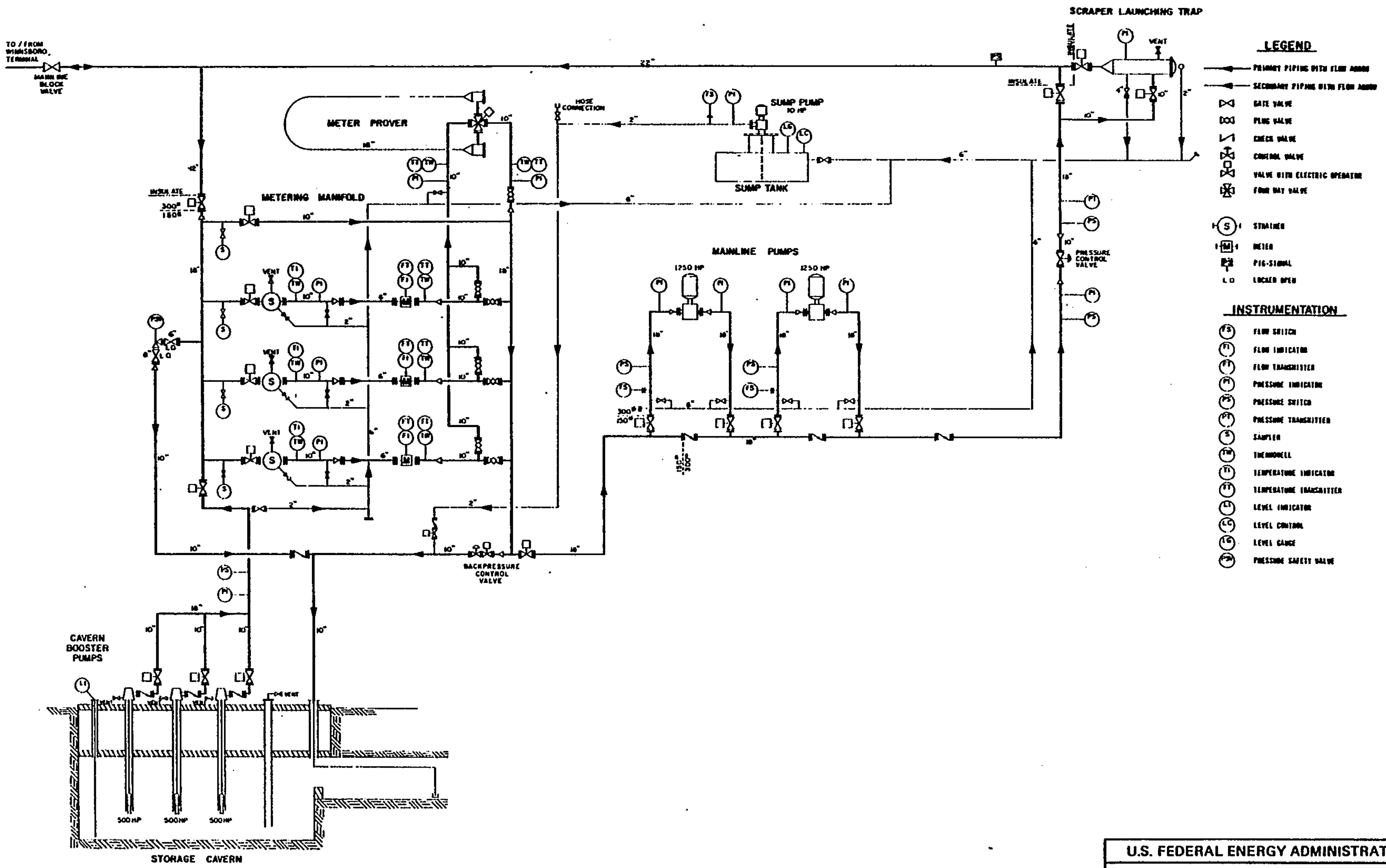

Figure 2.3-2 Construction schedule for Option 2: expedited oil storage with temporary mine shutdown




U. S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-3

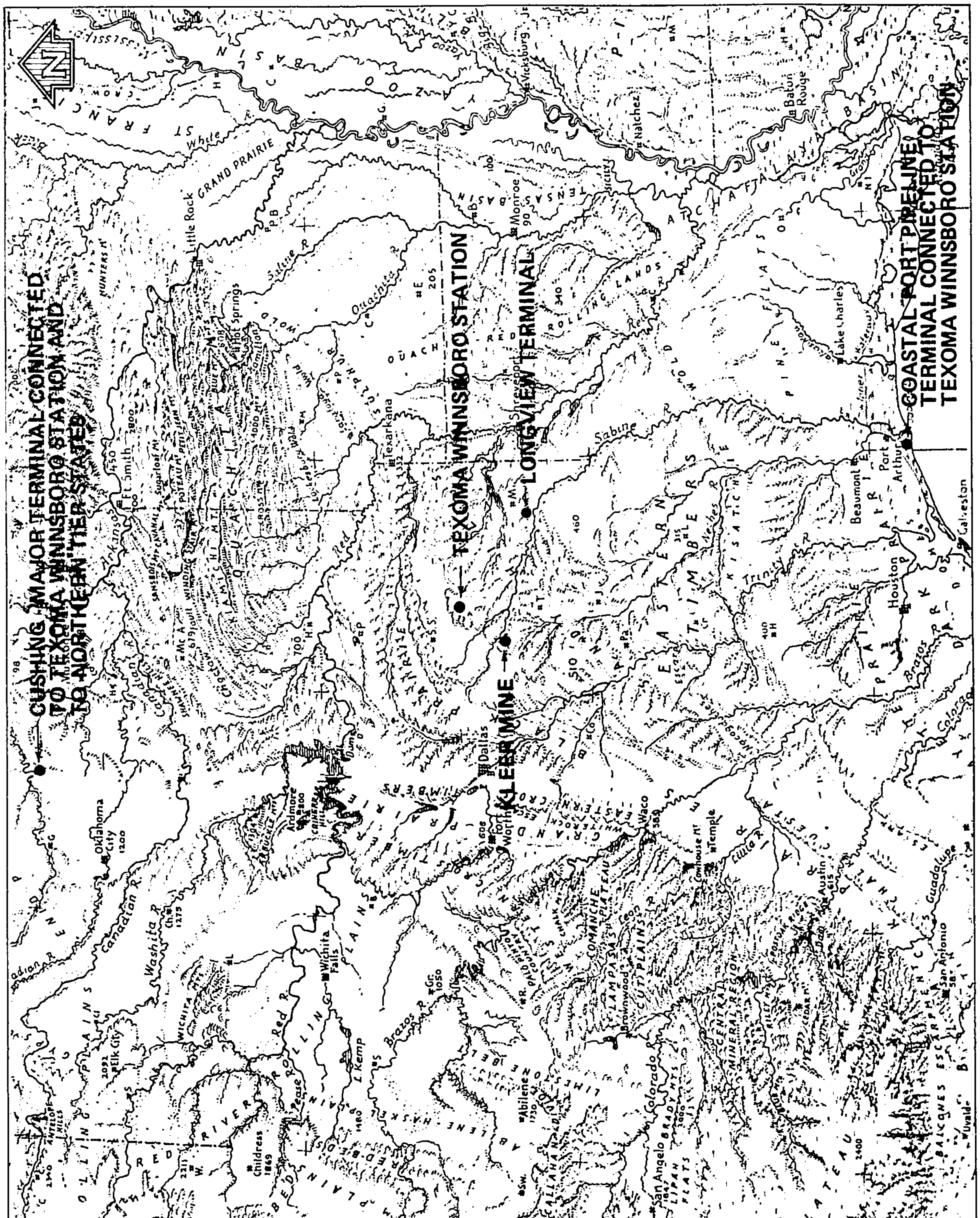
GENERAL ARRANGEMENT PLAN
STORAGE SITE & PUMP STATION
KLEER MINE SYSTEM




U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-4

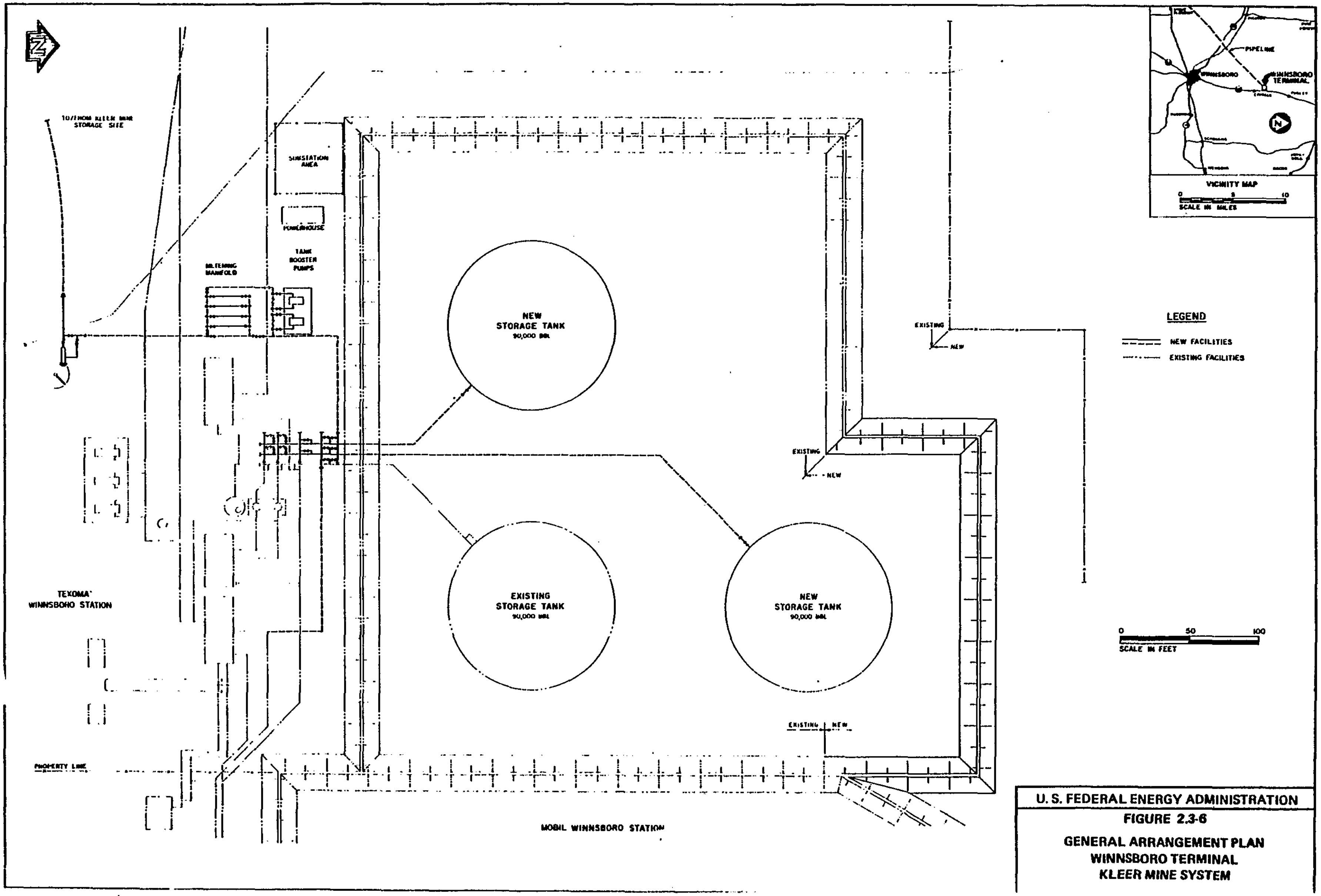
PIPING & INSTRUMENT DIAGRAM
STORAGE SITE AND PUMP STATION
KLEER MINE SYSTEM




SOURCE: LANDFORMS OF THE UNITED STATES, 6TH REV. ED., ERWIN RAISZ, CAMBRIDGE, MASS. (1957).

25 0 25 50
SCALE IN MILES

FIGURE 2.3-5 Location of pertinent oil pipeline terminals




U. S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-6

GENERAL ARRANGEMENT PLAN
WINNSBORO TERMINAL
KLEER MINE SYSTEM

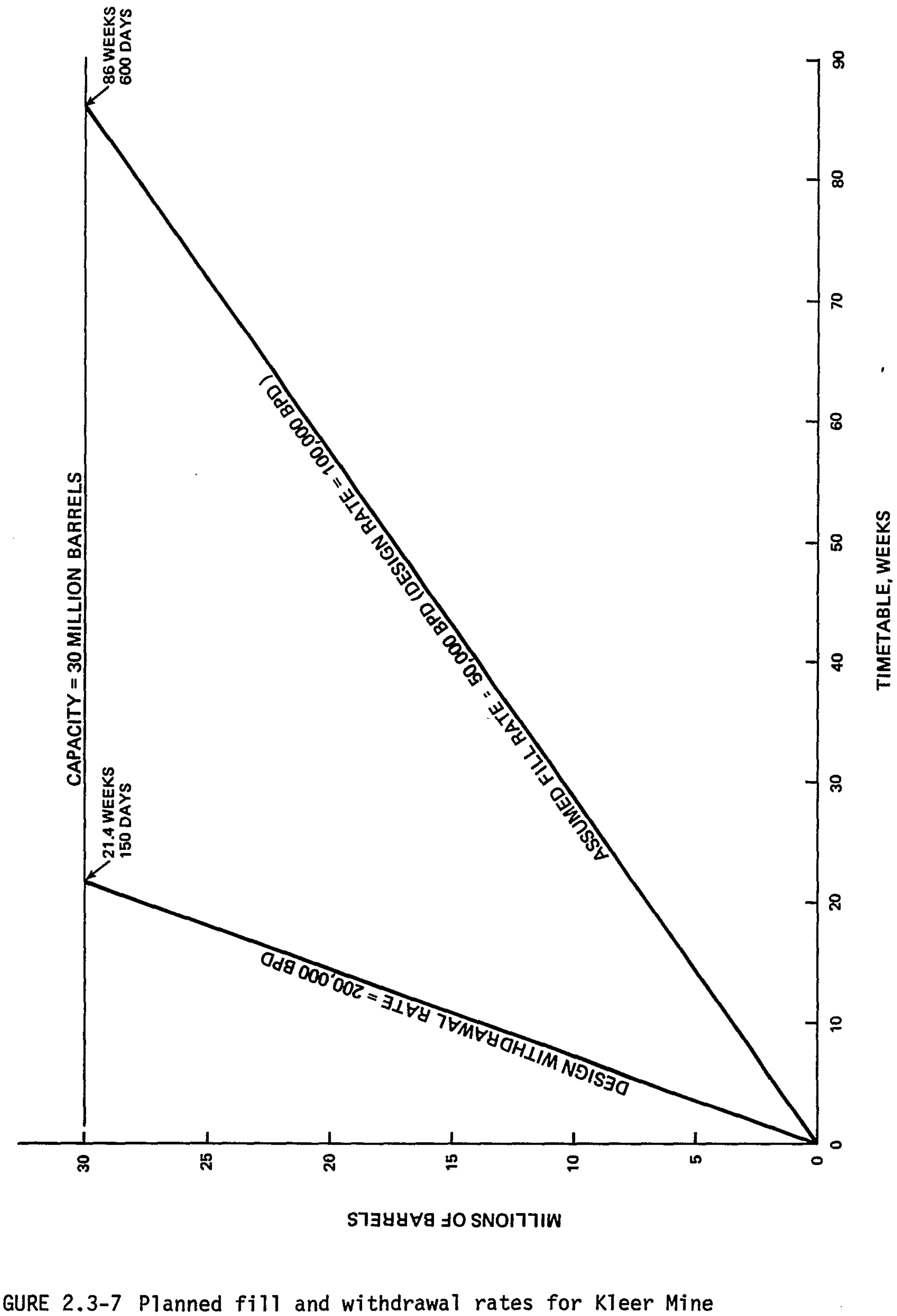



FIGURE 2.3-7 Planned fill and withdrawal rates for Kleer Mine

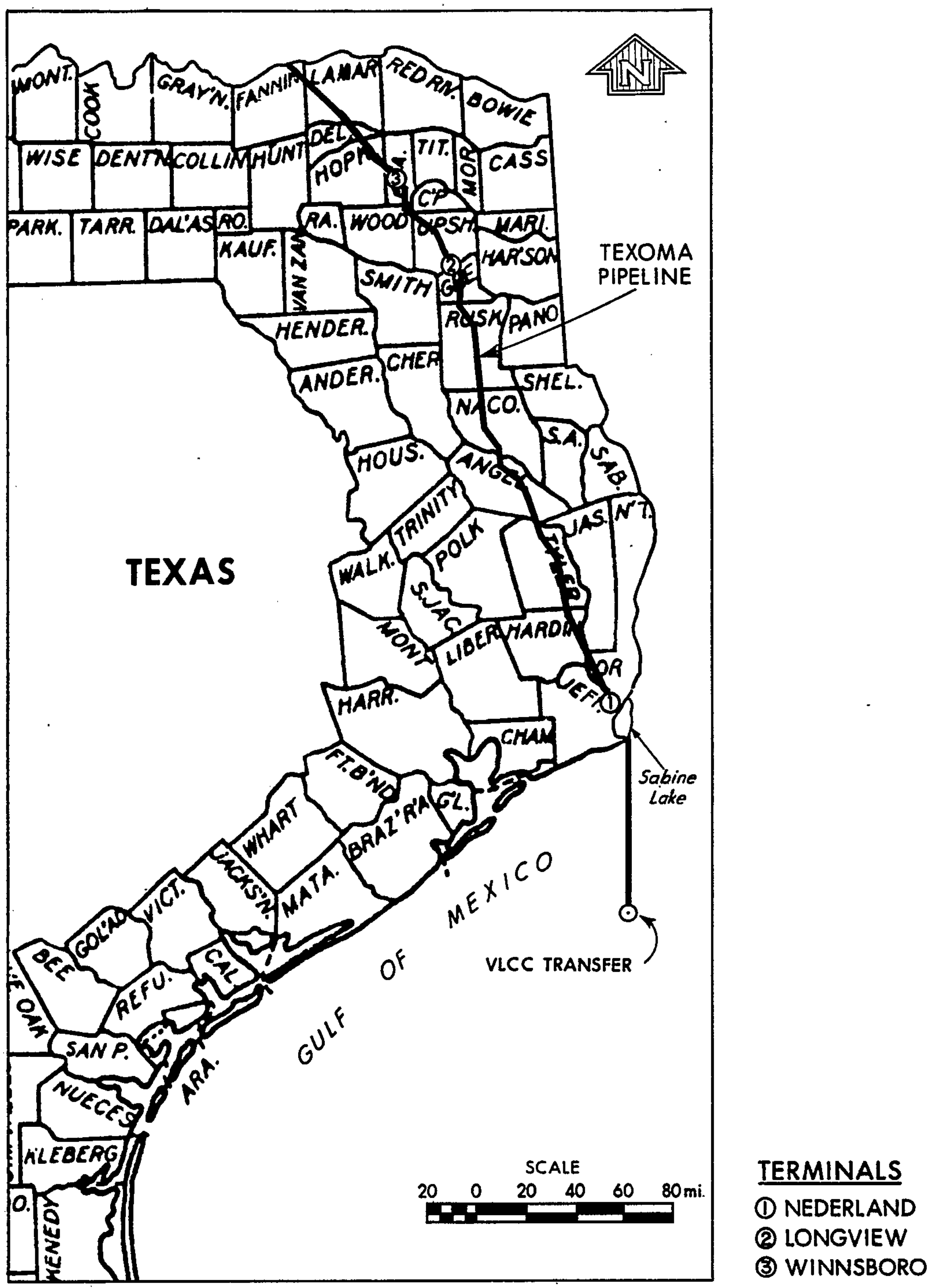



Figure 2.3-8 Marine and pipeline transportation routes to be used for delivery of crude oil to Winnsboro

## 2.4 NEW MINE DEVELOPMENT

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

The FEA is considering two possible plans for scheduling the new mine construction. Figures 2.3-1 and 2.3-2 indicate the anticipated construction and fill schedules for each of these plans. Option 1 allows completion of the new mine prior to closing the existing mine. This would avoid any disruption of salt production, but would require a delay of 40 weeks in converting the existing mine. Such a delay could reduce the storage capability of the facility within the time frame of the SPR (January 1979) to about 9.5 million barrels or less, depending upon when construction begins. Option 2 provides for conversion of the existing mine in the most expeditious manner possible, including closing production operations at a point in time that would prevent delay of the conversion effort. Approximately 23.5 million barrels could be in storage by January 1979 with this option. Although new mine construction could occur concurrently with conversion activities, this plan would result in a suspension of salt production for about 40 weeks. This could impact significantly upon the socio-economic environment (see section 4.2.7). A comparison of the required manpower (and associated earnings) for conversion and new mine construction under each of the plans is given in Table 2.3-1.

Although the decision to construct the new mine and the construction activity itself would be the responsibility of Morton, a new mine design has been assumed here for purposes of analysis.

The design concept for the new mine is to provide equivalent facilities suitable for the current production capacity and work force at the earliest possible time with either Option 1 or 2. Existing aboveground facilities would be retained to the extent practical; the amount of underground equipment salvaged would depend upon the development schedule and the condition of the equipment.

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

Based on the existing Kleer Mine layout, the shaft arrangement includes a low extraction ratio in the area of the shaft. This ratio is much less than in the working area of the mine, and the shafts are separated by several hundred feet. These factors are included in the layouts of the relocated mine.

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

### 2.4.1 Underground

The production shaft design for the relocated mine duplicates shaft No. 1 at the existing facilities with regard to diameter, type and depth of lining, and shaft fixtures. The existing 12-foot service shaft may be replaced by a 9-foot shaft in the new mine, however. Foundations for head frame, hoist equipment, and shaft collars were calculated to support the same hoisting loads and handling equipment that are being used at the existing mine. The relatively large diameter of the production shaft dictates that the sinking method of excavation (in which a hole is blasted and/or dug, and a liner is poured) would have to be used. The 9-foot service shaft diameter has been chosen so that it can meet ventilation requirements and still be drilled (usually by rotary drill, with continuous casing in unstable sections), since shaft installation by drilling is much faster than using sinking methods. There is some disagreement among contractors as to the maximum diameter shaft that can be drilled. Therefore, at the time of final design, the service shaft diameter might be increased. The shafts would be sunk after a geotechnical exploration at the surface and within the dome locates the optimum shaft sites.

Each of the shafts would be lined at least 200 feet into the salt and provided with ground water seepage monitoring equipment similar to that installed in the converted pump shaft. The new shafts would be separated by 500 feet, and due consideration has been given to the extraction ratio used around shafts in the existing mine. The new production shaft is located approximately 1300 feet away from the existing shaft, with the cavern perimeters separated by 300 feet.

The 16-foot diameter production shaft would be excavated by conventional mining methods. To minimize problems with ground water and shaft collapse during sinking, ground freezing techniques would be employed in the overburden above the salt. With this method, calcium chloride brine is circulated from a refrigeration plant at the surface through a series of 6-inch pipes installed in vertical holes drilled in a circle 10 to 20 feet outside the planned perimeter of excavation. After the ground is frozen, some variant of the conventional drill and blast process is applied to excavate the shaft.

Opening the new mine is essentially a 3-phase process:

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

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

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

The production potential at Kleer Mine is at least 250,000 tons annually. Prior to being hoisted, primary and secondary crushing and screening of the rock are done. The same facilities are included in the plans for the new mine. Based on present equipment used in the existing mine, and on production requirements, the following new equipment would be required to open the new mine:

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

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

### 2.4.2 Aboveground

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

Existing office buildings, storage areas and parking lots would be retained for use with the new mine if at all possible.

### 2.4.3 Operation

Production at the new Kleer Mine would continue unchanged by the oil storage project (except for the possible temporary shutdown associated with development Option 2). Production potential, employment level, and working conditions would remain unaltered.

### 2.4.4 Costs

Construction costs for developing the new mine are estimated to be $0.52 per barrel storage capacity, or $15.7 million (see Table 2.3-2). Total project costs are thus $0.99 per barrel storage capacity, or

$29.6 million, including mine conversion costs but excluding site acquisition and abandonment costs. Estimates include duplication of all underground and production shaft equipment, some of which might be salvaged under Option 2. These costs are estimates which do not take into consideration project details.

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SECTION 3.0

DESCRIPTION OF THE EXISTING ENVIRONMENT

## 3.1 INTRODUCTION AND SUMMARY

Kleer Salt Mine is one of the proposed crude oil storage facilities suitable for the Early Storage Reserve, a part of the Strategic Petroleum Reserve storage program. This section summarizes the existing physical, biological and socioeconomic environments surrounding the mine site, proposed pipeline route, and connecting terminal. Detailed site information for Kleer Mine, Winnsboro Terminal and the connecting pipeline is given in Sections 3.2 through 3.9. Environmental characteristics of the oil transportation route between the Gulf of Mexico and Winnsboro are provided in Section 3.10.

### 3.1.1 Existing Site Environment

Kleer Mine is located within the Grand Saline salt dome in northeastern Van Zandt County, Texas (Figure 2.1-1). The proposed pipeline route extends from the Kleer mine northeast through Van Zandt, Wood, Hopkins, and Franklin Counties to the Texoma-Winnsboro Terminal (Figure 3.2-2). The mine site is approximately 1 mile south of the town of Grand Saline and 4 miles southwest of the Sabine River. Grand Saline salt dome is one of the 18 known domes that pierce the East Texas Embayment, a northeast trending syncline of the Texas Coastal Plain. The dome extends downward from 200 feet below the surface to a depth of 15,000 to 20,000 feet (location of the Louann salt bed). It is roughly 8000 feet in diameter and nearly flat at the top. Underground room-and-pillar mining has been carried on by the Morton Salt Company since 1929.

On the surface of the dome, adjacent to the mine site, there is a depression which is partially occupied by a salt marsh and encircled by low hills that formed when the rocks were uplifted and tilted by the piercement of the salt dome. The surrounding land is on the southeast edge of the Texas Blackland Prairie, near the transition zone with the east Texas timberlands. Dominant characteristics of the land are gently rolling hills covered in oak-savannah vegetation interspersed with thickets and flood plain hardwoods. Elevations within 1 mile of the site range from 360 feet above MSL to about 455 feet above MSL.

Major streams in the area are the Sabine River and Lake Fork Creek (a tributary to the Sabine). Grand Saline Creek is located less than

1/2 mile from the mine site. The flood plains are generally covered in dense bottomland hardwoods. There are several water development projects in the area, and more are planned. These provide recreation and dependable water supply to the local population.

The climate is characterized as subtropically-humid with mild winters and hot summers. Rainfall averages about 43 inches per year. The lack of heavy industry and population centers, and the location in a region of extended prairie terrain with excellent ventilation result in generally excellent regional air quality.

The site is within the extensive east Texas oil field region. Dominant land use is beef cattle pasture, with some agriculture and timber harvesting. Widespread lumbering, cultivation of cropland, oil field development, and cattle industries have left few unmodified areas except along some of the flood plains. No unique or endangered species of plants or animals are known to occupy the region.

A number of archaic and neo-American archaeological sites are known or suspected in the project area, some of which have been examined by excavations. Two historical sites are listed (Grand Saline Salt Dome and Rock Hill Baptist Church) as being near the proposed disturbance areas.

The area is not densely populated (20 to 40 persons per square mile). Towns are generally less than 10,000 population. Dallas, 70 miles to the west, is the largest nearby city.

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

Van Zandt County and the East Texas Planning Region are expected to continue the relatively slow population growth of the past 15 years. Planned water resource projects in the area will provide additional recreation opportunities and increase the visual attractiveness of the area. A number of archaeological sites have been or will be professionally excavated during reservoir and dam site clearing operations.

The trend toward fewer and larger farms will probably continue. Marginal croplands will be converted to pasture and contribute to the growth of the livestock industry. Oil and gas production will probably continue a slow decline as reserves are reduced. Few new oil or gas discoveries are expected in such a heavily explored area; however, improved recovery techniques could revive the regional oil and gas production.

At Kleer Mine, salt production and processing is expected to continue on a scale similar to that of the recent past. The surface is privately owned and not likely to be sold or developed for other uses.

Future conditions without the project are therefore expected to remain little changed from present conditions.

## 3.2 GEOLOGY

The earliest record of salt mining at the Grand Saline salt dome was during the Civil War. Salt was recovered by shallow brine wells that produced an estimated "one thousand 200-pound sacks per day" (Powers and Hopkins, 1923). Brine well operations continued under various owners until 1929, when the Morton Salt Company sank its first deep shaft. Although the brine wells continued working, the main operation became underground room-and-pillar mining. At present, average annual production at the mine is 250,000 tons at a rate of 1000 to 1500 tons per day.

### 3.2.1 Physiography and Topography

The proposed project is within the West Gulf Coastal Plain, a section of the Coastal Plain Physiographic Province (Figure 3.2-1). The West Gulf Coastal Plain can be separated into an inner and outer portion. The outer portion consists of a series of coalescing deltaic and alluvial plains that form seaward facing scarps; this portion extends from the Gulf of Mexico inland about 120 miles. The inner portion, which is adjacent to the Great Plains Physiographic Province, contains a series of lowlands and low, west-facing scarps that have formed on more resistant Tertiary and Cretaceous age rocks. The project is located in the inner portion within one of the lowland areas, where the terrain is gently rolling, becoming flat along flood plains (Figure 3.2-2).

An unusual geomorphic feature of northeast Texas is the phenomenon of "pimpled ground" areas covered with small mounds generally 30 to 35 feet in diameter and 2 to 3 feet high with no discernible pattern. Various theories have been used to explain these mounds, such as animal burrows and gas bubbles, but recent studies have shown them to be "micro-knolls," resulting from low stream base profiles, low regional dip and a lithologic composition of interbedded clay, sand, and silt (Goebel and Hoover, 1971). The microknoll topography is a small-scale local mature topography that has developed on the regional topographic surface.

The Grand Saline salt dome exhibits typical salt dome surface topography. A central depression, which at Grand Saline is partially occupied by a salt marsh, is encircled by low hills that have formed on the rocks that have been uplifted and tilted by the piercement of the salt dome (Figure 3.2-3). Elevations within 1 mile of the Kleer Mine site range from about 360 feet above MSL to about 455 feet above MSL, resulting in 95 feet of local relief (Figure 3.2-4). The hills north and west of the site are slightly higher than those to the south and southeast.

Drainage in northern Van Zandt County follows Sabine River River and its principle tributaries: McBee, Mill, Caney, Village, and Grand Saline Creeks. Drainage from the site is into Grand Saline Creek, which passes about 0.7 mile southeast of the site. From there, the Grand Saline Creek flows eastward about 6 miles where it empties into the Sabine River.

The proposed oil pipeline would extend to a point about 6 miles north of Winnsboro, in Franklin County (Figure 3.2-2). This site is also within the West Gulf Coastal Plain Physiographic Province. The Winnsboro Terminal and the northernmost 5 miles of pipeline lie in the Big Cypress Creek Watershed of the Red River Basin. Physiography pertinent only to a general description of the Red River Basin Watershed is briefly discussed in section 3.3.1.1.

### 3.2.2 Regional Stratigraphy and Tectonic History

The oldest rocks known to underlie the West Gulf Coastal Plain are Paleozoic meta-sedimentary rocks that were metamorphosed during the Ouachita Orogeny, a major tectonic movement. The orogeny was caused by compressional forces from the south and southeast during mid-Pennsylvanian time.

Following the Ouachita Orogeny, the region was subjected to tensional forces, causing block-faulting along the interior periphery of the West Gulf Coastal Plain. A series of Triassic-age sediments, mainly clastics, were deposited over the faulted surface (Table 3.2-1). During middle to late Jurassic time, the Gulf Coastal Plain began subsiding and tilting seaward, resulting in the deposition of both clastic and carbonate shelf deposits. During this period the Louann Salt, the mother salt for Gulf Coast salt domes, was laid down and the East Texas Embayment began deepening.

The beginning of the Cretaceous period brought a northwest transgressing sea along with continued subsidence and gulfward tilting of the Gulf Coastal Plain. By Upper Cretaceous time the sea, though still transgressing, was undergoing great fluctuations, which resulted in widespread deposition of sandstones, shales, marls, and chalks (Table 3.2-1). Volcanic activity outside of Texas supplied vast amounts of ash to northeast Texas, also during Upper Cretaceous time.

Cenozoic age deposition was controlled by a rise of the continental landmass causing a gulfward migration of depositional centers. The inner portion of the West Gulf Coastal Plain remained relatively stable, however, and received a thick mass of deltaic sands and shales as the Eocene coastline migrated gulfward. Although subsequent sea level fluctuations affected sediment deposition in the outer portion, the inner West Gulf Coastal Plain has remained above sea level since Eocene time.

### 3.2.3 Geologic Structure

The site lies on the western flank of the Mississippi Embayment, a great downwarp of Cretaceous and Tertiary age rocks that extends eastward to Alabama, northward to southern Illinois, and westward almost 400 miles into Texas (Figure 3.2-5). The regional structure in eastern Texas is a broad homocline striking northeast with a southeast dip as a result of the Mississippi Embayment downwarping; however, more localized structures, mainly uplifts, downwarps, and fault systems, have affected the distribution and attitudes of the sedimentary rocks.

One of these, the Sabine Uplift, a 100-mile diameter domal structure centered 100 miles east of the site, has persisted as a positive structural element throughout the Cenozoic Era (Figure 3.2-5). Rock units thin across it and several short, discontinuous faults have developed across it and along its flanks.

The East Texas Embayment is a trough-like basin with a northeast trending axis east of Van Zandt County. This downwarp, which began developing during the Jurassic period, collected a thick sequence of Eocene age sediments. The weight of the sediments may have weakened portions of the embayment, allowing salt domes to pierce it. The Grand Saline salt dome is one of these. The Van dome, located 10 miles south of the site, has been formed by a similar rising salt dome.

The Mt. Enterprise Fault System is related to the Sabine Uplift and the East Texas Embayment (Figure 3.2-5). The fault system, located about 70 miles southeast of the site, forms a graben structure by means of normal, east-northeast trending faults that dip to 35 to 50 degrees. The faults are probably the result of tensional stresses created by the arching or draping of sediments over a basement high connecting the Sabine Uplift and the East Texas Embayment. The faulting began in the Lower Cretaceous period and continued into middle Eocene time.

The most extensive fault system in the region is the Balcones-Mexia-Talco Fault System, a complex system of normal faults that developed at the edge of the West Gulf Coastal Plain in response to the collapse of the Ouachita Orogeny. The Mexia-Talco Zone, the northern section of the system, is more than 500 miles long and comes within 25 miles of the site to the west (Figure 3.2-5). Here the zone trends north-northeast, with dips of 30 to 55 degrees, and forms complex graben structures with up to 600 feet of displacement. Thirty miles farther north the zone bends sharply to the east. The major movement of the Mexia-Talco Fault Zone was from Jurassic to Oligocene time, with its final activity occurring possibly as late as the Holocene epoch.

### 3.2.4 Regional Seismicity

A subjective assessment of earthquake effects (i.e., damage) has been used to categorize earthquakes since earliest written record. Different damage scales have been developed, but the scale most commonly used in the United States and many other countries is the Modified Mercalli Intensity scale (Table 3.2-2).

The northeast Texas region is one of low seismicity. Documentation of its earthquake history has been limited by inadequate instrumental coverage and a generally sparse population. Earthquakes rarely occurred that were of sufficient intensity to be identified as an earthquake prior to instrumental coverage. Figure 3.2-5 shows the epicentral locations and intensities of all earthquakes that are known to have occurred within 200 miles of the site.

The largest earthquake in the region was of Modified Mercalli Intensity (MMI) VII and occurred on October 22, 1882, in western Arkansas, about 180 miles from the site. Although felt over 135,000 square miles, the only damage reported was movable objects overturned and bricks thrown from chimneys.

On January 8, 1891, another reported MMI VII event occurred at Rusk, Texas, about 65 miles southeast of Grand Saline. Though several chimneys were reported leveled, surrounding communities reported feeling nothing. Reinvestigation of the Risk event suggests that it may have been a less intense earthquake, or even a very severe storm. Weather maps at the time showed a storm front moving through the region about the same time that the earthquake was supposed to have occurred (Dames & Moore, 1974).

Two MMI VI earthquakes had epicenters within 200 miles of the site. The first, the Wortham-Mexia earthquake, occurred April 9, 1939, about 80 miles southwest of the site. The shock caused little damage; some loose bricks were thrown from chimneys and small plaster cracks developed. It was also felt over the relatively small area of 1000 square miles.

On October 14, 1968, another MMI VI earthquake took place in the area of Durant, Oklahoma, about 110 miles northeast of the site. This shock was felt only locally, but caused windows to break, plaster to crack, and existing wall cracks to enlarge.

The closest earthquake epicenter to the site was that of the 1957 MMI V event, situated 60 miles to the southeast. The shock came on March 19 and was felt over 10,000 square miles in northeast Texas. However, damage was slight, with only two windows broken and small movable objects overturned.

Epicentral locations are related to tectonic features in order to assess the potential of a certain intensity earthquake occurring within a certain distance of the site. If an event can be related to a specific structure, it is assumed that a similar event can recur anywhere along the structure. If no relationship can be established, the events must be regarded as random events that can occur anywhere within the tectonic province with which they are associated.

The 1882 earthquake, the largest documented event within 200 miles of the site, is related to the Ouachita Tectonic Province, and the 1968 shock is related to the Wichita Orogenic Province. Neither is related to any specific structures. Both are separated from the site by the Mexia-Talco Fault System, which serves as a tectonic buffer or boundary (Dames & Moore, 1974).

The 1932 Wortham-Mexia earthquake is associated with the Mexia-Talco Fault System, which passes within 25 miles of the site. Since the "felt" area for the shock extended only about 19 miles east of the fault zone (Dames & Moore, 1974), an earthquake of similar intensity occurring within the fault zone at its closest approach to the site would hardly be felt.

The 1957 earthquake is related to the Mt. Enterprise Fault System, which passes within 55 miles southeast of the site. The Rusk event, if it was an earthquake, would be related to the Mt. Enterprise Fault System. The recurrence of similar events would produce no greater than an MMI IV at the site.

All other events within 200 miles of the site are of MMI V or less, and are related to specific structures other than the East Texas Embayment. The recurrence of similar events would be felt very slightly, if at all, at the site.

If an event similar in intensity to the 1882 earthquake of MMI VII occurred at the Ouachita Tectonic Province's closest approach to the site, it could result in an MMI VI being felt at the site. An MMI VI would not affect the underground oil storage, but it could cause some minor damage to the surface facilities.

### 3.2.5 Mineral Resources

Although salt domes often have large associated oil and/or natural gas deposits, the Grand Saline salt dome has produced no significant amounts of either. Numerous test wells have been drilled along the periphery of the dome, but only one well is known to produce oil, and its production is very low. At present, natural gas wells for production are being drilled along the northern perimeter of the dome, north of Grand Saline.

Lignite is a potential resource of the area and was mined extensively prior to the large-scale use of natural gas. Mining was done by means of shafts and open pits between 1890 and the late 1940's. The principle lignite deposit in the area is a 10-mile band that extends from eastern Rains County to central Wood County, north of Van Zandt County. Although there are some thin lignitic layers above the salt dome, they are not extensive enough to mine.

Another resource of the area is clay, both ceramic and nonceramic. At present, no attempt is being made to commercially exploit the clays, and the total size of the deposits is uncertain. At one time, however, clay was mined by means of open pits south and west of Alba and between Alba and Quitman, (see Figure 2.1-1) for local use and for export.

Iron ore, resulting from the weathering of greensands and other iron-bearing materials, is another mineral resource of northeast Texas. However, the largest deposits of iron ore are in the Queen City Sand and younger formations that crop out east of the area of interest.

Sand and gravel deposits are relatively uncommon in the area. The nearest sand deposit is south of Winnsboro, 40 miles away.

Salt, of course, is the most abundant resource in the Grand Saline area and is very common throughout northeast Texas in numerous salt domes (Figure 3.2-5).

### 3.2.6 Site Geology

#### 3.2.6.1 General

The site is located on the northwestern flank of the East Texas Embayment, (Figure 3.2-5) a trough-like structure with the axis trending northeast through Smith County east of Van Zandt County. Due to this downwarp, the sedimentary units in the project area generally crop out in northeast trending belts and have a southeastward dip. The Grand Saline salt dome is one of 18 known salt domes that have pierced the embayment, tilting and uplifting adjacent beds.

Except for alluvium, all the rock units cropping out in the site vicinity are Eocene in age (Figure 3.2-6). The oldest is the Midway Group, composed mainly of calcareous clays. The Midway Group crops out 10 miles west of the site, but is significant in that it forms a basal confining layer for ground water in the overlying aquifers (White, 1973).

Overlying the Midway Group is the Wilcox Group, which crops out at the site and in the vicinity of Grand Saline. More than half of the Wilcox Group is composed of medium- to very fine-grained quartz sand, normally in thin, lenticular layers. The same portion of the Wilcox Group is over 900 feet thick in some places and is the principal source of ground water in the area (see section 3.3.2 also). The remainder is a heterogeneous accumulation of sandy clay and shale, cross-bedded ferruginous and micaceous sandstone, lignitic shale and lignite.

Areas underlain by the Wilcox units form slightly undulating to hilly terrain that is well drained. Soils that develop on the Wilcox Group are generally grayish-brown, sandy loam near the surface, but become mottled red, yellow, and gray acidic clay or sandy clay 6 to 12 inches below the surface (White, 1973).

Four miles east of the site, the Carrizo Sand, part of the Claiborne Group, crops out. It is a white to gray, fine- to medium-grained quartz sand with minor amounts of silt and clay, and is up to 150 feet thick. Together with the Wilcox Group and the overlying Reklaw Formation, the Carrizo Sand forms the Carrizo-Wilcox Aquifer.

The Reklaw Formation crops out 5 miles east of the site. It is also part of the Claiborne Group and contains a lower member, the Newby Sand, and an upper member, the Marquez Shale. The Newby Sand, which is hydraulically connected with the Wilcox Group and the Carizzo Sand, is a gray to green, fine- to very fine-grained glauconitic sand, 20 to 30 feet thick. The Marquez Shale, a black to brown silty, carbonaceous shale 30 to 40 feet thick, forms a hydrologic boundary that retards the vertical movement of water. The Marquez Shale and the lower Midway Group, therefore, create effective and persistent confining layers above and below the Carrizo-Wilcox Aquifer (White, 1973).

Overlying the Reklaw Formation is the Queen City Sand, another unit fo the Claiborne Group. The Queen City Sand, a fine- to medium-grained quartz sand with some silt and clay, is a secondary aquifer to the area. Although its nearest outcrop is 6 miles east of the site, it is significant hydrologically.

Alluvium is the only other recognized geologic unit in the site vicinity. The alluvia materials are clay, silt, sand, and minor amounts of gravel. Alluvium found in the flood plains of the Sabine River and its principle tributaries is generally less than 10 feet thick. However, it can be up to 50 feet thick along the river (White, 1973).

Although the sedimentary rocks in the site area form a simple homocline that dips southeasterly at 50 to 80 feet per mile, in the immediate site vicinity they form a quaquaversal, or domal, structure. Wilcox beds adjacent to the Grand Saline salt dome have been uplifted and tilted so that they dip as much as 20 degrees away from the center of the salt dome. The dips flatten rapidly, however, and only an area 3 miles in diameter exhibits surface effects of the salt dome (Powers and Hopkins, 1923).

#### 3.2.6.2 The Grand Saline Salt Dome

The Grand Saline salt dome has the shape of a truncated cone. Although it extends downward 15,000 to 20,000 feet, it is only 8000 feet in diameter. The top is nearly flat and the outer edges of the salt body dip away from the center at 65 to 70 degrees (Muehlberger, 1959).

The salt of the dome is white to light gray, consisting of aggregates of halite crystals with some anhydrite. The salt alternates white and light gray layers, less than 1 inch to several feet thick. The layers are isoclinally folded around vertical axes (Atwater, 1968).

Even though the dome is 200 feet below the ground surface, it is topographically expressed by a circular, shallow depression partially covered by a salt marsh and encircled by low hills formed on the uplifted rocks (Figure 3.2-4). The depression is the result of ground water dissolving the top of the salt dome and causing a collapse feature (Powers and Hopkins, 1923).

Directly above the salt dome is a caprock composed of the less soluble residue left from the natural salt solutioning. The caprock has an average thickness of 25 feet, although it varies from 4 to 71 feet. The variation may be the result of differing quantities of impurities in the salt or possibly the result of solutioning of "spines" that were sent upward from the salt dome (Muehlberger, 1959). The lower portion of the caprock is a thin layer of residual anhydrite and sand that was probably deposited by inflowing ground water. Over this is a thicker section of limestone (Figure 3.2-7). The caprock is very cavernous and contains large quantities of salt water, which is typical of most salt dome caprocks (Borchert and Muir, 1964).

The northern perimeter of the dome has been extensively explored for oil, gas, salt, and sulfur. These exploratory drillings were mostly in the form of individual, small efforts. Commercially oriented salt mining, before establishment of the Kleer Mine, in 1930, was concentrated in an area situated in the northwest quadrant of the dome.

A recent near-surface collapse occurred on April 20, 1976 at the site of an abandoned leached brine well in the northwest corner of the dome. As reported in The Houston Post (1976) by Howard Woodall, publisher of the Grand Saline Sun, a hole gradually opened to about 200 feet long by 80 feet wide, 50 to 60 feet deep, and filled with water to about 20 feet from the surface. This was the second collapse at this site and was probably due to continued natural solutioning of the old solution hole that was not properly capped when the hole was abandoned. Two smaller collapses have also occurred in areas where exploratory drilling had taken place. No serious damage was caused by these recent events.

Overlying the caprock is a horizontal sequence of sandy clays, clays, and silts with some lignite that extends to the surface

(Figure 3.2-7). These are alluvial materials that were deposited in the depression formed by the continual solutioning of the top of the salt dome after the rocks overlying the salt were eroded away.

### 3.2.6.3 Kleer Mine

Two vertical shafts provide access to the underground mine workings. Shaft No. 1, located in the center of the central section of the mine, was constructed in the early 1930's. It is 16 feet in diameter and 750 feet deep. Shaft No. 2, at the southeast corner of the central workings, was completed in 1970. It is 12 feet in diameter and 700 feet deep.

The portion of the Grand Saline salt dome revealed in Kleer Mine is well suited for crude oil storage. No fractures or faults show in the mine. Gas has not been detected anywhere, nor are there wall rock inclusions. The salt mine contains no natural ground water or brine (Muehlberger, 1960). The only moisture found is due to either seepage in the shafts, in extremely small amounts, or condensation from humid air entering through the shafts.

Salt domes, particularly the Grand Saline, are generally excellent for liquid storage due to their extremely low permeability. Tests done on samples of Grand Saline salt showed an effective porosity of 1.71 percent. Effective porosity of in-situ salt would be less than this, since the test sample was fractured during removal. The permeability of the salt was essentially zero, so crude oil could not be transmitted any distance through it (Reynolds and Gloyna, 1960).

The mine is also very stable. No spalling, rock bursts or rock falls have occurred. The only instability is from the plastic flow, or creep, of the salt, which is minor. Twenty-year-old timbers in the old workings at a depth of about 700 feet have been crushed by the salt flowing at an average rate of 0.1 to 0.2 mm per year (Muehlberger, 1959). Studies done on cavities within the mine indicated that 95 percent of the total deformation takes place in the first 5 years after a cavity is opened. The total amount of deformation, according to the studies, is on the order of 5 percent of the initial cavity dimensions (Reynolds and Gloyna, 1960).

Three deep brine wells are located about 1 mile north of the Morton salt facilities. Wells 1 and 2 are presently abandoned. In 1965, sonar was used to determine the shapes and sizes of the solution cavities formed by these wells. (Well No. 3 was not drilled at that time.) Both cavities have a volume of 8 to 9 million gallons (1.1 to 1.2 million cubic feet). The cavities are similar in shape, both vertically oblong and oval in cross section. The cross sections average 150 by 100 feet. The tops of the cavities are about 800 feet deep, and the bottoms are about 1600 feet deep. Neither cavity is closer than 2500 feet from the present underground mine workings.

Brine well No. 3, directly east of abandoned wells 1 and 2, is cased down to an 800-foot depth and completed at 1600 feet (Figure 3.2-4). The cavity associated with this well should be smaller than the others, but its shape has not yet been logged. Both horizontal (about 2500 feet) and vertical (about 100 feet) separation of the solution cavity from existing or planned room-and-pillar operations preclude any foreseeable effects of one operation upon the other.

### 3.2.7 Geology of the Pipeline Corridor

The proposed pipeline route will cross the same geologic units found within the site vicinity: the Wilcox Group, the Carrizo Sand, and the Reklaw Formation (section 3.2.6.1). It will also cross the Sabine River, the principle drainage in the area, and one of its major tributaries, Lake Fork Creek, along with numerous smaller intermittent creeks(Figure 2.1-1). The terminal point of the 42-mile route is at Texoma's Winnsboro Terminal (Figure 3.2-2).

Materials composing the Wilcox Group, Carrizo Sand, and Reklaw Formation are basically weakly to moderately consolidated clays, silts, and sands. They should be easily excavated. Permeabilities are generally low, although some of the medium-grained sands have much higher permeabilities. Most of the soils are acid, requiring corrosion protection on underground pipe.

Soils that develop on these materials on the broad upland areas are classified as fine, sandy loams ranging from 40 to 100 inches in thickness (see Appendix I for soils descriptions). The soils have low permeabilities and very slow runoff. The slow runoff often causes rain to collect in depressions and form swampy, almost quicksandlike areas (Liddle, 1936).

The Sabine River and Lake Fork Creek Valleys are underlain by alluvial materials 10 to 50 feet thick. Composed of clay, silt, sand, and minor gravel, the alluvial deposits have a low permeability generally. Soils that develop on the alluvial deposits in the Sabine River Valley are clayey, 20 to 50 inches thick, with very low permeabilities. In the Lake Fork Creek Valley, the soils have an upper loamy horizon and lower clay loam horizon, which have a combined thickness of 30 to 70 inches. These soils have a low to moderate permeability. All the valley soils have very slow runoff.

Topography along the pipeline corridor is gently rolling with an average relief of about 60 feet. The river and stream valleys are essentially flat and may necessitate soft ground pipelaying techniques.

TABLE 3.2-1 Generalized regional stratigraphic column

| Era | Period | System | Group | Formation | Lithology | Thickness (in feet) |
|---|---|---|---|---|---|---|
| CENOZOIC | Quaternary | Holocene | | Undifferentiated | Alluvium - sand, silt, clay and gravel | 50 |
| CENOZOIC | Tertiary | Eocene | Claiborne<br>Wilcox<br>Midway | | Clay, sandy clay, sand, lignitic shale and lignite | 2300+ |
| MESOZOIC | Cretaceous | Upper | Navarro | | Clays, sandy clays, marls, shales and silty sand | 1500 to 3600 |
| | | | Taylor | | Dark colored shales with local chalk and sandstone units | |
| | | | Austin | | Chalk with minor shale, sandstone and marl | |
| | | | Eagle Ford | | Gray silty shales and flaggy limestones | |
| | | | Woodbine | | Conglomeratic sands; gray, green and red shales; chloritic sands | |
| | | Middle | Washita<br>Fredericksburg | | Undifferentiated gray and black shales and limestones | 1000 |
| | | Lower | Trinity | Paluxy | Light sands with red, gray or brown shales | 1500 |
| | | | | Travis Peak (or Hosston) | Red, cherty sandstones and shales with an upper limestone member | 1500 |
| | Jurassic | Upper | Cotton Valley | Schuler<br>Bossier | Red sandstones and conglomerates | 1500 |
| | | | Louark | Haynesville | Carbonate and evaporite rock overlain by red to pink sandstone and anhydrite | 800 |
| | | | | Smackover | Interbedded dark shale and porous, vuggy fossiliferous limestone | 2000 |
| | | | | Norphlet | Red and gray sand, shale and local conglomerate | 150 |
| | | | Louann | Louann | Bedded salt | 500 |
| | | | | Werner | Anhydrite, conglomerate, and red beds | 200 |
| MESOZOIC / PALEOZOIC | Triassic | | | Eagle Mills | Red, gray and green mudstone and silt | 7000 |
| PALEOZOIC | | | Ouachita Facies | | Meta-sedimentary rocks | ? |

TABLE 3.2-2 Modified Mercalli Intensity (damage) scale of 1931 (abridged)

| | |
|---|---|
| I. | Not felt except by a very few under especially favorable circumstances. |
| II. | Felt only by a few persons at best, especially on upper floors of buildings. Delicately suspended objects may swing. |
| III. | Felt quite noticeable indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated. |
| IV. | During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. |
| V. | Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. |
| VI. | Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. |
| VII. | Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly-built or badly-designed structures; some chimneys broken. Noticed by persons driving motorcars. |
| VIII. | Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly-built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed. |
| IX. | Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. |
| X. | Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. |
| XI. | Few, if any, masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly. |
| XII. | Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown upward into the air. |


FIGURE 3.2-1 Physiography of the West Gulf Coastal Plain

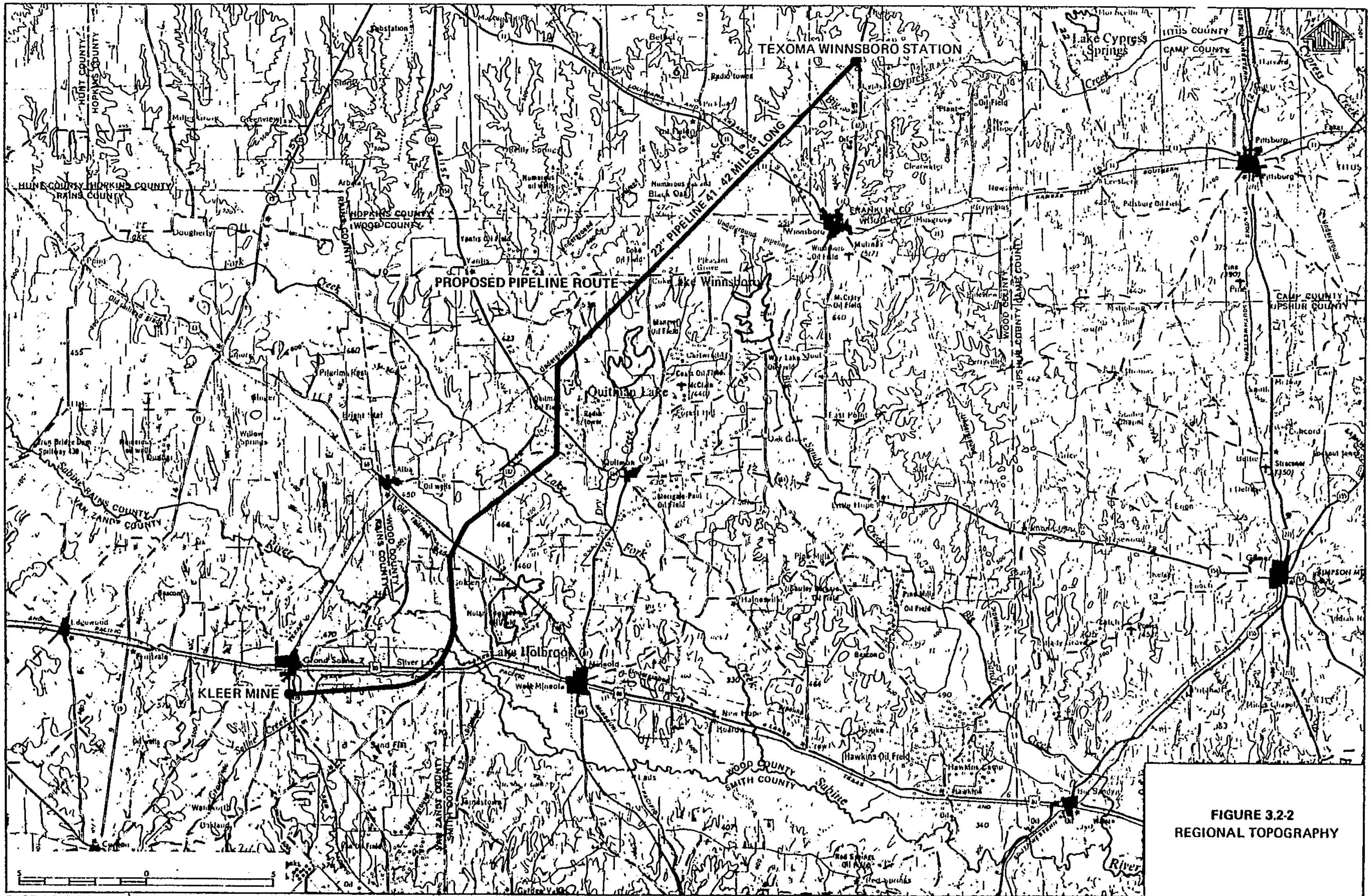



FIGURE 3.2-2
REGIONAL TOPOGRAPHY

BASE: USGS 1:250,000 MAPS FOR TYLER (1963) AND TEXARKANA (1972), TX.

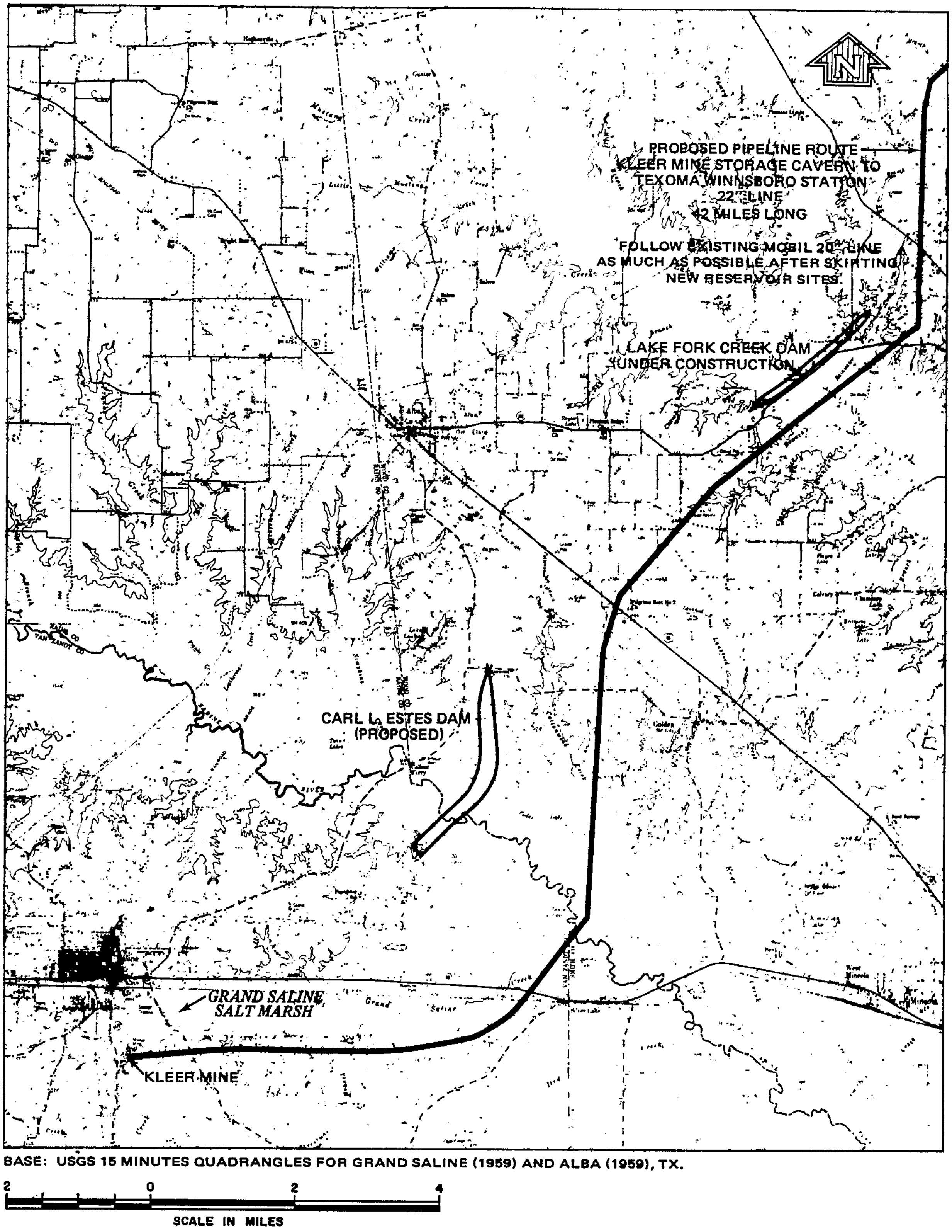



FIGURE 3.2-3 Topography of the Grand Saline area

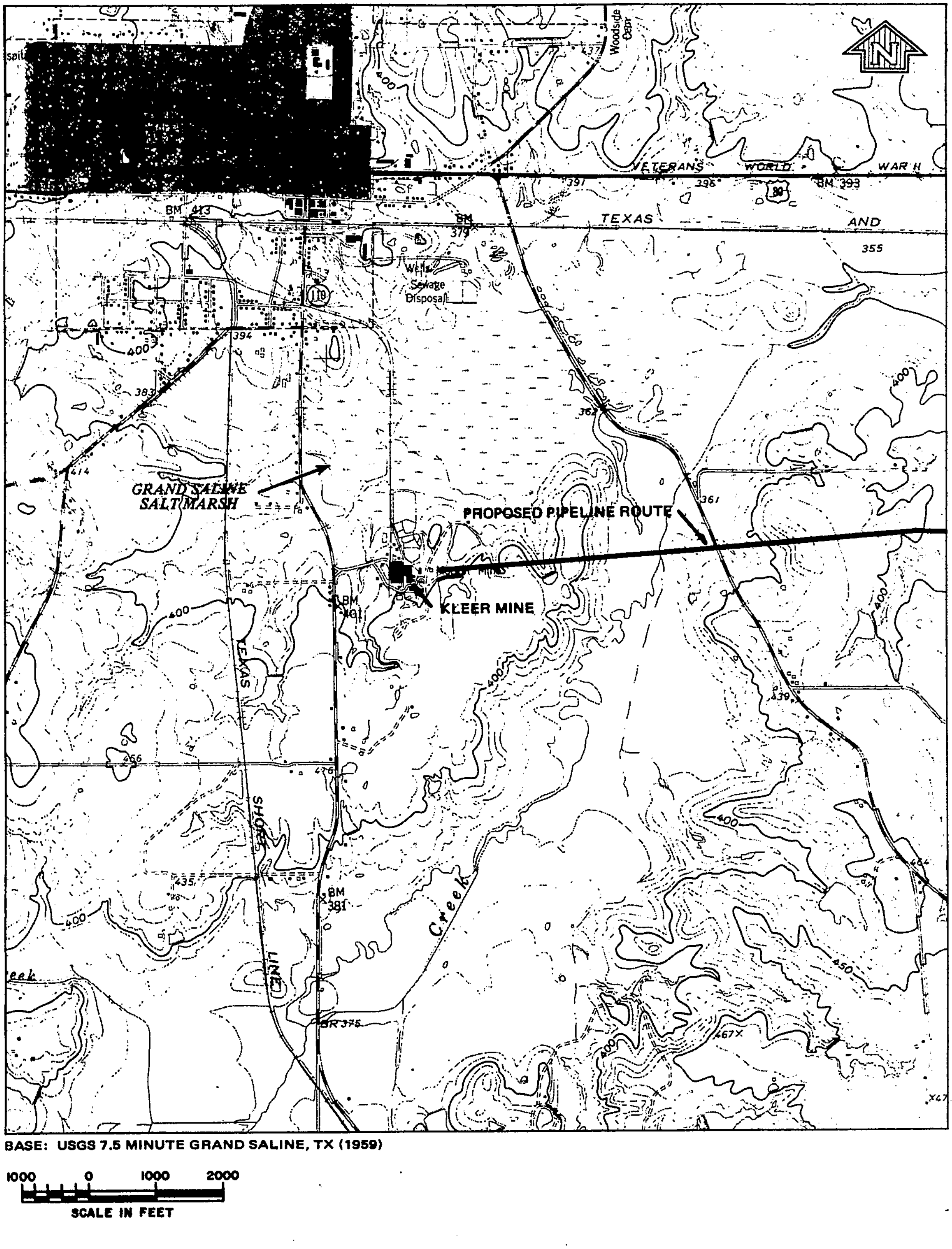



FIGURE 3.2-4 Topography of the Kleer Mine area

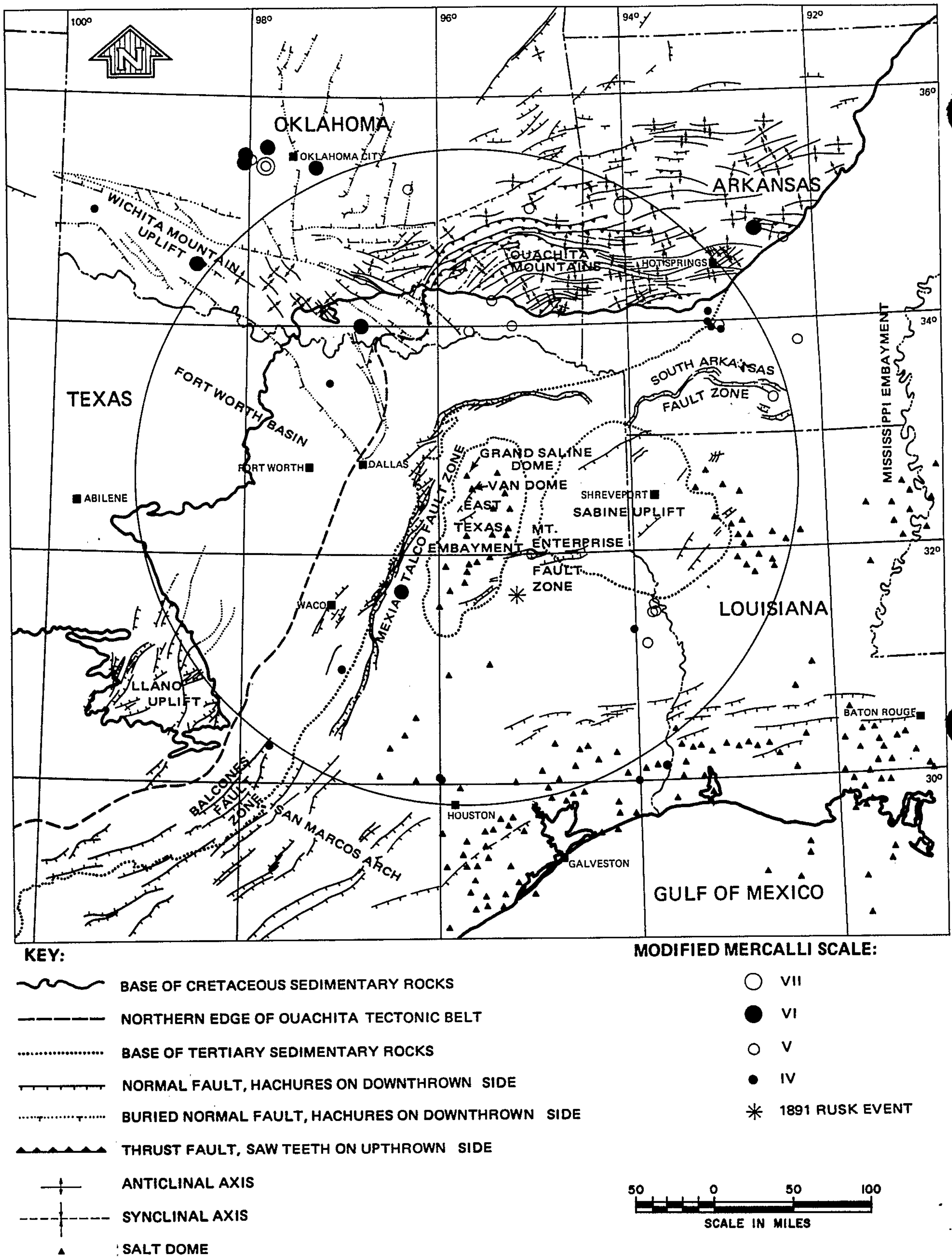



FIGURE 3.2-5 Regional seismotectonic map showing earthquake epicenters within 200 miles of the site

SOURCE: STRUCTURES AFTER COHEE, 1962; EPICENTERS FROM COFFMAN AND VON HARE, 1973A, 1973B, 1974, COFFMAN, 197 DAMES AND MOORE, 1974.

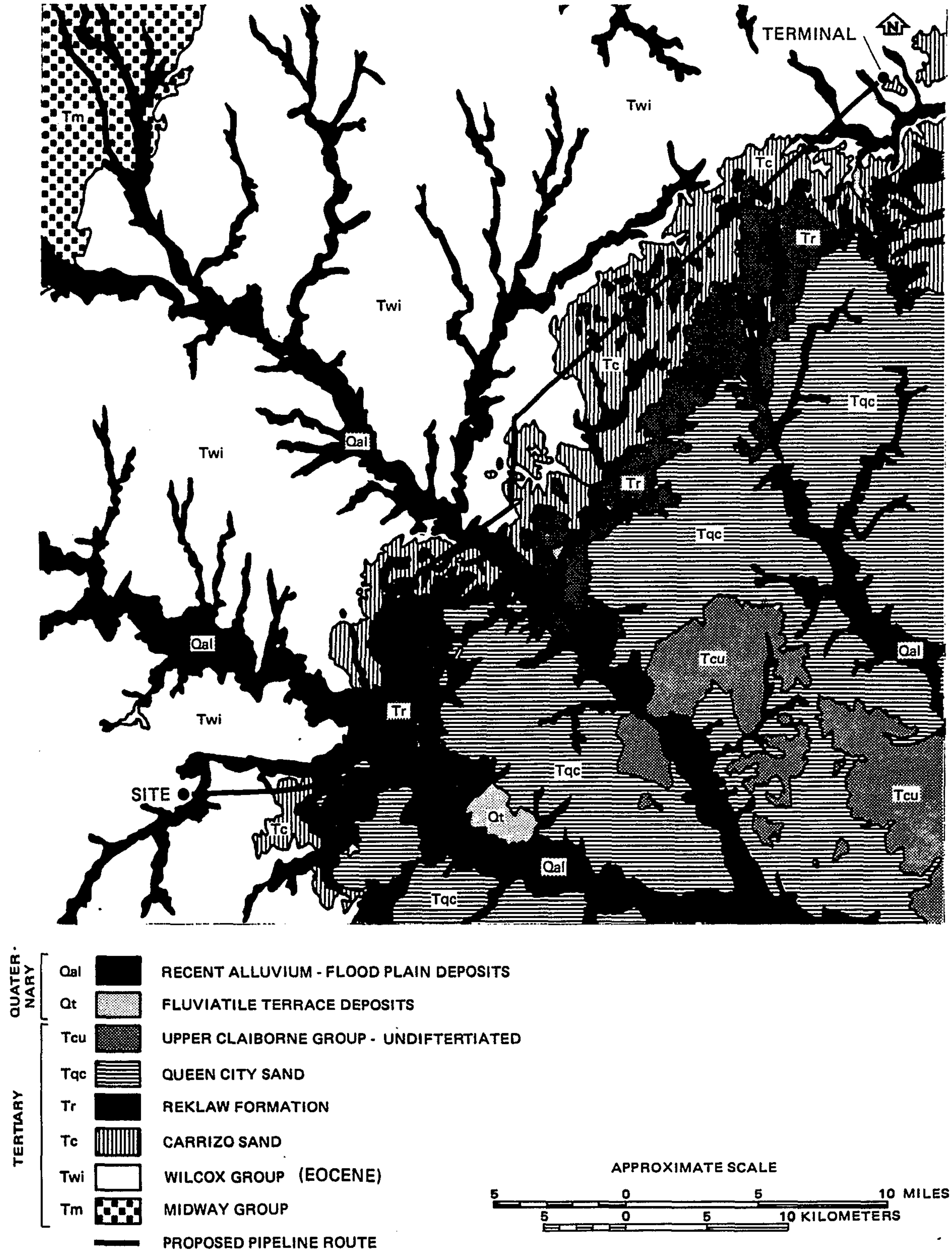
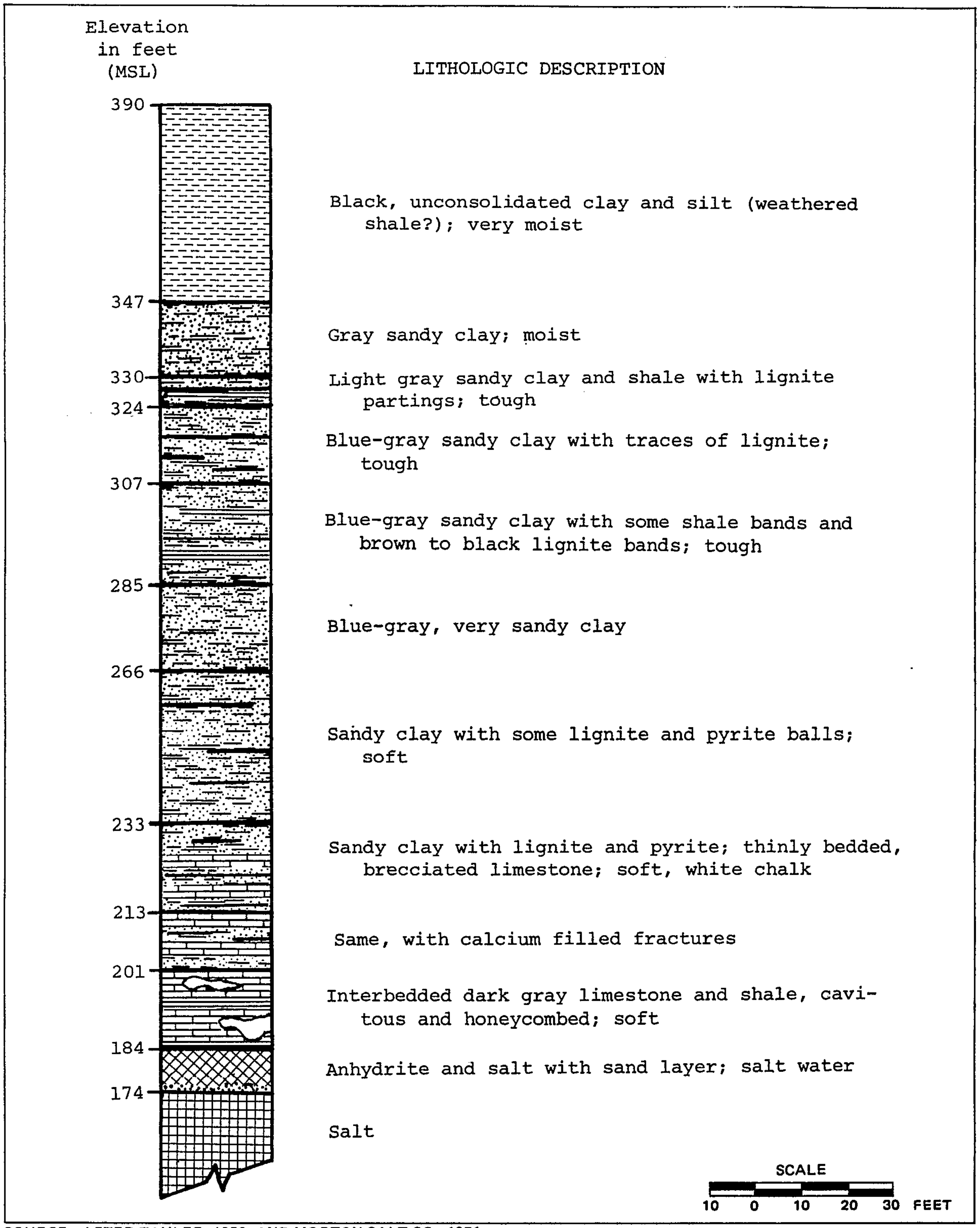



FIGURE 3.2-6 Regional geologic map



SOURCE: AFTER TAYLER, 1932, AND MORTON SALT CO., 1971.

FIGURE 3.2-7 Site stratigraphic column, Kleer Mine site

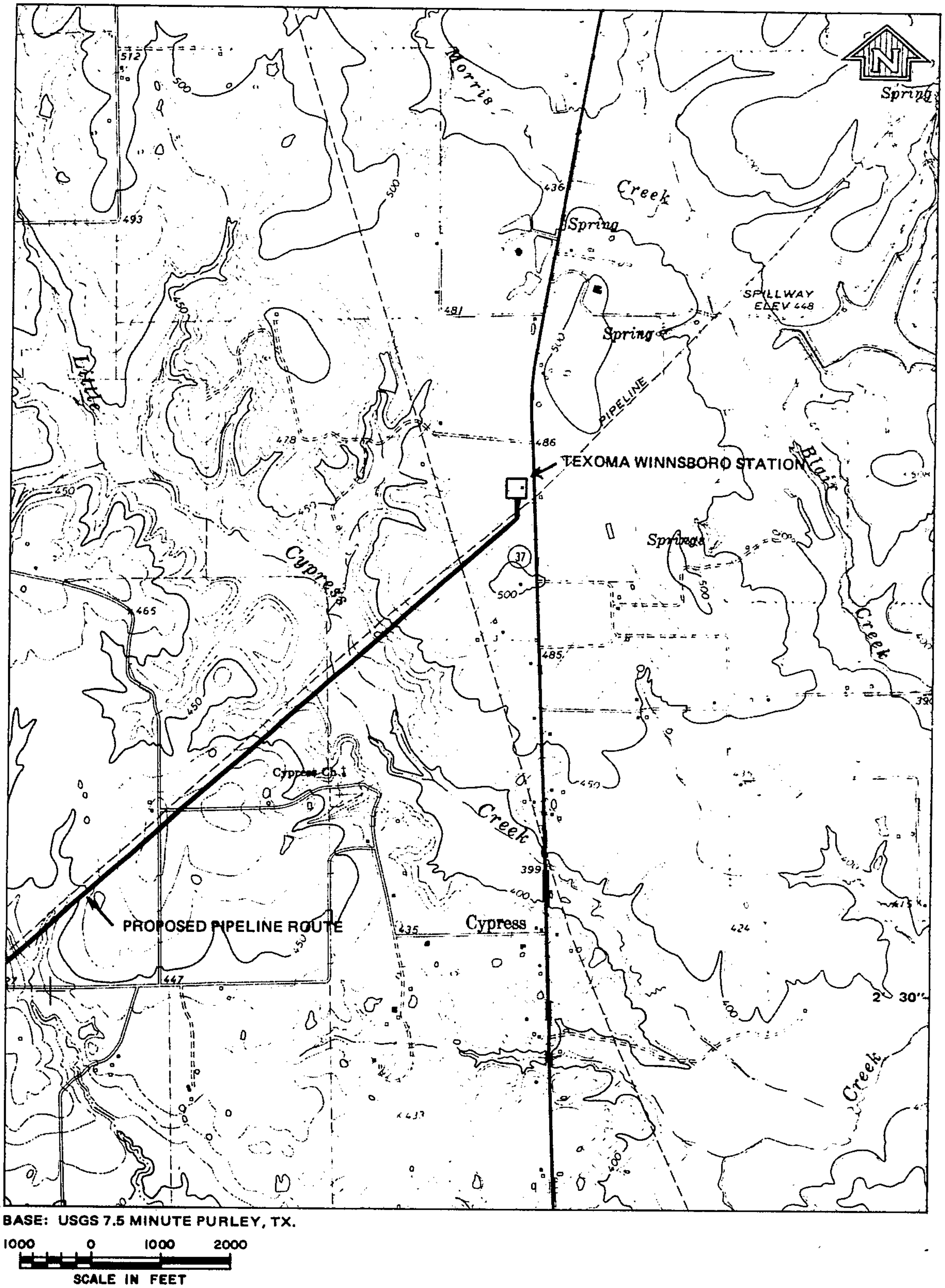



FIGURE 3.2-8 Site topography, Winnsboro Terminal

## 3.3 HYDROLOGY

### 3.3.1 Surface Water

#### 3.3.1.1 General Description of Watersheds

The proposed oil storage facility, including Kleer Mine, an underground pipeline, and the Winnsboro Terminal, extends about 42 miles in a northeasterly direction, passing through parts of Van Zandt, Wood, Hopkins, and Franklin Counties. The route crosses 4 subwatersheds of the Sabine River Basin (Grand Saline Creek Watershed; Sabine River Basin upstream of Mineola, Texas; Lake Fork Creek Watershed; and Big Sandy Creek Watershed), and one subwatershed of the Red River Basin (Big Cyprus Creek Watershed).

The length of pipeline in each subwatershed is:

1. Sabine River Basin - 36.77 miles
   a. Grand Saline Creek Watershed - 7.14 miles; major stream crossings: Grand Saline Creek.
   b. Lake Fork Creek Watershed - 21.14 miles; major stream crossings: Lake Fork Creek.
   c. Big Sandy Creek Watershed - 2.33 miles; major stream crossings: None.
   d. Sabine River Basin (exclusive of the above-mentioned subwatersheds) - 5.16 miles; major stream crossings: Sabine River.
2. Red River Basin - 5.44 miles
   a. Big Cyprus Creek Watershed - 5.44 miles; major stream crossings: Big Cyprus Creek.

The Kleer Mine pipeline route follows an existing 20-inch Mobil pipeline route from a point about 6 miles north of Quitman, Texas, to the Winnsboro Terminal, about 6 miles north of Winnsboro, Texas, on the west side of State Highway 37.

Several existing and proposed reservoirs are within the area of concern for this study (Figure 2.1-1). These reservoirs are listed from west to east in three categories:

Existing

Lake Tawakoni (Iron Bridge Dam)

Lake Quitman

Lake Winnsboro

Lake Cypress Spring

Lake of the Pines (Ferrells Bridge Dam)

Lake Holbrook

Lake Hawkins

Under Construction

Lake Fork Dam and Reservoir

Lake Bob Sandlan

Proposed

Carl L. Estes Dam and Reservoir

Big Sandy Dam and Reservoir

### 3.3.1.2 Sabine River Basin

#### General Location and Size

The Sabine River Basin lies in the eastern part of Texas and the western part of Louisiana, and is bounded by the basins of the Neches River on the west, the Trinity River on the northwest, the Red River on the north and northeast, and the Calcasieu River on the east (Figure 3.3-1). The basin extends in a general northwest-southeast direction from eastern Collin and Rockwall Counties about 35 miles northeast of Dallas, Texas, 165 miles to the eastern boundary of the state; thence southerly in Texas and Louisiana about 145 miles, to the head of Sabine Lake near Orange, Texas. The basin is about 300 miles long and varies in width from a minimum of 16 miles to a maximum of 48 miles (Figure 3.3-2). The watershed has an area of about 9756 square miles, of which 2330 square miles are in Louisiana and 7426 square miles are in Texas.

#### Physical Characteristics

The Sabine River Basin lies within the West Gulf Coastal Plain section of the Coastal Plain Physiographic Province. The land elevation within the basin varies from sea level near the coast to about 730 feet above sea level in the headwaters. In the extreme upper end of the basin, the land surface is undulating to gently rolling and the streams lie in shallow valleys. The lower 60 miles along the coast are flat to undulating; the central portion of the basin has rolling to hilly terrain with occasional flat areas along the interstream divide. In the hilly section, the principal streams are entrenched in broad flat valleys. Four major land resource areas comprise the Sabine Basin: Texas Blackland Prairie, Southern Coastal Plain, Gulf Coast Prairies, and Gulf Coast Marsh (Figures 2.3-5 and 3.2-1). Climate is generally mild, varying from moderate Gulf Coast conditions in the south to continental conditions in the north.

There are numerous tributary streams discharging into the Sabine River, most of them small. The channels of the stream tributaries are generally poorly defined, crooked, and badly obstructed by brush and drift. In the rolling hilly sections of the basin, the tributaries have steep slopes and shallow valleys in lower reaches. Tributaries in the Gulf Coast Prairies have flat slopes and shallow valleys throughout the greater part of their courses. Floods on these streams cover wide areas and, in some instances, flood waters flow across interstream divides. Channel capacity of the Sabine River in the project area varies from 2000 cubic feet per second (cfs) at Carl L. Estes Dam site to 6000 cfs below Lake Fork Creek (U.S. Army Corps of Engineers, 1967).

Cedar Lake is a small natural lake that is located about 1 mile downstream of the proposed Carl L. Estes Dam site. The pipeline will be within the drainage area of this natural lake. There are no water rights filed for this lake, and data concerning volume or water quality are unavailable.

A large portion of the Sabine River Basin is located in the Southern Coastal Plain. The soils of this area are mostly light colored, fine, sandy loams and loamy sands with subsoil that ranges from loamy sand to plastic clay in texture. The upper portion of the basin lies on the Texas Blackland Prairie; soils are characterized as gray and black calcareous clay grassland that has been formed from underlying clay marl and chalky limestone.

Water Development Projects

There are 3 existing reservoirs and 1 planned project in the Sabine River Basin within the project area (Figure 2.1-1):

1. Lake Tawakoni - Lake Tawakoni occupies a 20-mile stretch of the upper Sabine River in Hunt, Rains, and Van Zandt Counties, Texas, and has a total upstream drainage area of 752 square miles. The dam (located at River Mile 514.5) was completed in 1960, and the reservoir was filled by 1964; both dam and reservoir are owned by the Sabine River Authority. The maximum test flood elevation is 452.4 feet above MSL, with a corresponding storage of 1,560,000 acre-feet.

2. Lake Holbrook - Lake Holbrook is owned by Wood County for the purpose of recreation (fishing and swimming). The dam is located on Keys Creek with the top of the dam at elevation 387.0 feet above MSL. The usable storage is 7770 acre-feet; the maximum storage is 7990 acre-feet. The total drainage area above the dam is 15 square miles. The surface area of the lake is 653 acres.

3. Lake Hawkins - Lake Hawkins is owned by Wood County for the purpose of recreation (fishing and swimming). The dam is located at latitude 32°36.7' and longitude 95°15.1'. The top of the dam is at elevation 363 feet above MSL. The usable storage is 11,570 acre-feet; the maximum storage is 11,890 acre-feet. The total drainage area above the dam is 30.0 square miles. The surface area is 1064 miles.

4. Carl L. Estes Dam and Reservoir - The dam site will be located at River Mile 479.7 on the Sabine River, about 34.8 miles downstream from the existing Iron Bridge Dam (Lake Tawakoni) and about 6 miles upstream from U.S. Highway 80. The reservoir will be in parts of Wood, Rains, and Van Zandt Counties. The project will be formed by an earth-and-rock-fill dam with a maximum height of 108.5 feet above the streambed and a total length of 15,830 feet, including a concrete spillway 232 feet long. The spillway, with a net opening of 200 feet, will be located in a saddle on the right bank. The flood control outlet works will consist of one 15-foot diameter gated conduit controlled by two 7- by 15-foot slide gates. Construction of this project will take about 6 years.

   The reservoir will have a total controlled storage of 1,205,200 acre-feet and a water surface area of 44,000 acres at elevation 403 feet above MSL -- the top of the flood control pool. The top of the water supply pool will be at elevation 379 feet above MSL, with an area of 24,900 acres and a capacity of 393,000 acre-feet.

Grand Saline Creek Watershed

General Location and Size - Grand Saline Creek Watershed is drained by Grand and Little Saline Creeks, which flow into the Sabine River. The watershed lies entirely within Van Zandt County (Figure 2.1-1). Grand Saline creek originates approximately 7 miles southeast of Canton, Texas, and flows generally in a northeasterly direction for about 21 miles to enter the Sabine River near the Van Zandt-Smith County line. The watershed has a drainage area of 93.0 square miles, or 59,529 acres, which is about 2 percent of the drainage area of the entire Sabine Basin.

Physical Characteristics - The topography of the watershed ranges from rolling in the upland area to gently sloping in the broad stream valleys. The Grand Saline Creek headwaters begin at elevation 480 feet above MSL, and the creek converges with the Sabine River at elevation 325 feet above MSL. Little Saline Creek headwaters begin at elevation 500, and the creek flows 5.5 miles to converge with the Grand Saline Creek at elevation 385 feet above MSL. These data yield approximate, average streambed slopes of 0.14 percent and 0.40 percent, respectively.

There are numerous small lakes within the watershed, of which 3 are in the immediate vicinity of the Kleer Mine site. The largest, Metzger Lake, is within the subwatershed of the Little Saline Creek. A 340-acre salt marsh area southeast of Grand Saline, Texas, lies partly within the mine site (Figure 3.2-4). The site elevation ranges from about 370 to 400 feet above MSL, while the marsh is at the approximate elevation of 360 feet above MSL.

The upland soils in the watershed are predominantly deep, medium-textured, slow to moderately permeable, and sandy. The alluvial soils in the flood plain are predominantly fine- to medium-textured and moderately permeable. Saline soils influenced by upward movement of ground water over the Grand Saline salt dome occur in the vicinity of the salt marsh south of Grand Saline.

The soils are highly erodable under conditions of poor cover and moderate to high rainfall. However, the land is used primarily as pasture, which provides good cover and reduces the erosion rate. The

U.S. Soil Conservation Service (SCS) (1973a) has estimated the annual gross erosion rate in this area to be 1.0 to 1.5 acre-feet per square mile per year. At a unit weight of 100 pounds per cubic foot, this is equivalent to 2178 to 3267 tons per square mile per year; or 3.4 to 5.1 tons per acre per year.

Water Development Projects - There are several small lakes within this watershed. The larger ones, Metzger and Club 20 Lakes, are located in the headwaters of Grand Saline Creek. The Morton Salt Company has water rights filed on two small ponds located immediately adjacent to the mine site.

Lake Fork Creek Watershed

General Location and Size - Lake Fork Creek Watershed is drained by Lake Fork Creek and its tributaries. The watershed lies within Wood, Rains, Hunt, and Hopkins Counties (Figure 3.3-2). The creek originates about 15 miles southeast of Greenville (in Hunt County), and flows generally in a southeasterly direction to enter the Sabine River at River Mile 444.9 (at elevation 282 feet above MSL). The creek has a length of 77.5 river miles and drains an area of about 685 square miles. The basin is about 40 miles long and has a maximum width of about 25 miles. The channel capacity from the Lake Fork Dam site to the mouth is 3000 cfs.

Physical Characteristics - The pertinent perennial tributaries to Lake Fork Creek are Caney Creek, Dry Creek, Glade Branch, and Brushy Creek. Caney Creek lies west of the proposed pipeline route; the other tributaries are crossed by the proposed route.

There are numerous small lakes within the watershed. The larger ones are Lake Lydia, Greens Lake, New Wells Lake, Andrews Lake, Garner Lake, Lake Brenda, and Lake Quitman. Lake Quitman, the only existing lake that could be affected by this project, is described as an existing water development project. There are several marshy areas throughout the watershed. These are located generally in the area between the towns of Quitman and Mineola, adjacent to Lewellyn Glade and Edmore Creeks.

The extreme upper portion (the first 10 miles) of this watershed consists primarily of the Houston Black-Burlesson-Wilson soil complex, which is primarily a clay soil. The lower 15 miles consist primarily of the Axtill-Tabor-Lufkin soil complex, which is primarily a sandy-loam soil.

Water Development Projects - There is only one significant reservoir in the watershed (Figures 3.3-2 and 2.1-1). One sizeable project is under construction.

1. Lake Quitman - Lake Quitman is owned by Wood County for the purpose of recreation (fishing and swimming). The dam is located on Dry Creek; the top of the dam is at elevation 413 feet above MSL. The usable storage is 7440 acre-feet and the surface area is 800 acres. The total drainage area above the dam is 31.0 square miles.

2. Lake Fork Dam and Reservoir - This project is just entering the construction phase. Lake Fork Dam site is located at River Mile 28.1 on Lake Fork Creek, about 3-1/2 miles west of Quitman, and has a total upstream drainage area of 493 square miles. The proposed pipeline route passes below the dam (Figure 2.1-1). The reservoir will be formed by a compacted earth fill dam with a maximum height of 85 feet above streambed and a total length of 12,600 feet, including a 100-foot concrete spillway.

   Lake Fork Dam and Reservoir will have a total controlled storage of 1,096,854 acre-feet and a water surface area of 40,600 acres at elevation 415.6 (the top of the flood control pool) feet above MSL. At elevation 403 feet above MSL, the top of the water supply pool, the reservoir will have an area of 27,690 acres and a storage capacity of 675,819 acre-feet. The present construction schedule calls for closure of the dam by July 1978 and the commencement of water withdrawals by September 1979.

Big Sandy Creek Watershed

General Location and Size - This watershed is comprised of Big Sandy Creek and its tributaries. The watershed lies within Hopkins, Wood, and Upshur Counties. Big Sandy Creek originates at Lake Winnsboro, which is about 4 miles to the southwest of the town of Winnsboro. The creek flows generally in a southeasterly direction and enters the Sabine River at River Mile 412.4 (at elevation 258 feet above MSL). The creek has a length of 55.0 river miles, and drains an area of about 239 square miles. The basin is about 38 miles long and has a maximum width of about 9 miles. The channel capacity from the Big Sandy Dam site to the mouth is 1000 cfs.

Physical Characteristics - Little Sandy Creek, which is perennial, is the only tributary of Big Sandy Creek that is close to the pipeline. This tributary is not intersected by the pipeline, but the pipeline does lie at its extreme headwaters.

There are a few small lakes within the watershed: Midway Lake, Wheeler Lake, Railroad Pool, and Lake Winnsboro. Lake Winnsboro is the only lake that could be affected by this project and is described in more detail below. There are also several marshes within the watershed. There is a marshy area on Big Sandy Creek that extends about 2 miles upstream from where State Highway 37 crosses. There is also a marshy area on Buck Creek that extends about 2.5 miles upstream from its confluence with Big Sandy Creek.

This basin consists of the Bowie-Ruston-Lakeland soil complex.

Water Development Projects - There is one significant reservoir and one planned project in this watershed.

1. Lake Winnsboro - Lake Winnsboro is owned by Wood County for the purpose of recreation (fishing and swimming). The dam is located on Big Sandy Creek; the top of the dam is at elevation 436.5 feet above MSL. The usable storage is 8100 acre-feet. The total drainage area above the dam is 31.0 square miles and the surface area is 800 acres.

2. Big Sandy Dam and Reservoir - Big Sandy Dam site is located at River Mile 15.3 of Big Sandy Creek about 6 miles northwest of Big Sandy, Texas, and has a total upstream drainage of 196 square miles. The reservoir will be almost entirely in Wood County, with a small area extending into Upshur County. This project will be formed by an earth-and-rock-fill dam with a maximum height of 93.5 feet above streambed and a total length of 5,760 feet, including a concrete spillway. The spillway will consist of a 100-foot uncontrolled broadcrested weir, the outlet works, and a 9-foot diameter conduit controlled by two 4.25- by 9-foot slide gates.

   Big Sandy Reservoir will have a total controlled storage of 385,900 acre-feet and a water surface area of 15,800 acres at elevation 380.0 feet above MSL, the top of the flood control pond. At elevation 367.5 feet above MSL, the top of the water supply pool, the reservoir will have an area of 10,810 and a storage capacity of 221,200 acre-feet.

3.3.1.3 Red River Basin

General Location and Size

The Red River Basin below Denison Dam (near the Texas-Oklahoma border on the Red River) is located in southeastern Oklahoma, northeastern Texas, southwestern Arkansas, and northwestern Louisiana, and comprises an area of about 29,500 square miles, exclusive of the Ouachita-Black Basin. The basin outline tapers from a width of about 130 miles in the upper portion to about 20 miles in the lower portion. Its length, measured along its major axis, is about 400 miles. It is bounded by the basins of the Canadian River on the north, the Ouachita-Black Rivers on the east, the upper Red, Trinity, and Sabine Rivers on the west and south, and the Mississippi-Atchafalaya system on the southeast (Figure 3.3-1).

Physical Characteristics

The basin consists of a large alluvial valley flanked by gently rolling terrain. Elevations are generally below 400 feet above MSL. Sinuous stream courses, natural levees, oxbow lakes, and abandoned stream channels are the predominant physiographic features. The streams have wide, nearly flat flood plains bounded by a series of terraces formed by ancient streambeds. A small area in the northern extremity of the basin lies within the Kiamichi (Ouachita) Mountains. Elevations in this area vary from about 2800 feet on the summits of a few isolated mountains to about 600 feet in the narrow, steep-sided valleys (Figure 2.3-5).

The lower Red River Basin includes sections of three physiographic provinces: Central Lowland, Ouachita province, and the Coastal Plain.

The Ouachita province and Central Lowland, which comprise the northern 1/3 of the basin, are characterized by high ridges of chert and sandstone and intervening wide, flat valleys, with their long axes in a general north-south direction. Altitudes range from about 600 to 2700 feet above sea level. The highest point is located in the Ouachita Mountains along the Arkansas-Oklahoma state line.

The Ouachita province is bounded on the south by gulfward-dipping Cretaceous rocks of the Coastal Plain Province. Low relief and the gentle southeastward slope of the land characterize the province. The streams have wide, nearly flat flood plains bounded by a series of terraces, which in some places are more than 100 feet higher than the present stream channels. Uplands are irregular and rolling to hilly.

Normal seasonal temperatures in the basin range from 82 degrees in summer to 48 degrees in winter. The growing season has a length of about 8 months; the first killing frost occurs about the middle of November and the last one about the middle of March. The prevailing wind in the area of the basin between Denison Dam and Fulton, Arkansas is from the south at about 11 miles per hour.

The Red River, which is the main stem of the drainage system, flows generally southeasterly 470 miles from Denison Dam to its confluence with Old River. The river channel is from 700 to 1200 feet wide, between high banks ranging from 15 to 35 or 40 feet above low water, except for occasional short reaches where the channel lies against the high escarpments that border the alluvial plain. The flood plain, 8 to 10 miles wide in general, narrows to about 2 miles near Denison Dam. Below Alexandria the flood plain becomes integral with the alluvial valley of the Mississippi River.

Many tributaries enter Red River at points scattered throughout its length. Generally, tributaries in its upper reaches are fast, freely flowing streams; tributaries in the lower reaches are slow, congested streams.

Big Cyprus Creek Watershed

General Location and Size - The Big Cyprus Creek watershed covers approximately 3520 square miles within the Red River Basin (Figure 3.3-3). The main river from the mouth to the headwaters is about 143 miles long. Runoff from about 860 square miles of the drainage area is controlled by the Ferrels Bridge Dam (Lake of the Pines) on Cypress Creek. Flood control storage is 587,200 acre-feet. Downstream of the dam, Black Cypress and Little Cypress join Cypress Bayou before it enters Caddo Lake. James Bayou, another major tributary, drains directly into Caddo Lake. Discharges from Caddo Lake are joined by flows from Black Bayou and are conveyed via Twelve Mile Bayou to the Red River at Shreveport, Louisiana.

The Kleer Mine pipeline and Texoma Winnsboro Terminal are located in the extreme upper portion of this watershed (Figures 2.1-1 and 3.3-3). The pipeline and terminal are entirely within the area controlled by Lake Cyprus Springs Dam, which has a design storage capacity of 72,800 acre-feet. Immediately downstream of Lake Cypress Springs, Lake Bob Sandlan Dam is under construction and is scheduled for completion in November 1976.

Physical Characteristics - The basin above Ferrels Bridge Dam has a total length of about 59 miles and a maximum width of about 21.5 miles. The elevation ranges from 500 feet above MSL in the westernmost portion of the basin to 300 feet above MSL at the USGS gage near Pittsburg, 8.5 miles below Lake Bob Sandlan Dam.

The major streams of the Big Cypress Creek Basin above Ferrells Bridge Dam (Lake of the Pines) are Big Cypress, Hart, and Boggy Creeks. Both Hart and Boggy Creeks are tributaries to Big Cypress Creek.

### 3.3.1.4 Flooding

Average annual precipitation in the project area ranges between 40 and 45 inches. Maximum and minimum precipitation recorded at Greenville, about 45 miles northwest of Grand Saline, was 75.7 inches and 17.6 inches, respectively. Soils in the area have hydrologic characteristics ranging from moderate to very slow infiltration and transmission rates, and moderate to high runoff potential. The average annual net evaporation loss (evaporation minus rainfall) is about 4 inches. Annual runoff ranges from 1 to 30 inches, with an annual average of about 10 inches. Because of rainfall variability and high runoff potential during peak rainfall periods, stream flows can be highly variable.

#### Historical Floods

During an 83-year historical period beginning in 1884, there have been 18 floods in the Sabine River Basin that may be classified as general floods. There have been many more local floods. The floods of May 1844, April 1913, and April-June 1953 established maximum flood stages along the Sabine River below Bon Wier. The flood of March-April

1945 established maximum flood stages along the central and upper Sabine River. There are approximately 952,900 acres of land subject to flooding in the basin.

Most upstream tributaries in the Sabine River Basin have a high frequency of flooding, ranging from 2 to 6 times per year. Major floods that inundate more than half of the flood plain occur an average of at least once per year in all watersheds and, in some watersheds, as much as 3 times per year. Floods occur in any month, but most frequently during the spring and fall. Thunderstorms occur frequently and cause severe local floods. In the upper part of the basin, above Lake Tawakoni, flooding is usually of short duration, lasting but a few hours. Duration of flooding increases progressively toward the lower part of the basin, and even the more frequent floods last for periods of 2 to 3 days. In the lower part of the basin, inadequate outlets and poor surface drainage cause inundation from a single flood event to last for as long as 10 days.

Historical records of rainfall and streamflow in the Red River Basin indicate that between 1900 and 1958, the Red River flooded 13 times. Recent flooding in one or more major tributary streams occurred 9 times between 1944 and 1966.

## Stream Flow Frequencies

Stream flow frequencies have been determined for the various sub-basins of the Sabine and Red River Basins (U.S. Corps of Engineers, 1967, 1968; USGS, 1975). Discharges for the streams in the vincinity of the project are:

| Stream | Average Annual | Average Annual Minimum | Average Annual Maximum |
|---|---|---|---|
| Sabine (near Mineola) | 1089 cfs | --- | --- |
| Grand Saline (at Highway 80) | 61.8 cfs | --- | --- |
| Lake Fork (north of Mineola) | 418 cfs | 34.9 cfs | 1214 cfs |
| Big Sandy (just above Sabine River) | 185 cfs | 41 cfs | 528 cfs |
| Big Cypress (near Winnsboro) | 47 cfs | --- | --- |

A summary of USGS computations of 7-day low flow and annual flood discharge for recurrence intervals of 2, 5, 10, 50, and 100 years is given in Table 3.3-1. Sabine River and Lake Fork Creek have the greatest flow rate potential. Grand Saline Creek often has no flow. Big Sandy Creek has the largest base flow.

Potential Floods from Precipitation Runoff

To investigate potential flooding of the Kleer Mine site, the following flood discharges and river stages were calculated:

| | 100-Year Discharge | Stage |
|---|---|---|
| Sabine River at Mineola gage | 100,000 cfs | 27.3 ft |
| Sabine River at Grand Saline Creek confluence (Corps data) | 130,000 cfs | 28.4 ft |
| Grand Saline Creek at Grand Saline Creek gage | 24,318 cfs | 14.5 ft |

(Source: U.S. Army Corps of Engineers, 1976. Using the most conservative estimates, stages were determined by stage-discharge curves.)

These discharges reflect conditions following the construction of Iron Bridge Dam (Lake Tawakoni), but do not reflect the conditions that would occur following the construction of Carl L. Estes Dam and Reservoir. The construction of the dam will reduce the flood discharge and stage (downstream) since the maximum spillway discharge is 55,000 cfs and the maximum "gated" flood control release is 4000 cfs. Thus, analysis of flooding conditions at the mine site for pre-dam conditions provides a conservative estimate of flood stage.

At the confluence of the Grand Saline Creek, the 100-year flood plain for the Sabine River is at elevation 350 feet above MSL (U.S. Army Corps of Engineers, 1976). The following assumptions are made in order to estimate very conservatively the water surface elevation near the mine site during the 100-year return period flood:

1. The peak discharge of Grand Saline Creek will coincide with the peak discharge of the Sabine River.

2. The flood stage of Grand Saline Creek will be transposed onto the flood stage of the Sabine River without consideration of any hydraulic interactions.

3. The peak discharge and stage at the Grand Saline Creek gage is representative of the creek adjacent to the mine site.

On the basis of these extremely conservative assumptions, the maximum flood stage at the Kleer Mine site would be:

| | | |
|---|---|---|
| Flood elevation (Corps data) due to Sabine River flooding | = | 350 ft above MSL |
| Flood stage due to Grand Saline Creek flooding | = | 14.5 ft above MSL |
| Maximum Flood Elevation | = | 364.5 ft above MSL |

The mine shaft openings are located at elevation 390 feet above MSL, and the minimum site elevation is 370 feet above MSL. Thus, there is no foreseeable danger to the mine site due to flooding on either Sabine River or Grand Saline Creek.

Potential Floods from Exceeding Dam Design Flood Conditions

For the purposes of this study, the extreme event being considered is the 100-year event. Thus, dam performance during a 100-year rainfall must be examined.

The upstream reservoirs (on the Sabine River) are Lake Tawakoni Dam and Reservoir, and the future Carl L. Estes Dam and Reservoir. According to Mr. A. Martelli of URS/Forrest and Cotton, Inc. (the engineering firm that designed the Lake Tawakoni Dam), the dam was designed for a standard project flood of about a 300-year return period. The proposed Carl L. Estes Dam was designed by the Corps for an even more conservative probable maximum flood. Thus, both upstream reservoirs are conservatively designed to contain the 100-year rainfall flood.

3.3.1.5 Droughts

Several drought periods have been experienced in the Sabine River Basin since about 1900. There is evidence of an historical drought during the periods 1924-1925, 1950-1956, and 1962-1965.

As a point of comparison, the equivalent average annual runoff (in inches) is compared below with the average value for the period 1924-1965 (U.S. Corps of Engineers, 1967).

| Gaging station | Normal<br>1924-1965 | Drought<br>Jul 1924-<br>Sep 1925 | Drought<br>June 1954-<br>Mar 1957 | Drought<br>June 1962-<br>Dec 1965 |
|---|---|---|---|---|
| Mineola | 10.54 | 0.93 | 2.51 | 6.77 |

Data on low flows for the area streams have been presented in Table 3.3-1.

3.3.1.6 Water Availability

An analysis of surface water availability was beyond the scope of this report, since the project will use or discharge very small quantities of water. Municipal water sources in the area are both wells and surface reservoirs (Texas Water Rights Commission, 1976). The towns of Mineola, Big Sandy, Grand Saline, Quitman, Winnsboro, and Pittsburg obtain water from deep wells. Recent data indicate a withdrawal of over 5 million gallons per day (MGD) with potential for expansion. The towns of Gladewater, Longview, Marshall, Jefferson, Daingerfield, Hughes Spring, and Mt. Pleasant withdraw up to 36 MGD from nearby lakes including Lake of the Pines (0.75 MGD) (see Figure 2.1-1). Other withdrawals are made from Grand Saline Creek, Sabine River, Lake Fork Creek, Big Sandy Creek and Big Cypress Creek for irrigation, municipal supply, industry, and recreation (Texas Water Rights Commission, 1976).

3.3.1.7 Water Quality

Sabine River

The USGS has collected water quality data from the Sabine River at two sampling stations near Emory and Mineola, Texas. Samples were taken between October 1967 and September 1974. The Emory sampling station is located at the intersection of the Sabine River and State Highway 19, approximately 7.2 miles south of Emory (above the project route, Figure 3.2-2). The Mineola site is located on the Sabine River approximately 3.5 miles south of Mineola on U.S. Highway 69 (below the project route, Figure 2.1-1). The proposed Carl L. Estes Dam site is midway between these sampling stations. A summary of the water quality tests is shown in Table 3.3-2. The average dissolved solid concentration increases from 109 mg/l (milligrams per liter) at Emory to 308 mg/l at Mineola. This is due to the increased dissolved solid inflow from Grand Saline Creek, which enters the Sabine River below the proposed Carl L. Estes Dam site. The chloride concentration similarly increases from an average concentration of 6.5 mg/l to 111 mg/l. The dissolved oxygen tends to drop below the 5.0 mg/l recommended minimum during low flow periods (see Appendix A for state stream standards). The average concentration of sulfate increases from 14.5 mg/l at Emory to 45 mg/l at Mineola, and the average hardness increases from 76 mg/l to 97 mg/l. These average values are well within the recommended standards.

An analysis of the water quality data for the Sabine River near Mineola performed by the EPA indicates that the present quality of the water in the proposed project area is good to excellent. The data indicate that concentrations of the various chemical constituents during normal flow conditions are within the criteria set by the Texas Water Quality Board. Some individual samples during low flows are found to be outside the standards for short periods of time, but indicate only limited detrimental effects. There has been a slight increase in pollution over the years, as evidenced by decreases in dissolved oxygen concentration and pH. The waters of the river can, with proper treatment, be used for municipal water supply, recreation, and propagation of fish. The water upstream from the Emory site in Lake Tawakoni is presently being used for these purposes.

Creeks

The following creeks have been analyzed and their water quality compared to Texas criteria. It should be noted, however, that the creeks are not large enough to be required to conform to the state standards.

Grand Saline Creek - The USGS has collected water quality data from the Grand Saline Creek at the gage station at the U.S. Highway 80 bridge (Figure 3.2-2). Chemical analyses have been conducted from February 1968 to September 1973. The results of an EPA analysis of the data for certain key parameters are summarized below:

| | | | |
|---|---|---|---|
| 1. | Water Temperature | - | $19^{o}C$ |
| 2. | Specific Conductance (at $25^{o}C$) | - | 4428 micromhos |
| 3. | pH | - | 6.85 |
| 4. | Total Hardness | - | 215 mg/l (as $CaCO_3$) |
| 5. | Calcium | - | 56.6 mg/l |
| 6. | Sodium | - | 746.9 mg/l |
| 7. | Sulfate | - | 169.5 mg/l |
| 8. | Dissolved Solids | - | 2520.6 mg/l |
| 9. | Nitrate | - | 3.6 mg/l |
| 10. | Chloride | - | .1389 mg/l |

These data indicate that the concentrations of the various minerals exceed all of the Texas numerical criteria and that the water quality in the creek is poor. According to a representative of the Texas Water Quality Board, Grand Saline Creek is subject to natural fish kills. These kills are caused by extreme increases in salinity due to the surface water runoff following heavy precipitation: the runoff "washes" the salts from the soil.

Lake Fork Creek - The USGS has collected water quality data for Lake Fork Creek at the Quitman gage (at the State Highway 37 bridge, 0.3 mile downstream from Dry Creek., Figure 3.2-2). The period of record for this gage is December 1961 to June 1965, and November 1967 to September 1974. The results of an EPA analysis of the data for certain key parameters are summarized below:

| | | | |
|---|---|---|---|
| 1. | Water Temperature | - | $18^{o}C$ |
| 2. | Specific Conductance (at $25^{o}C$) | - | 477.9 micromhos |
| 3. | pH | - | 6.7 |
| 4. | Total Hardness | - | 97.6 mg/l (as $CaCO_3$) |
| 5. | Calcium | - | 23.2 mg/l |

6. Sodium - 57.3 mg/l
7. Sulfate - 59.2 mg/l
8. Dissolved Solids - 248.5 mg/l
9. Nitrate - 0.67 mg/l
10. Chloride - 87.7 mg/l

These data indicate that the concentrations of the various minerals are within the limits set by the state of Texas and that the water quality is good.

Big Sandy Creek - The USGS has collected water quality data for Big Sandy Creek at a gage near Big Sandy (at the State Highway 155 bridge, 0.5 mile upstream from the St. Louis Southwestern Lines Bridge, Figure 3.2-2). The period of operation of this gage is October 1969 to September 1974. The results of an EPA analysis of these data for certain key parameters are summarized below:

1. Water Temperature - 17°C
2. Specific Conductance (at 25°C) - 195.4 micromhos
3. pH - 6.3
4. Total Hardness - 31.0 mg/l as ($CaCO_3$)
5. Calcium - 7.3 mg/l
6. Sodium - 22.0 mg/l
7. Sulfate - 16.9 mg/l
8. Dissolved Solids - 91.5 mg/l
9. Nitrate - 0.16 mg/l
10. Chloride - 31.7 mg/l

These data indicate that the concentrations of the various minerals are within the limits set by the state of Texas and that the water quality is good.

Big Cypress Creek - The USGS has collected water quality data for Big Cypress Creek near Pittsburg. The period of operation of the gage is 1967 to the present (1976). The results of an EPA analysis of these data for certain key parameters are presented below:

1. Water Temperature - 17.9°C
2. Specific Conductance (at 25°C) - 360.1 micromhos
3. pH - 6.8

| | | | |
|---|---|---|---|
| 4. | Total Hardness | - | 68.1 mg/l as ($CaCO_3$) |
| 5. | Calcium | - | 17.2 mg/l |
| 6. | Sodium | - | 34.6 mg/l |
| 7. | Sulfate | - | 45.5 mg/l |
| 8. | Dissolved Solids | - | 202.1 mg/l |
| 9. | Nitrate | - | 7.7 mg/l |
| 10. | Chloride | - | 55.5 mg/l |

These data indicate that the concentrations of the various minerals are within the limits set by the state of Texas and that the water quality is good.

3.3.1.8 Erosion and Sedimentation

Erosion rates in the Sabine River Basin range from moderate in the Texas Blackland Prairie to very low in the Coastal Plain. The annual gross erosion rate varies from 4.0 acre-feet per square mile in the extreme upper basin to 0.5 acre-feet per square mile near the coast. Average rates in the project area are 1.0 to 1.5 acre-feet per square mile per year. These low erosion rates occur, despite the fact that the soils are highly erodible under conditions of poor cover and moderate to high rainfall, because most lands are in pasture rather than cropland (as was the case in the early 1900's) (U.S. Corps of Engineers, 1967).

Studies have been made of sediment accumulation rates in many existing reservoirs and lakes in the project area. Lakes Winnsboro, Hawkins, Holbrook, and Quitman all have current annual sediment accumulations of about 0.25 acre-feet per square mile of drainage basin and estimated storage lives of from 820 to 2000 years. Lake Tawakoni (upstream of the project) has an annual sediment accumulation of just over 1.0 acre-feet per square mile and an estimated reservoir storage life of 1156 years. Toledo Bend Reservoir, located over 100 miles below the project on the Sabine Reservoir, has an annual sediment accumulation of 0.15 acre-feet per square mile and an estimated storage life of 620 years. (U.S. Corps of Engineers, 1967). Erosion/sedimentation rates should be similar in the Big Cypress Creek Watershed of the Red River Basin.

Thus, sedimentation does not appear to be a major threat to the water resource projects in the area.

### 3.3.2 Ground Water

#### 3.3.2.1 General

Ground water supplies more than 60 percent of the total water utilized for municipal, rural (excluding irrigation), and industrial purposes in Van Zandt County and nearly all the water used in Wood County. Rock units of Eocene age are the principal acquifers in both counties. Table 3.3-3 describes the rock units in the area and their water-bearing properties. Further discussion of the rock units is provided in section 3.2.6.1.

#### 3.3.2.2 Aquifer Characteristics

The principle aquifer in Van Zandt and Wood Counties is the Carrizo-Wilcox Aquifer, which is composed of the Wilcox Group, the Carrizo Sand, and the Newby Sand Member of the Reklaw Formation. All three units are hydraulically connected. The Midway Group forms a lower confining bed and the Marquez Shale Member of the Reklaw Formation acts as an upper confining bed. Ground water near the surface of the aquifer outcrop is generally under water table conditions. Ground water stored in deeper sands of the Carrizo-Wilcox Aquifer and downdip from its outcrop area is under artesian conditions.

The Carrizo-Wilcox Aquifer receives recharge where the aquifer crops out. The ground water then moves toward areas of discharge by gravity. Generally, the water moves downdip to the east and southeast, and toward larger streams in some area. In the vicinity of the salt dome, however, the ground water has an upward flow (Figure 3.3-4). The slope of the water table (i.e., the hydraulic gradient) is very low, on the order of 5 feet per mile (White, 1973).

Water levels in wells are generally a few feet to around 60 feet below the surface, although levels in many municipal and industrial wells are much lower as a result of extensive pumping (Appendix B and Figure 3.3-4). The water level in a shallow well can drop as much as 10 feet during the dry season (summer to fall) but recovers during periods of low usage and/or following heavy spring rains. Water-bearing sands at the site are found at a depth of about 40 feet, and water rises to static levels 15 to 20 feet below the surface (Hardiman, 1976). Water found during shaft excavations at the site was at a depth of around 38 feet. Most recent data indicate the water level is at a depth of 15 to 20 feet.

The Carrizo-Wilcox Aquifer receives very little recharge annually. Of the 43 inches of annual precipitation, 12 inches are lost by runoff and 30 inches are returned to the atmosphere by evapotranspiration. A portion of the remaining 1 inch percolates down to the water table, and migrates laterally to topographic lows where it is discharged by seepage or by evapotranspiration. The remainder of the rainfall (about 5000 acre-feet of water annually) moves downdip to recharge the deeper sands of the aquifer (White, 1973).

The hydraulic conductivity (which expresses an aquifer's ability to transmit water) of the Carrizo-Wilcox Aquifer, as indicated by aquifer tests in Van Zandt County, is about 6.3 cubic feet per day (White, 1973); this is very low for a principal aquifer.

Transmissivity, the product of an aquifer's thickness and its hydraulic conductivity, indicates how much water will move through an aquifer. An average transmissivity of 600 cubic feet per day was derived for the Carrizo-Wilcox Aquifer.

The amount of water that can be removed from an aquifer is indicated by the coefficient of storage, which relates the volume of water taken from storage to the change in head. For the Carizzo-Wilcox Aquifer in the Grand Saline area, pumping tests produced an average storage coefficient of 0.00038, which is within the normal range for artesian aquifers.

An estimated 50 million acre-feet of water is in storage in the Carrizo-Wilcox Aquifer. This large storage contrasts with its very low recharge rate of 5000 acre-feet per year. Because of its low hydraulic conductivity and coefficient of storage, only 10 percent of the water in storage, or about 5 million acre-feet, is economically retrievable through pumping wells.

Another property that indicates the water-yielding capability of an aquifer is the specific capacity. Although specific capacity is a characteristic of each individual well and is often a function of the well's construction, it can be representative of the aquifer. Specific capacity is the ratio of discharge to drawdown (or recovery) during a given time interval. The average specific capacity for a 24-hour period is 2.4 gpm per foot (which is low) for the Carrizo-Wilcox Aquifer in Van Zandt County.

Although the Carrizo-Wilcox Aquifer contains a large amount of water, the previously described hydraulic properties indicate why excessive, prolonged pumping has resulted in significant drawdowns in water levels in the area. On the western side of the city of Grand Saline, municipal and industrial pumping has caused the water level to decline almost 100 feet since 1936.

Short-term excessive pumping can also cause significant temporary drawdowns. During a 48-hour pumping test near Grand Saline, water was pumped at an average rate of 130 gpm. The water level in the well had declined 118 feet by the end of the pumping period.

3.3.2.3 Water Quality

The contemplated use of water controls, to a great extent, the inferred "quality" of the water. Standards for various uses have been established for dissolved solids, bacterial content, and physical properties (temperature, odor, color, and turbidity). Table 3.3-4 summarizes the source and significance of the more common dissolved materials found in water.

Ground water in Van Zandt and Wood Counties is almost always fresh, containing small to moderate amounts of dissolved solids (White, 1973). Chemical analyses of ground water samples considered representative of the area show that more than 90 percent of the water contains less than 1000 mg/l dissolved solids, with less than 250 mg/l chloride or sulfate, and less than 45 mg/l nitrate. The few wells that exceed 45 mg/l nitrate are shallow wells, indicating that the high concentration of nitrate is probably the result of surface contamination.

Generally, ground water in the area is soft, although some areas have problems with hardness exceeding 120 mg/l. Excessive amounts of iron and high acidity in sands at shallow depth exist in places, causing some problems. Carbonaceous material may occasionally give the water an undesirable color.

Chemical analyses of wells within 5 miles of the site do not show an excess of salt-derived solids, except for 1 well 4 miles to the north which contains large amounts of sulfate and chloride. Several wells show high iron content, which is a natural phenomenon caused by oxidizing zones coming in contact with reducing zones within the aquifer.

Water in the sediments overlying the salt dome is generally fresh, although a chemical analysis of the water has not been performed. Water within the caprock of the salt dome is probably 80 to 85 percent saturated with salt. As shown on Figure 3.3-4, ground water directly above the salt dome has an upward flow, causing the salty ground water to be carried upward and to be discharged into the overlying salt marsh by means of seeps and springs.

TABLE 3.3-1 USGS discharge-frequency analysis - summary

| | 7 - Day low flow (cfs) | | | | | Annual flood discharge (cfs) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Return period (yrs) | 2 | 5 | 10 | 50 | 100 | 2 | 5 | 10 | 50 | 100 |
| Sabine River near Mineola | 0.27 | 0.024 | 0.007 | 0.001 | 0.000 | 12,850 | 26,000 | 35,600 | 56,900 | 65,600 |
| Grand Saline Creek near Grand Saline | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3,074 | 7,480 | 11,150 | 20,271 | 24,318 |
| Lake Fork Creek near Quitman | 0.67 | 0.18 | 0.08 | 0.02 | 0.01 | 12,180 | 25,250 | 36,100 | 65,400 | 79,700 |
| Big Sandy Creek near Big Sandy | 16.0 | 10.7 | 8.6 | 5.9 | 5.1 | 2,320 | 5,200 | 7,830 | 15,700 | 20,000 |
| Big Cypress Creek near Pittsburg | 3.3 | 1.2 | 0.65 | 0.20 | 0.13 | 6,975 | 15,400 | 22,800 | 44,300 | 55,457 |

Source: U.S. Geological Survey, Reston, Virginia.

TABLE 3.3-2 Sabine River water quality data

| Parameter | Sampling Station 1967 to 1974 Near Mineola, Texas | | | Sampling Station 1967 to 1974 Near Emory, Texas | | | Proposed Texas Water Quality Board Standards |
|---|---|---|---|---|---|---|---|
| | Maximum | Minimum | Mean | Maximum | Minimum | Mean | Average not to be exceeded |
| Discharge, cfs | 25,300.0 | 0.0 | 1,243.0 | 5,470.0 | 0.2 | 994.0 | - |
| Specific conductance, umhos | 11,400.0 | 70.0 | 565.0 | 1,222.0 | 68.0 | 242.0 | - |
| Calcium, mg/l | 130.0 | 5.0 | 28.0 | 55.0 | 5.5 | 25.6 | - |
| Magnesium, mg/l | 32.0 | 1.2 | 6.6 | 18.0 | 1.5 | 4.0 | - |
| Sodium, mg/l | 1.970.0 | 10.0 | 61.0 | 0.0 | 0.0 | 0.0 | - |
| Potassium, mg/l | 9.3 | 2.2 | 4.1 | 0.0 | 0.0 | 0.0 | - |
| Bicarbonate, mg/l | 1.080.0 | 8.0 | 68.0 | 136.0 | 8.0 | 84.0 | - |
| Carbonate, mg/l | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | - |
| Sulfate, mg/l | 820.0 | 8.0 | 45.0 | 28.0 | 7.2 | 14.3 | 100 |
| Chloride, mg/l | 3.010.0 | 9.0 | 111.0 | 13.0 | 3.0 | 6.5 | 200 |
| Nitrate, mg/l | 10.0 | 0.0 | 0.8 | 5.0 | 0.0 | 0.4 | - |
| Dissolved solids, mg/l | 5.060.0 | 47.0 | 308.0 | 174.0 | 42.0 | 109.0 | 500 |
| Hardness (total), mg/l | 450.0 | 20.0 | 95.0 | 120.0 | 20.0 | 76.0 | - |
| Hardness (noncarbonate), mg/l | 320.0 | 0.0 | 40.0 | 170.0 | 0.0 | 13.0 | - |
| Sodium absorption ratio | 41.0 | 0.2 | 3.3 | 2.2 | 0.4 | 0.73 | - |
| Silica, mg/l | 18.0 | 2.0 | 6.8 | 8.5 | 0.0 | 3.50 | - |
| Fluoride, mg/l | 0.7 | 0.0 | 0.2 | 0.5 | 0.1 | 0.2 | - |
| pH | 7.9 | 5.9 | 7.0 | 7.7 | 6.4 | 7.2 | 6.0 - 8.5 |
| Temperature, $^{o}$ C | 29.0 | 2.0 | 17.2 | 31.0 | 4.5 | 18.5 | 32 |
| Dissolved oxygen, mg/l | 12.4 | 7.0 | 7.3 | 11.5 | 3.8 | 6.3 | 5.0 (minimum) |
| Phosphorus, mg/l | 0.17 | 0.0 | 0.11 | 0.44 | 0.0 | 0.13 | - |

Source: U.S. Army Corps of Engineers District, Fort Worth, Texas; Draft Environmental Statement for Carl L. Estes Lake.

TABLE 3.3-3 Local geologic units and their water bearing properties

| System | Series | Group | Formation | Geologic Unit | Approximate Maximum Thickness (ft) | Character of Sediments | Water-Bearing Properties |
|---|---|---|---|---|---|---|---|
| Quaternary | Holocene and Pleistocene | | | Alluvium | 50 | Sand, silt, clay and minor amounts of gravel | Not known to yeild water to wells in the area. The thicker deposits would probably yield small to moderate quantities of water |
| Tertiary | Ecocene | Claiborne | | Queen City Sand | 400 | Sand, silt, and clay with stringers of lignite and bentonitic clay | Yields small quantities of fresh water to domestic and stock wells in southeastern Van Zandt County and large quantities in eastern Wood County |
| Tertiary | Ecocene | Claiborne | Reklaw Formation (70) | Marquez Shale Member | 40 | Silty shale | Not known to yield water to wells in the area |
| Tertiary | Ecocene | Claiborne | Reklaw Formation (70) | Newby Sand Member | 30 | Glauconitic sand | Yields less than 50 gpm of fresh water to large-diameter wells on the outcrop. Wells tapping the Newby and Carrizo Sand in southeastern Van Zandt County yield larger quantities |
| Tertiary | Ecocene | Claiborne | | Carrizo Sand | 150 | Sand and minor amount of silt and clay | Yields less than 50 to 150 gpm of fresh water to wells in southeastern Van Zandt County |
| Tertiary | Ecocene | Wilcox | | | 960 | Lenticular beds of sand, with sandy clay, shale, sandstone and lignite | Yields less than 25 to more than 500 gpm to wells in Rains and Van Zandt Counties. Large quantities have been pumped during aquifer tests in a few wells near Grand Saline |
| Tertiary | Ecocene | Midway | | | Not Measured | Calcareous clay with stringers of limestone and glauconitic sand | Yields very small quantities of water to a few wells in western Rains and Van Zandt Counties |

TABLE 3.3-4 Source and significance of dissolved-mineral constituents and properties of water

| Constituent or Property | Source or Cause | Significance |
|---|---|---|
| Silica ($SiO_2$) | Dissolved from practically all rocks and soils, commonly less than 30 mg/l. High concentrations, as much as 100 mg/l, generally occur in highly alkaline waters | Forms hard scale in pipes and boilers. Carried over in steam of high pressure boilers to form deposits on blades of turbines. Inhibits deterioration of zeolite-type water softeners |
| Iron (Fe) | Dissolved from practically all rocks and soils. May also be derived from iron pipes, pumps, and other equipment. More than 1 or 2 mg/l of iron in surface waters generally indicates acid wastes from mine drainage or other sources | On exposure to air, iron in ground water oxidizes to reddish-brown precipitate. More than about 0.3 mg/l stains laundry and utensils reddish-brown. Objectionable for food processing, textile processing, beverages, ice manufacture, brewing, and other processes. U.S. Public Health Service (1962) drinking water standards state that iron should not exceed 0.3 mg/l. Larger quantities cause unpleasant taste and favor growth of iron bacteria |
| Calcium (Ca) and magnesium (Mg) | Dissolved from practically all soils and rocks, but especially from limestone, dolomite, and gypsum. Calcium and magnesium are found in large quantities in some brines. Magnesium is present in large quantities in sea water | Cause most of the hardness and scale-forming properties of water; soap consuming (see hardness). Waters low in calcium and magnesium desired in electroplating, tanning, dyeing, and in textile manufacturing |

TABLE 3.3-4 Continued

| Constituent or Property | Source or Cause | Significance |
|---|---|---|
| Chloride (Cl) | Dissolved from rocks and soils. Present in sewage and found in large amounts in ancient brines, sea water, and industrial brines | In large amounts in combination with sodium, gives salty taste to drinking water. U.S. Public Health Service (1962) drinking-water standards recommend that the chloride content should not exceed 250 mg/l |
| Fluoride (F) | Dissolved in small to minute quantities from most rocks and soils. Added to many waters by fluoridation of municipal supplies | Fluoride in drinking water reduces the incidence of tooth decay when the water is consumed during the period of enamel calcification. However, it may cause mottling of the teeth, depending on the concentration of fluoride, the age of the child, amount of drinking water consumed, and susceptibility of the individual. (Maier, 1950) |
| Nitrate ($NO_3$) | Decaying organic matter, sewage, fertilizers, and nitrates in soul | Concentration much greater than the local average may suggest pollution. U.S. Public Health Service (1962) drinking-water standards suggest a limit of 45 mg/l. Waters of high nitrate content have been reported to be the cause of methemoglobinemia (an often fatal disease in infants) and therefore should not be used in infant feeding. Nitrate has been shown to be helpful in reducing intercrystalline cracking of boiler steel. It encourages growth of algae and other organisms which produce undesirable tastes and odors. |

TABLE 3.3-4 Continued

| Constituent or Property | Source or Cause | Significance |
|---|---|---|
| Sodium (Na) and potassium (K) | Dissolved from practically all rocks and soils. Found also in ancient brines, sea water, industrial brines, and sewage | Large amounts, in combination with chloride, give a salty taste. Moderate quantities have little effect on the usefulness of water for most purposes. Sodium salts may cause foaming in steam boilers and a high sodium content may limit the use of water for irrigation |
| Bicarbonate ($HCO_3$) and carbonate ($CO_3$) | Action of carbon dioxide in water on carbonate rocks such as limestone and dolomite | Bicarbonate and carbonate produce alkalinity. Bicarbonates of calcium and magnesium decompose in steam boilers and hot water facilities to form scale and release corrosive carbon dioxide gas. In combination with calcium and magnesium, cause carbonate hardness |
| Sulfate ($SO_4$) | Dissolved from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Commonly present in mine waters and in some industrial wastes | Sulfate in water containing calcium forms hard scale in steam boilers. In large amounts, sulfate in combination with other ions gives bitter taste to water. Some calcium sulfate is considered beneficial in the brewing process. U.S. Public Health Service (1962) dringing-water standards recommend that the sulfate content should not exceed 250 mg/l |

TABLE 3.3-4 Continued

| Constituent or Property | Source or Cause | Significance |
|---|---|---|
| Dissolved solids | Chiefly mineral constituents dissolved from rocks and soils. Includes some water of crystallization | U.S. Public Health Service (1962) drinking-water standards recommend that waters containing more than 500 mg/l dissolved solids not be used if other less mineralized supplies are available. Waters containing more than 1000 mg/l dissolved solids are unsuitable for many purposes |
| Hardness as $CaCO_3$ | In most waters nearly all the hardness is due to calcium and magnesium. All the metallic cations other than the alkali metals also cause hardness | Consumes soap before a lather will form. Deposits soap curd on bathtubs. Hard water forms scale in boilers, water heaters, and pipes. Hardness equivalent to the bicarbonate and carbonate is called carbonate hardness. Waters of hardness as much as 60 mg/l are considered soft; 61 to 120 mg/l, moderately hard; 121 to 180 mg/l, hard; more than 180 mg/l, very hard |
| Specific conductance (micromhos at 25°C) | Mineral content of the water | Indicates degree of mineralization. Specific conductance is a measure of the capacity of the water to conduct an electric current. Varies with concentration and degree of ionization of the constituents. |

TABLE 3.3-4 Continued

| Constituent or Property | Source or Cause | Significance |
|---|---|---|
| Hydrogen ion concentration (pH) | Acids, acid-generating salts, and free carbon dioxide lower the pH. Carbonates, bicarbonates, hydroxides, and phosphates, silicates, and borates raise the pH | A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote increasing alkalinity; values lower than 7.0 indicate increasing acidity. pH is a measure of the activity of the hydrogen ions. Corrosiveness of water generally increases with decreasing pH. However, excessively alkaline waters may also attack metals. |

Source: Committee on Water Quality Criteria, 1972.

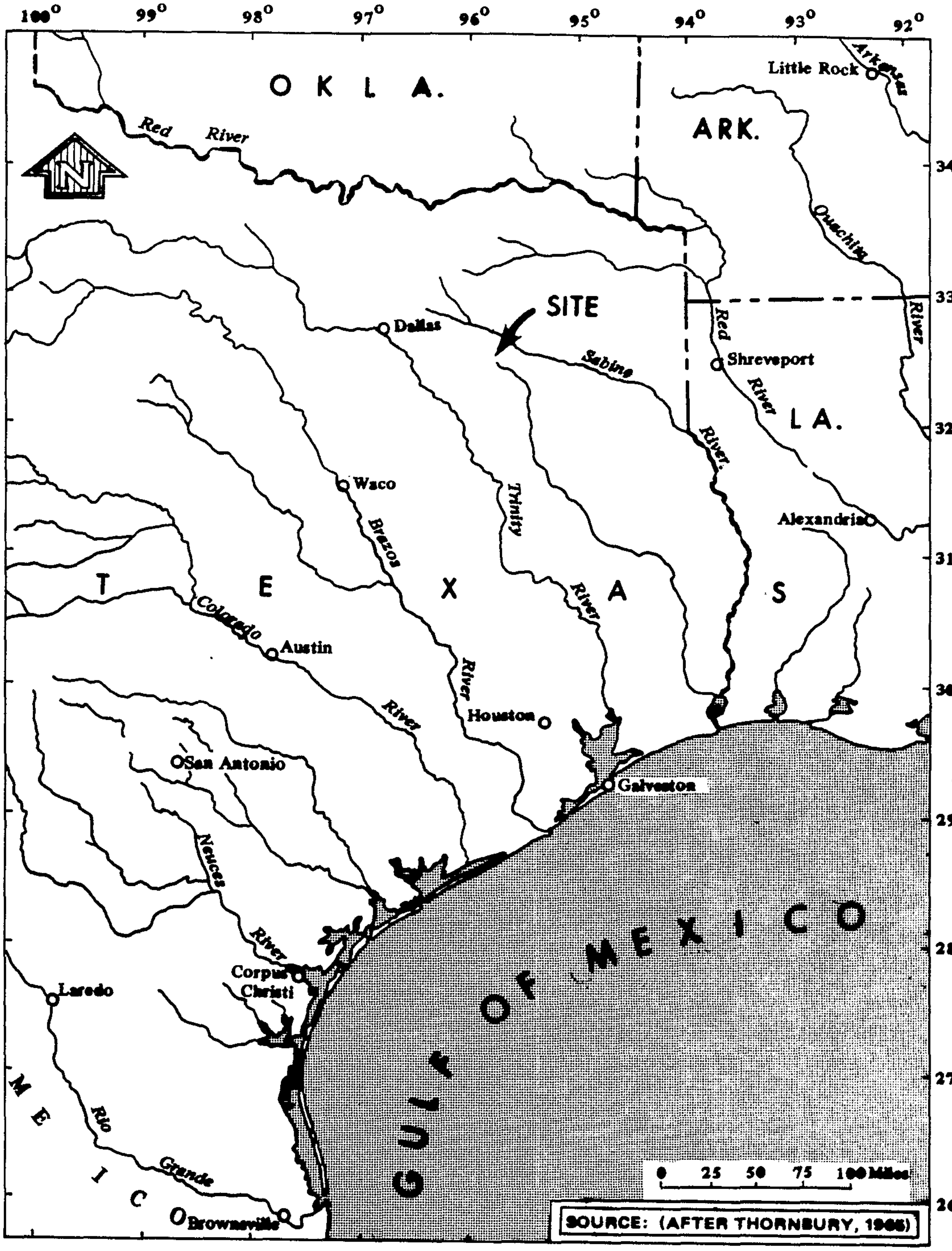
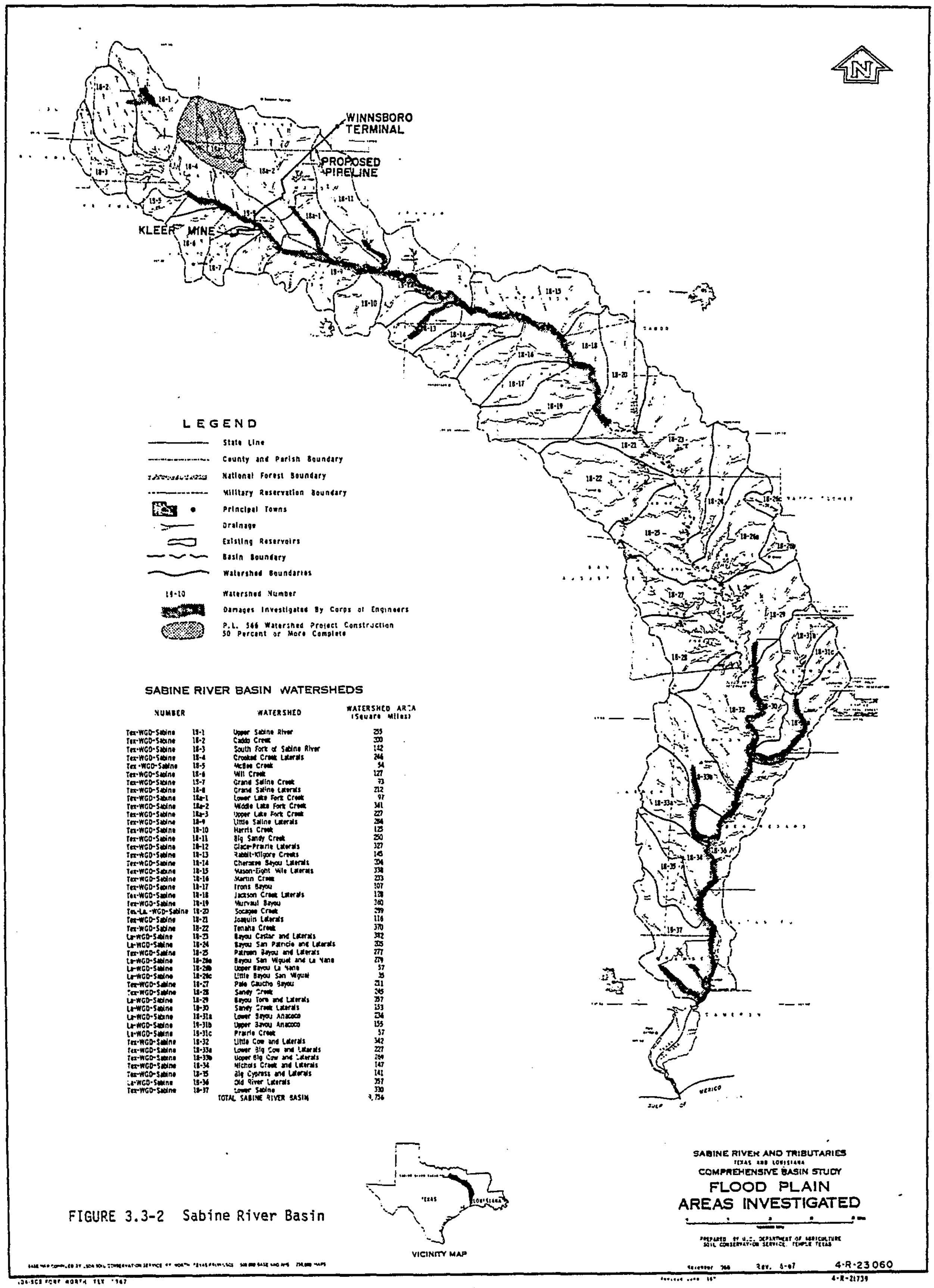



FIGURE 3.3-1 River basins in the project area




## SABINE RIVER BASIN WATERSHEDS

| NUMBER | | WATERSHED | WATERSHED AREA (Square Miles) |
|---|---|---|---|
| Tex-WGD-Sabine | 18-1 | Upper Sabine River | 255 |
| Tex-WGD-Sabine | 18-2 | Caddo Creek | 330 |
| Tex-WGD-Sabine | 18-3 | South Fork of Sabine River | 142 |
| Tex-WGD-Sabine | 18-4 | Crooked Creek Laterals | 246 |
| Tex-WGD-Sabine | 18-5 | McBee Creek | 54 |
| Tex-WGD-Sabine | 18-6 | Mill Creek | 127 |
| Tex-WGD-Sabine | 18-7 | Grand Saline Creek | 73 |
| Tex-WGD-Sabine | 18-8 | Grand Saline Laterals | 212 |
| Tex-WGD-Sabine | 18a-1 | Lower Lake Fork Creek | 97 |
| Tex-WGD-Sabine | 18a-2 | Middle Lake Fork Creek | 341 |
| Tex-WGD-Sabine | 18a-3 | Upper Lake Fork Creek | 227 |
| Tex-WGD-Sabine | 18-9 | Little Saline Laterals | 284 |
| Tex-WGD-Sabine | 18-10 | Harris Creek | 125 |
| Tex-WGD-Sabine | 18-11 | Big Sandy Creek | 250 |
| Tex-WGD-Sabine | 18-12 | Glade-Prairie Laterals | 327 |
| Tex-WGD-Sabine | 18-13 | Rabbit-Kilgore Creeks | 145 |
| Tex-WGD-Sabine | 18-14 | Cherokee Bayou Laterals | 304 |
| Tex-WGD-Sabine | 18-15 | Mason-Eight Mile Laterals | 338 |
| Tex-WGD-Sabine | 18-16 | Martin Creek | 233 |
| Tex-WGD-Sabine | 18-17 | Irons Bayou | 107 |
| Tex-WGD-Sabine | 18-18 | Jackson Creek Laterals | 128 |
| Tex-WGD-Sabine | 18-19 | Murvaul Bayou | 360 |
| Tex-La.-WGD-Sabine | 18-20 | Socagee Creek | 259 |
| Tex-WGD-Sabine | 18-21 | Joaquin Laterals | 116 |
| Tex-WGD-Sabine | 18-22 | Tenaha Creek | 370 |
| La-WGD-Sabine | 18-23 | Bayou Castor and Laterals | 392 |
| La-WGD-Sabine | 18-24 | Bayou San Patricio and Laterals | 325 |
| Tex-WGD-Sabine | 18-25 | Patroon Bayou and Laterals | 277 |
| La-WGD-Sabine | 18-26a | Bayou San Miguel and La Nana | 279 |
| La-WGD-Sabine | 18-26b | Upper Bayou La Nana | 57 |
| La-WGD-Sabine | 18-26c | Little Bayou San Miguel | 35 |
| Tex-WGD-Sabine | 18-27 | Palo Gaucho Bayou | 231 |
| Tex-WGD-Sabine | 18-28 | Sandy Creek | 245 |
| La-WGD-Sabine | 18-29 | Bayou Toro and Laterals | 357 |
| La-WGD-Sabine | 18-30 | Sandy Creek Laterals | 153 |
| La-WGD-Sabine | 18-31a | Lower Bayou Anacoco | 234 |
| La-WGD-Sabine | 18-31b | Upper Bayou Anacoco | 155 |
| La-WGD-Sabine | 18-31c | Prairie Creek | 57 |
| Tex-WGD-Sabine | 18-32 | Little Cow and Laterals | 342 |
| Tex-WGD-Sabine | 18-33a | Lower Big Cow and Laterals | 227 |
| Tex-WGD-Sabine | 18-33b | Upper Big Cow and Laterals | 269 |
| Tex-WGD-Sabine | 18-34 | Nichols Creek and Laterals | 147 |
| Tex-WGD-Sabine | 18-35 | Big Cypress and Laterals | 141 |
| La-WGD-Sabine | 18-36 | Old River Laterals | 357 |
| Tex-WGD-Sabine | 18-37 | Lower Sabine | 330 |
| | | TOTAL SABINE RIVER BASIN | 9,756 |

FIGURE 3.3-2 Sabine River Basin

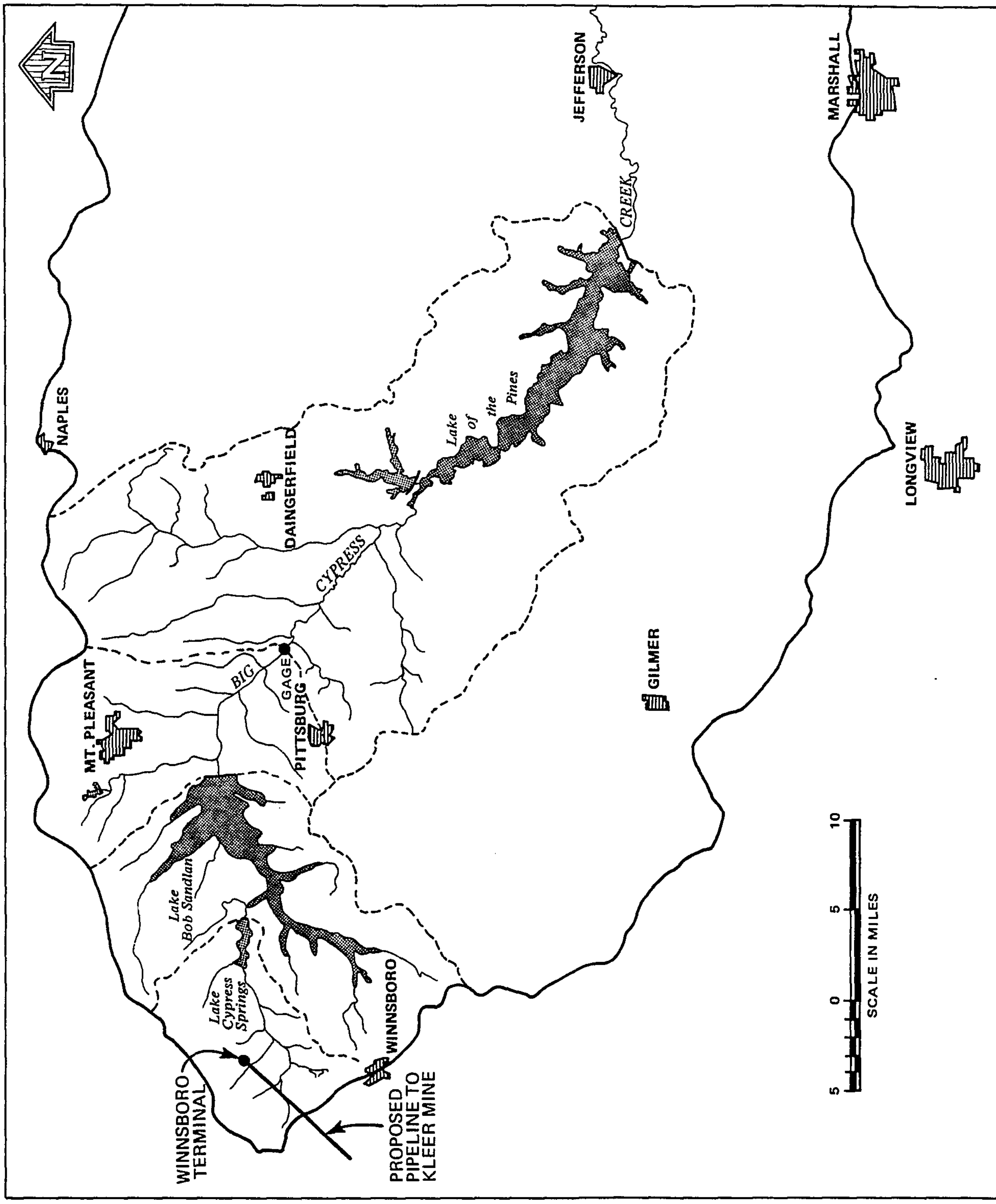
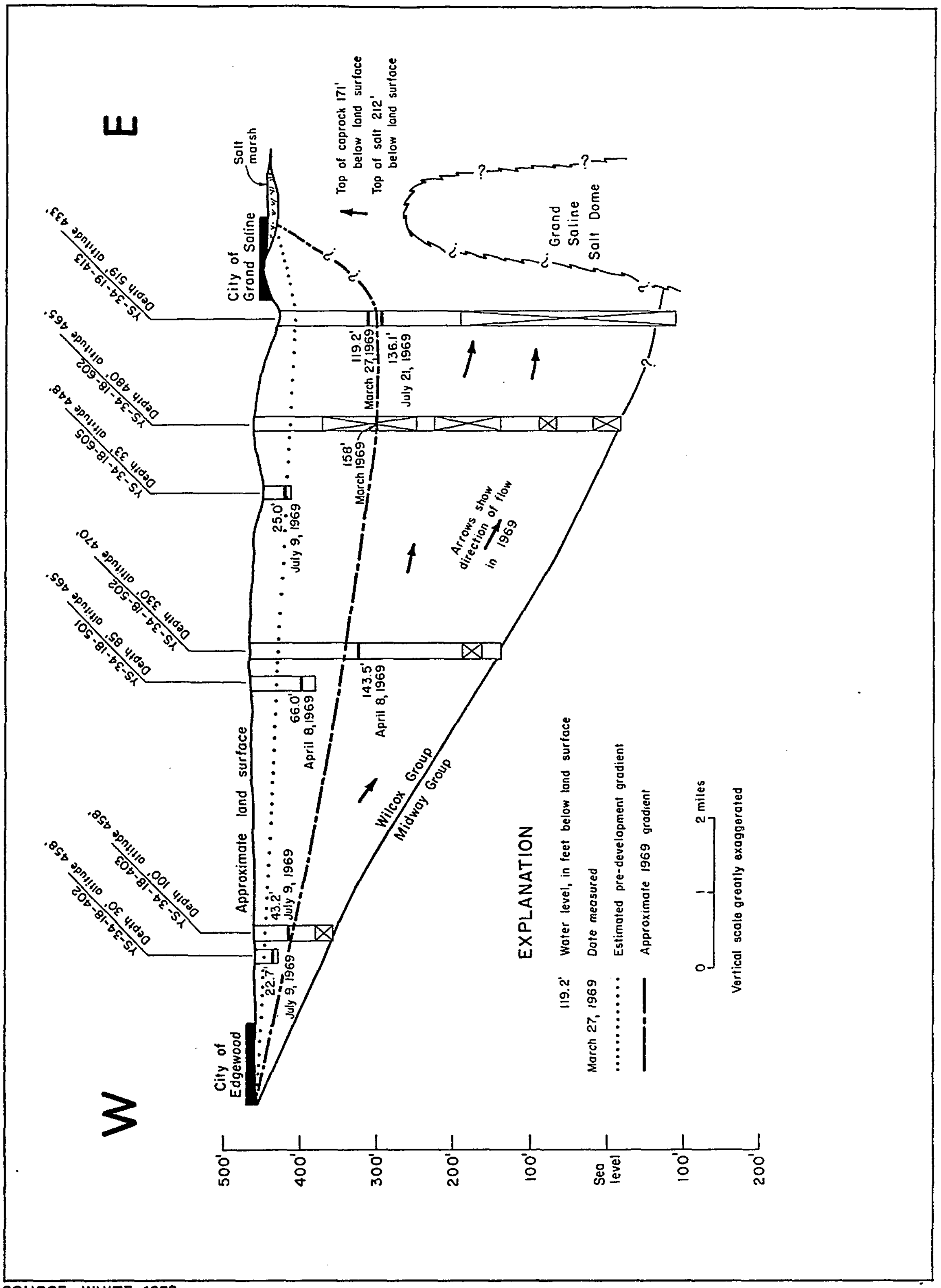



FIGURE 3.3-3 Big Cypress Creek Watershed




SOURCE: WHITE, 1973.

FIGURE 3.3-4 Water level profiles in the heavily-pumped sands in the Wilcox group between Grand Saline and Edgewood

## 3.4 CLIMATOLOGY AND AIR QUALITY

### 3.4.1 Regional Climatology

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

The Kleer Mine site is located in northeastern Texas, 250 miles north of the Gulf of Mexico. The climate of the region is broadly determined by the surrounding continental land mass, the subtropical latitude and the western edge of the Atlantic high pressure system.

The climate is primarily subtropically humid with hot summers and very mild winters. Primarily because of its location inland and the lack of surface moisture sources in the surrounding area, the humidity is not as oppressive as one finds nearer to the Gulf coast. The area is characterized by a wide range in annual temperature extremes. This is due to the frequent transition from a maritime tropical air mass to a continental polar air mass during the winter when northerly winds bring the cold stable air down from the plains. This type of cold air outbreak is most often associated with a fast moving well-developed high pressure system as it crosses the central United States. Because the continent has no major highlands between the arctic plains and the Gulf of Mexico, it becomes relatively easy for these outbreaks of polar air to progress southward toward Texas.

In the eastern portion of Texas during the summer months, tropical continental air masses may occasionally approach from the southwestern United States or northern Mexico. On these occasions very high temperatures and low humidity prevail. During the summer, the Bermuda high strengthens westward and the pressure gradient steepens across Texas toward a semi-permanent thermal low in the region of northwestern Mexico. This produces persistent moderate to strong southeasterly winds. Convective activity is most frequent during the summer. By mid-fall, the Bermuda high has begun its migratory movement eastward in the Atlantic. In November, westerly moving low-pressure systems bring their influence upon the weather in northern Texas and adjacent regions.

The region is frequently affected by frontal disturbances associated with cyclonic systems that cross the south central portions of the United States. With the warmer weather of the spring and summer, the major storm tracks have pushed to the north, and the area is affected more by local convective disturbances than by cyclonic systems.

The terrain in northeastern Texas is essentially flat with a few scattered rivers and lakes marking the landscape. Thus, there are no modification effects from surface terrain features on synoptic scale (100 to 1000 km) or mesoscale (10 to 100 km) weather elements.

3.4.1.2 Temperature

Winters are mild, but northerly cold outbreaks occur in the region about 3 times each month during the season and are accompanied by sudden drops in temperature. Periods of extreme cold that occasionally occur are short-lived so that even in January, mild weather occurs frequently. In an average year, temperature minima of 28$^{o}$F or below occur on only a few days each year. During both spring and fall, temperatures average between 55$^{o}$F and 75$^{o}$F. The highest summer temperatures are associated with fair skies, westerly winds and low humidities. Characteristically, hot spells in summer are broken into 3- to 5-day periods by thunderstorm activity. There are only a few nights each summer when the minimum temperature exceeds 80$^{o}$F, but a year when the temperature does not exceed 100$^{o}$F is rare.

The average length of the warm season (freeze-free period) in the Dallas-Fort Worth area is 249 days. The average date of the last occurrence of 32$^{o}$F or below is March 16. During the period from 1940 to 1970, the earliest occurrence was February 14, 1946; the latest was April 13, 1957. The average date of the first occurrence of 32$^{o}$F or below in the fall is November 21. The earliest occurrence during the period from 1940 to 1970, was October 27, 1957; the latest was January 4, 1972 (NOAA, 1974).

Table 3.4-1 presents the monthly mean and extreme temperatures measured at Dallas (approximately 70 miles west of Kleer Mine) during the preceding 11 years. The monthly means vary from 84.9$^{o}$F (95.5$^{o}$F is the monthly mean maximum, 74.0°F is the monthly mean minimum) in August to 44.8°F (55.7°F is the monthly mean maximum, 33.9°F is the monthly mean minimum) in January. The large variability of temperature in the area is best exemplified by the extremes: 112°F in August 1930, -8°F in February 1899.

Although Dallas is 70 miles west of the Kleer Mine, the temperatures are representative of the area because of the similar latitude, homogeneous terrain features, and the small variability of the surface wind. Monthly norms for northeast Texas match Dallas data fairly closely (Table 3.4-2).

#### 3.4.1.3 General Wind Conditions

The northeastern region of Texas is relatively windy due to the strong upper level airflow patterns often observed over the region and the low-lying terrain that allows unimpeded airflow. The prevailing surface wind direction is southerly, resulting in part from the influence of the eastern extension of the Atlantic subtropical anticyclone and continental land mass heating.

Table 3.4-3 lists the monthly distribution of winds reported at the Dallas airport. The strongest winds are observed during the spring months, reflecting the dominance of the polar jet stream over the south central United States during the season. Winds are lightest during the summer months. Monthly wind roses for the winter season exhibit northwesterly and northerly components of wind superimposed upon the prevailing southerly flow. These components are associated with the periodic outbreaks of cold continental polar air that occur during the season.

#### 3.4.1.4 Precipitation

Rainfall in northeastern Texas is moderate, increasing in a southeasterly direction from Dallas. Nearly 2/3 of the annual rainfall falls between the months of April and September. The greatest amounts of rain occur during the months of April and May. July and August are relatively dry. Throughout the year, rainfall occurs more frequently during the night than during the day. Periods of rainy weather usually last for only a day or two and are followed by several days with fair skies.

A large part of the annual precipitation results from thunderstorm activity, with occasional heavy rainfall over brief periods of time. Tables 3.4-4 and 3.4-5 present the monthly mean and extreme rainfall amounts for Dallas, Marshall and Longview. Heavy amounts of precipitation may occur over short time periods (e.g., 9.57 inches in 24 hours in 1957), but are not as extreme as one finds along the Gulf coast. Average precipitation over the Red River Basin is given in Table 3.4-6.

Figures 3.4-1 and 3.4-2 present rainfall intensity curves at various return intervals for Dallas and Greenville, Texas, respectively. The double maximum during the warm season and the winter minimum are characteristic of the south central United States. The rainfall increases sharply with the coming of spring, rapid surface heating, and the resulting inflow of Gulf air. At the same time, frontal disturbances remain numerous. The secondary minimum during the midsummer is the result of an anticyclonic circulation pattern in the mid-troposphere over the southern Great Plains that dampens any surface convection beginning in the unstable air from the Gulf.

3.4.1.5 Ice and Snow

A measurable amount of snow is reported on an average of only once per year at Dallas, Texas. During the month of January 1964, however, a total of 12.1 inches of snow was recorded. Freezing rain is occasionally observed during the months of December, January and February. Because periods of subfreezing temperatures are usually short lived, surface features remain ice-covered no longer than 1 or 2 days following freezing precipitation.

3.4.1.6 Evaporation

Eastern Texas is in a region of high spatial gradients of moisture and evaporation that lie between the Texas Gulf coast and the southeastern United States. The area in the vicinity of Kleer Mine experiences moderate evaporation with respect to other portions of the United States. The mean annual class A pan-evaporation is 75 inches per year, and the mean annual lake evaporation is 53 inches per year. Nearly 70 percent of the total annual evaporation occurs during the months of May through October (U.S. Weather Bureau, 1955).

3.4.1.7 Sky Cover

The Kleer Mine site is in a region where clear skies prevail during the summer, fall and early winter months. Clear or partly cloudy days number over 230 per year. Eastern Texas receives almost 70 percent of the annual possible sunshine. The higher percentage of cloudy weather occurs during the winter months, and is associated with the southward advance of the jet stream over the area, which brings increased cyclonic and frontal activity (Trewartha, 1966).

3.4.1.8 Fog

The occurrence of heavy fog (visibility less than 1/4 mile) in the area is minimal, averaging only 11 occurrences per year. When fog does occur, it is usually the result of an outbreak of polar air, causing radiational cooling of relatively moist surface layers of air in the late evening or early morning hours. Generally speaking, it is the high temperatures and homogeneous surface area of Texas that prevent the occurrence of frequent fogging.

3.4.1.9 Relative Humidity

The relative humidity in northeastern Texas averages nearly 70 percent annually. The diurnal variation is large, ranging from 50 to 60 percent in the mid-day to 80 to 90 percent in the early morning hours. Seasonally, the relative humidity follows the same trend as the rainfall -- spring and late summer maxima and a winter minimum.

3.4.1.10 Severe Weather Conditions

Tornadoes

The Texas plains region has historically been affected by a high frequency of tornadoes. Among the most important conditions conducive to tornado formation are the availability of low-level moisture supply, strong low-level heating, the presence of strong windsheer, and a triggering mechanism (such as a cold front). This region of Texas experiences these conditions often enough to have a tornado frequency as high as most regions of Nebraska and Kansas. Figure 3.4-3 (Pautz, 1969) shows the frequency of tornadoes by $1^{\circ}$ squares for the period 1955 through 1967. Thirty-six tornadoes were reported in the $1^{\circ}$ square surrounding the Kleer Mine site, representing an average of about 3 tornadoes per year. Statewide, Texas averaged 158 tornado days per year.

Most tornadic formation results from the squall line development associated with a well-developed cyclonic disturbance and its accompanying frontal passages. However, the convective heating in the region is sufficient to produce isolated thunderstorms severe enough to spawn funnel clouds.

Although tornadoes have been observed during all seasons of the year, they are most frequent in Texas during the months of April, May and June, with May as the peak month.

Thunderstorms and Hail

Thunderstorms occur each month but are most frequent during the months of April, May, and June when thunder is reported in the Dallas vicinity nearly once every 4 days. The annual average number of thunderstorms at Dallas is 45. The thunderstorms are associated with both frontal disturbances throughout the year and localized convection during the spring and summer season. Because of the available moisture from the Gulf and the high degree of surface heating that takes place in the area, severe thunderstorms can occur during the spring and summer months.

Meteorological records compiled at Dallas airport indicate that hail falls 2 or 3 days a year and ordinarily causes slight damage. The amount of hail occurrence is related to thunderstorm development and severity. The severity of thunderstorms in northern Texas is not like that of storms observed in Oklahoma and Nebraska; therefore, one finds correspondingly fewer hail reports. Based on data from 1955 to 1967, Pautz found only 13 reports (an average of 1 per year) of hail larger than 3/4 inches in the $1^{\circ}$ by $1^{\circ}$ square surrounding Kleer Mine (Figure 3.4-4).

Extreme Winds

Severe winds in the region occur in conjunction with severe thunderstorms and squall lines, and an occasional well-developed extratropical cyclone. Although the general wind patterns in northern Texas exhibit fairly high wind speeds, the occurrence of extreme winds is not as likely as in the central plain states to the north or at the Gulf coast: the plain states experience more severe thunderstorms and tornadic activity, and the Gulf coast area is more open to the threat of tropical storms and hurricanes. Pautz determined that there were just 21 reports of wind storms 50 knots or greater in the $1^{o}$ by $1^{o}$ area surrounding the Kleer Mine site between the years 1955 and 1967. The American National Standards Institute's (1972) annual extreme fastest mile wind speed (at 30 feet aboveground) for northeastern Texas is 70 miles per hour for both a 50- and 100-year mean recurrence interval.

Tropical Storms

The Kleer Mine site, situated some 250 miles inland from the Gulf coast, is only indirectly affected by tropical storms and hurricanes. By the time a tropical system has advanced as far inland as northern Texas, it has undergone a substantial transition to the extratropical storm stage, with less wind but heavy amounts of rain. The greatest problem caused by these heavy rains on a flat terrain of low-permeability soils is flooding (see section 3.3.1).

### 3.4.2 Climatological Factors Affecting Dispersion

The meteorological conditions that are generally conducive to high air pollution potential are light winds, stable layers aloft and surface based inversions. The northeast Texas region is characterized by frequent afternoon thunderstorms, high solar insolation and its associated instability in the lower layers, and frequent winds. These meteorological conditions do not contribute to a high air pollution potential. In addition, the flat low-lying terrain allows for uninterrupted wind flow and, thus, good ventilation. A description of air pollution potential for the site vicinity, based on Holzworth (1972) and mean mixing heights, is presented in Appendix E.

### 3.4.3 Air Quality

Pursuant to the Clean Air Act as amended in 1970, the U.S. Environmental Protection Agency (EPA) established primary and secondary standards for major pollutants. Primary standards define the levels judged necessary to safeguard public health with an adequate margin of safety. Secondary standards define air quality levels established for some pollutants to protect the public welfare from known or anticipated adverse effects of these pollutants.

Under the Clean Air Act, each state was required to submit an implementation plan for achieving, maintaining and enforcing the primary standards within 3 years after the plan's approval, and to achieve the secondary standards within a "reasonable time" thereafter. The Texas Air Quality Control Board air quality standards, shown in Tables 3.4-7 and 3.4-8, are identical to the Federal standards.

Because of the localized nature of most pollution problems, Air Quality Control Regions (AQCR) were established for the purpose of implementing pollution control and/or abatement programs. In these AQCR's, pollutants have been given priority classifications from I to III based on existing pollution levels, where known, or on estimated air quality in the area of expected maximum pollution concentrations where air quality is unknown. The classifications provide a means of identifying the relative time and resources which should be expended in developing a regional air quality control plan commensurate with the complexity and severity of the problem. A priority I classification is indicative of pollution levels in excess of the primary standards; a priority II represents concentrations between the primary and secondary standards; a priority III is indicative of concentrations generally below the secondary standards. Priority classifications in the Shreveport-Texarkana-Tyler AQCR of Texas, which includes Kleer Mine, are presented below:

| | Pollutant | | | | |
|---|---|---|---|---|---|
| | Sulphur Dioxide | Particulates | Nitrogen Dioxide | Oxidants | Hydrocarbons |
| Priority | III | II | III | III | III |

The Texas Air Quality Control Board has a limited on-going monitoring program in the Shreveport-Texarkana-Tyler AQCR. The closest monitoring station to the Kleer Mine site is located at Tyler, Texas, 25 miles southeast of the site. The monitoring station measures suspended particulates, sulphur dioxide ($SO_2$), and nitrogen dioxide ($NO_2$). Table 3.4-9 presents the highest 24-hour samples and geometric annual means of particulates and $SO_2$, based on 1973 data provided by the EPA (1974). Although hydrocarbons are not presently being monitored in northeastern Texas, it is the opinion of local officials at the Texas State Air Control Commission office (1974) that the existing levels of hydrocarbons are low. Table 3.4-9 reveals that the existing ambient level of $SO_2$ is below both the primary and secondary ambient air standards for the state of Texas, whereas the level of particulates exceeds these standards. The pollutants with the largest levels in relation to the current standards in the Shreveport-Texarkana-Tyler AQCR are suspended particulates.

TABLE 3.4-1 Monthly mean and extreme temperatures observed at Dallas, Texas*

| Month | Daily Maximum | Daily Minimum | Monthly Mean | Record Highest | Year | Record Lowest | Year |
|---|---|---|---|---|---|---|---|
| January | 55.7 | 33.9 | 44.8 | 88 | 1969 | 4 | 1964 |
| February | 59.8 | 37.6 | 48.7 | 87 | 1969 | 12 | 1971 |
| March | 66.6 | 43.3 | 55.0 | 96 | 1974 | 19 | 1965 |
| April | 76.3 | 54.1 | 65.2 | 95 | 1972 | 30 | 1973 |
| May | 82.8 | 62.1 | 72.5 | 96 | 1967 | 42 | 1971 |
| June | 90.8 | 70.3 | 80.6 | 105 | 1972 | 51 | 1964 |
| July | 95.5 | 74.0 | 84.8 | 106 | 1974 | 59 | 1972 |
| August | 96.1 | 73.7 | 84.9 | 108 | 1964 | 56 | 1967 |
| September | 88.5 | 66.8 | 77.7 | 102 | 1963 | 46 | 1971 |
| October | 79.2 | 56.0 | 67.6 | 96 | 1963 | 37 | 1966 |
| November | 67.5 | 44.1 | 55.8 | 88 | 1965 | 24 | 1970 |
| December | 58.7 | 37.0 | 47.9 | 84 | 1966 | 10 | 1963 |

*Period of record: 1964-1974.

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 112 in August 1936; lowest temperature -8 in February 1899.

Source: U.S. Dept. of Commerce, 1974.

TABLE 3.4-2 Monthly normal temperature for northeastern Texas

| | | | |
|---|---|---|---|
| January | 44.8° F | July | 83.2° F |
| February | 48.0° F | August | 83.4° F |
| March | 54.6° F | September | 76.9° F |
| April | 63.8° F | October | 66.9° F |
| May | 71.8° F | November | 53.7° F |
| June | 79.9° F | December | 46.8° F |

Source: Comprehensive Basin Study, Red River below Denison Dam, 1968.

TABLE 3.4-3 Monthly mean and extreme winds recorded at Dallas, Texas*

| Month | Mean Speed (MPH) | Prevailing Direction | Speed (MPH) | Direction | Year |
|---|---|---|---|---|---|
| January | 11.5 | S | 46 | N | 1957 |
| February | 12.3 | S | 51 | N | 1962 |
| March | 13.4 | S | 55 | WNW | 1954 |
| April | 13.2 | S | 55 | NW | 1970 |
| May | 11.6 | S | 55 | SE | 1955 |
| June | 11.1 | S | 52 | NW | 1955 |
| July | 9.8 | S | 65 | N | 1961 |
| August | 9.3 | S | 73 | N | 1959 |
| September | 9.8 | S | 53 | ESE | 1961 |
| October | 9.9 | S | 44 | W | 1957 |
| November | 10.9 | S | 50 | NNW | 1957 |
| December | 11.3 | S | 53 | NW | 1968 |

*Based on a 21-year (1954-1974) period of record.

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

TABLE 3.4-4 Monthly mean and extreme rainfall occurrence at Dallas, Texas*

| Month | Normal | Maximum Monthly | Year | Minimum Monthly | Year | Maximum in 24 Hrs. | Year |
|---|---|---|---|---|---|---|---|
| January | 1.80 | 3.60 | 1968 | 0.19 | 1971 | 2.36 | 1961 |
| February | 2.36 | 6.20 | 1965 | 0.15 | 1963 | 4.06 | 1965 |
| March | 2.54 | 6.39 | 1968 | 0.10 | 1972 | 2.99 | 1958 |
| April | 4.30 | 12.19 | 1957 | 0.92 | 1959 | 4.55 | 1957 |
| May | 4.47 | 12.64 | 1957 | 1.06 | 1961 | 4.86 | 1965 |
| June | 3.05 | 6.94 | 1962 | 0.40 | 1964 | 3.11 | 1966 |
| July | 1.84 | 11.13 | 1973 | 0.09 | 1965 | 3.22 | 1958 |
| August | 2.26 | 6.85 | 1970 | 0.01 | 1973 | 3.30 | 1970 |
| September | 3.15 | 9.52 | 1964 | 0.23 | 1956 | 4.76 | 1965 |
| October | 2.68 | 9.22 | 1959 | 0.20 | 1955 | 5.91 | 1959 |
| November | 2.03 | 6.23 | 1964 | 0.20 | 1970 | 2.83 | 1964 |
| December | 1.82 | 6.99 | 1971 | 0.21 | 1955 | 3.10 | 1971 |
| Year | 32.30 | 12.64 | May 1957 | 0.01 | Aug. 1973 | 5.91 | Oct. 1959 |

*Based on a 21-year (1954-1974) period of record.

Means and extremes above are from existing comparable exposures. Annual extremes have been exceeded at other sites in the locality: maximum monthly precipitation 17.64 in April 1922; minimum monthly precipitation 0.00 in November 1903; maximum precipitation in 24 hours 9.57 in September 1932.

Source: U.S. Dept. of Commerce, Local Climatological Data, Dallas, Texas; NOAA, Asheville, North Carolina.

TABLE 3.4-5 Precipitation data for Lake Fork Creek and Big Sandy Creek watersheds

| Station | Years of Record thru 1972 | Annual Precipitation Maximum (inches) | Annual Precipitation Minimum (inches) | U.S.W.B. normal (inches) |
|---|---|---|---|---|
| Marshall | 71 | 67.43 | 29.58 | 46.96 |
| Longview | 87 | 76.84 | 29.28 | 46.16 |

Maximum 24-hr and Maximum Monthly Precipitation

| Station | Years of Record thru 1972 | Maximum 24-hour rainfall (inches) | Minimum monthly rainfall (inches) |
|---|---|---|---|
| Marshall | 71 | 10.60 | 16.20 |
| Longview | 87 | 9.35 | 16.43 |

Source: Comprehensive Basin Study, Sabine River.

TABLE 3.4-6 Average precipitation by climatological division of Red River Basin (Inches)

| Month | Southeast Oklahoma | Northeast Texas | Southwest Arkansas | Northwest Louisiana |
|---|---|---|---|---|
| January | 3.05 | 3.83 | 4.78 | 5.43 |
| February | 3.35 | 3.68 | 4.28 | 4.72 |
| March | 3.51 | 3.93 | 4.65 | 4.87 |
| April | 4.72 | 4.95 | 5.41 | 5.22 |
| May | 5.91 | 5.33 | 5.01 | 5.57 |
| June | 4.00 | 3.77 | 3.54 | 3.70 |
| July | 3.36 | 3.41 | 3.99 | 4.41 |
| August | 2.89 | 2.69 | 2.94 | 3.25 |
| September | 3.46 | 2.97 | 2.80 | 2.92 |
| October | 3.30 | 3.13 | 3.00 | 2.94 |
| November | 3.15 | 3.95 | 4.15 | 4.59 |
| December | 3.02 | 4.01 | 4.71 | 5.43 |

Source: Comprehensive Basin Study, Red River below Denison Dam.

TABLE 3.4-7 Primary ambient air quality standards

| Air Contaminant | Standards Maximum Permissible Concentration |
| --- | --- |
| Suspended Particulate | 75 $\mu g/m^3$ (Annual geometric mean)<br>260 $\mu g/m^3$ (Maximum 24 hour concentration not to be exceeded more than once per year) |
| Sulfur Dioxide ($SO_2$) | 80 $\mu g/m^3$ or 0.03 ppm (annual arith. mean)<br>365 $\mu g/m^3$ or 0.14 ppm (Maximum 24 hour concentration not to be exceeded more than once per year) |
| Hydrocarbons (other than Methane) | 160 $\mu g/m^3$ (0.24 ppm) (Maximum 3 hour concentration between 6:00 a.m. and 9:00 a.m. not to be exceeded more than once per year) |
| Nitrogen Dioxide ($NO_2$) | 100 $\mu g/m^3$ (0.05 ppm) (Annual arith. mean) |

TABLE 3.4-8 Secondary ambient air quality standards

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

TABLE 3.4-9 Ambient air quality in northeast Texas*

| | Highest 24-hour Concentration ($\mu g/m^3$) | Annual Geometric Mean ($\mu g/m^3$) |
|---|---|---|
| Total Suspended Particulates measured at Tyler, Texas | 105 | 91 |
| Sulphur Dioxide measured at Tyler, Texas | 30 | 5.8 |
| Photochemical Oxidants (Ozone) measured at Fort Worth, Texas | 370 | 66 |

*Based on 1973 Air Quality Data furnished by the Environmental Protection Agency.

TABLE 3.4-10 Existing baseline air quality data in southeast Texas[a]

| Monitoring Location | Pollutants | Concentrations ($\mu g/m^3$)[b] 1-hour | 3-hour[c] | 8-hour | 24-hour | Annual[d] |
|---|---|---|---|---|---|---|
| Nederland, Texas | Ozone | 384 | | | | 64 |
| | CO | 6,007 | | 2,356 | | 235 |
| | NMHC | 4,102 | 2,966 | | | 379 |
| | $CH_4$ | 3,298 | | | | 1,077 |
| | $SO_2$ | 215 | 81 | | 0 | 0 |
| | $H_2S$[e] | 14 | | | | 0 |
| | $NO_2$ | 213 | | | 58 | 19 |
| | NO | 795 | | | 139 | 25 |
| | Particulates[f] | | | | 129 | 56 |

TABLE 3.4-10 Continued

| Monitoring Location | Pollutants | Concentrations ($\mu g/m^3$)[b] 1-hour | 3-hour[c] | 8-hour | 24-hour | Annual[d] |
|---|---|---|---|---|---|---|
| | Ozone | 340 | | | | 58 |
| | CO | 7,539 | | 5,065 | | 353 |
| | NMHC | 2,650 | 1,944 | | | 252 |
| West Orange, Texas | $CH_4$ | 4,442 | | | | 1,279 |
| | $SO_2$ | 26 | 26 | | 0 | 0 |
| | $H_2S$[e] | 14 | | | | 0 |
| | $NO_2$ | 174 | | | 38 | 19 |
| | NO | 277 | | | 25 | 13 |
| | Particulates[f] | 84 | | | | 50 |

[a]Based on Texas Air Control Board reports, 1977. Period of record Jan. through Dec., 1976. Shaded boxes indicate violation of standards.

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

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

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

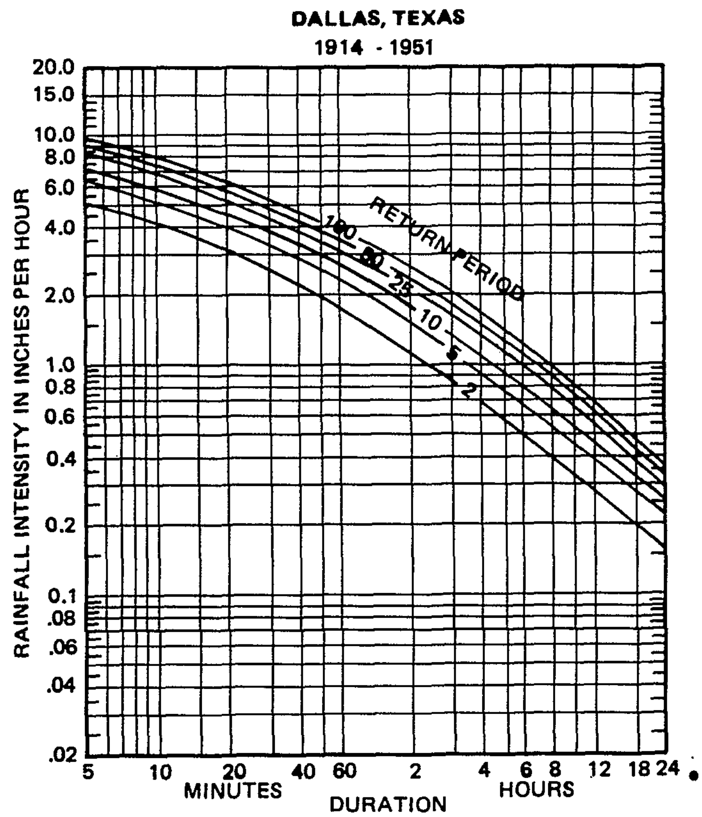
[e]The Texas $H_2S$ standard is based on a 30-minute averaging period and is not to be exceeded at all.

[f]Particulate data based on Science Applications, 1977. Period of record 1973-1974.

TABLE 3.4-11 Annual high and second high ozone concentrations in southeast Texas*

| | West Orange, Texas | | Nederland, Texas | |
|---|---|---|---|---|
| | High ($\mu g/m^3$) | Second High ($\mu g/m^3$) | High ($\mu g/m^3$) | Second High ($\mu g/m^3$) |
| 1972 | - | - | 623 | 612 |
| 1973 | - | - | 745 | 637 |
| 1974 | 406 | 382 | 368 | 341 |
| 1975 | 370 | 368 | 380 | 347 |
| 1976 | 332 | 288 | 366 | 356 |

*Based on 1977 communication from the Environmental Protection Agency.




NOTE: FREQUENCY ANALYSIS BY METHOD OF EXTREME VALUES, AFTER GUMBEL

FIGURE 3.4-1 Rainfall intensity-duration frequency curve for Dallas, Texas

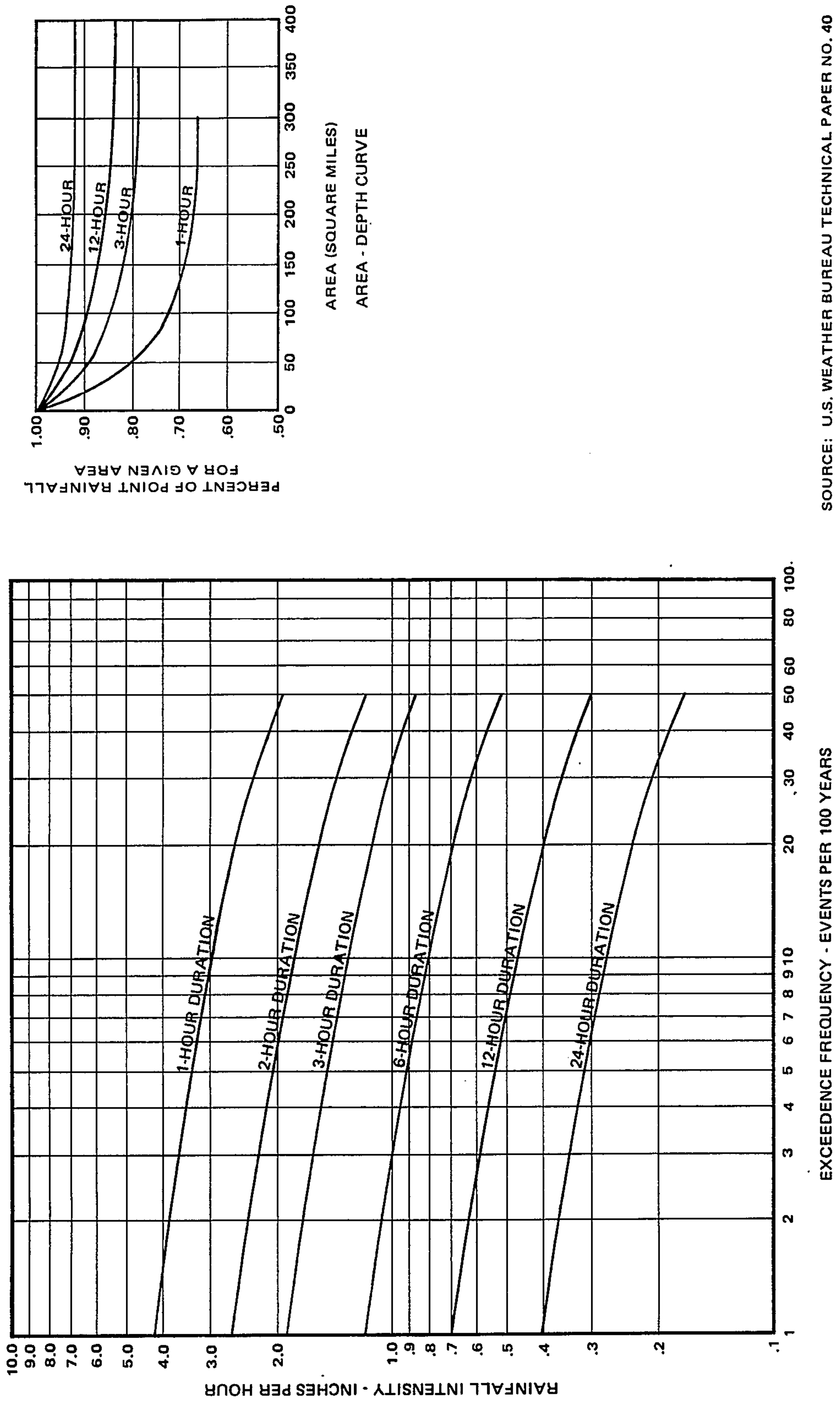
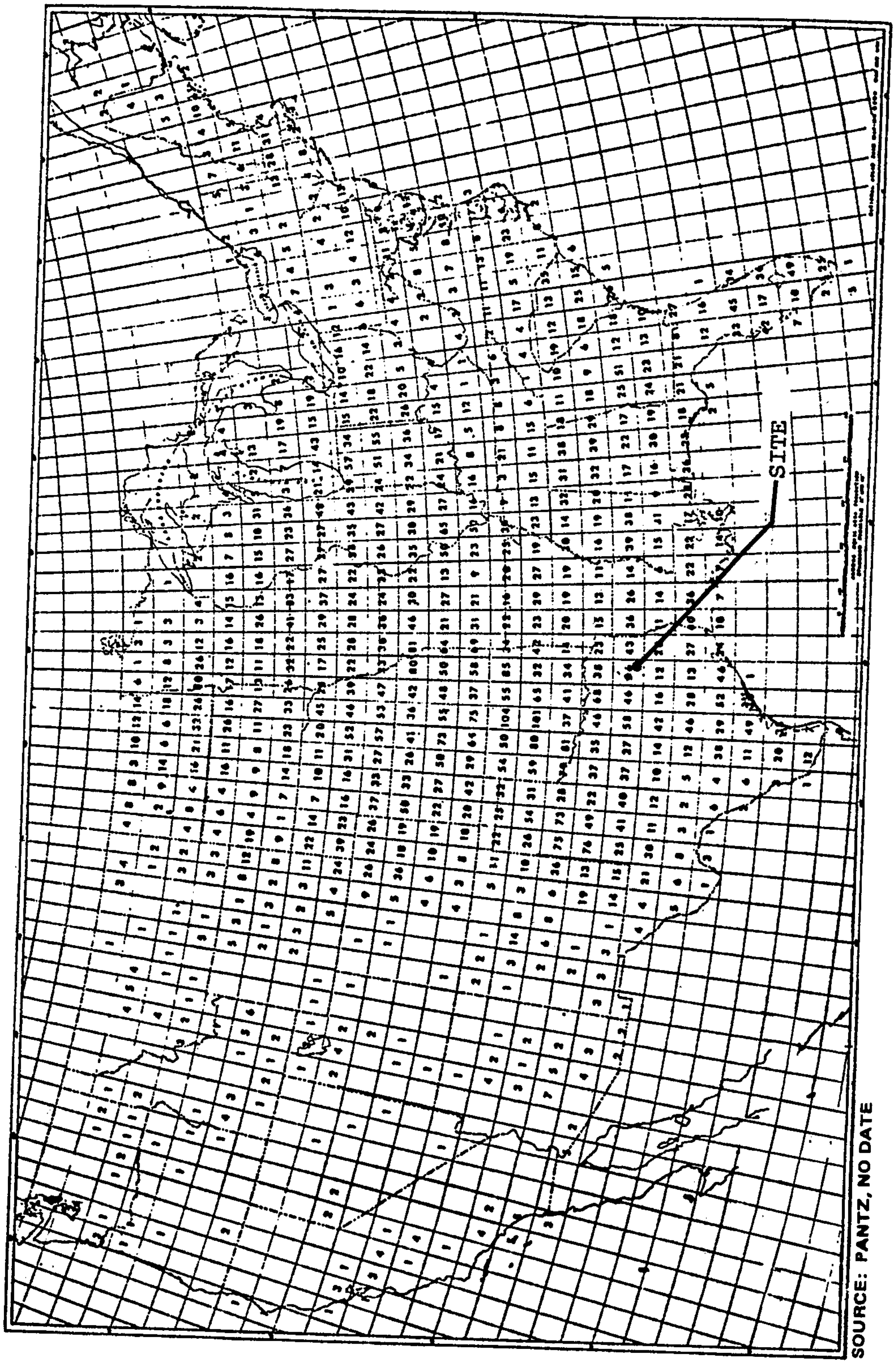
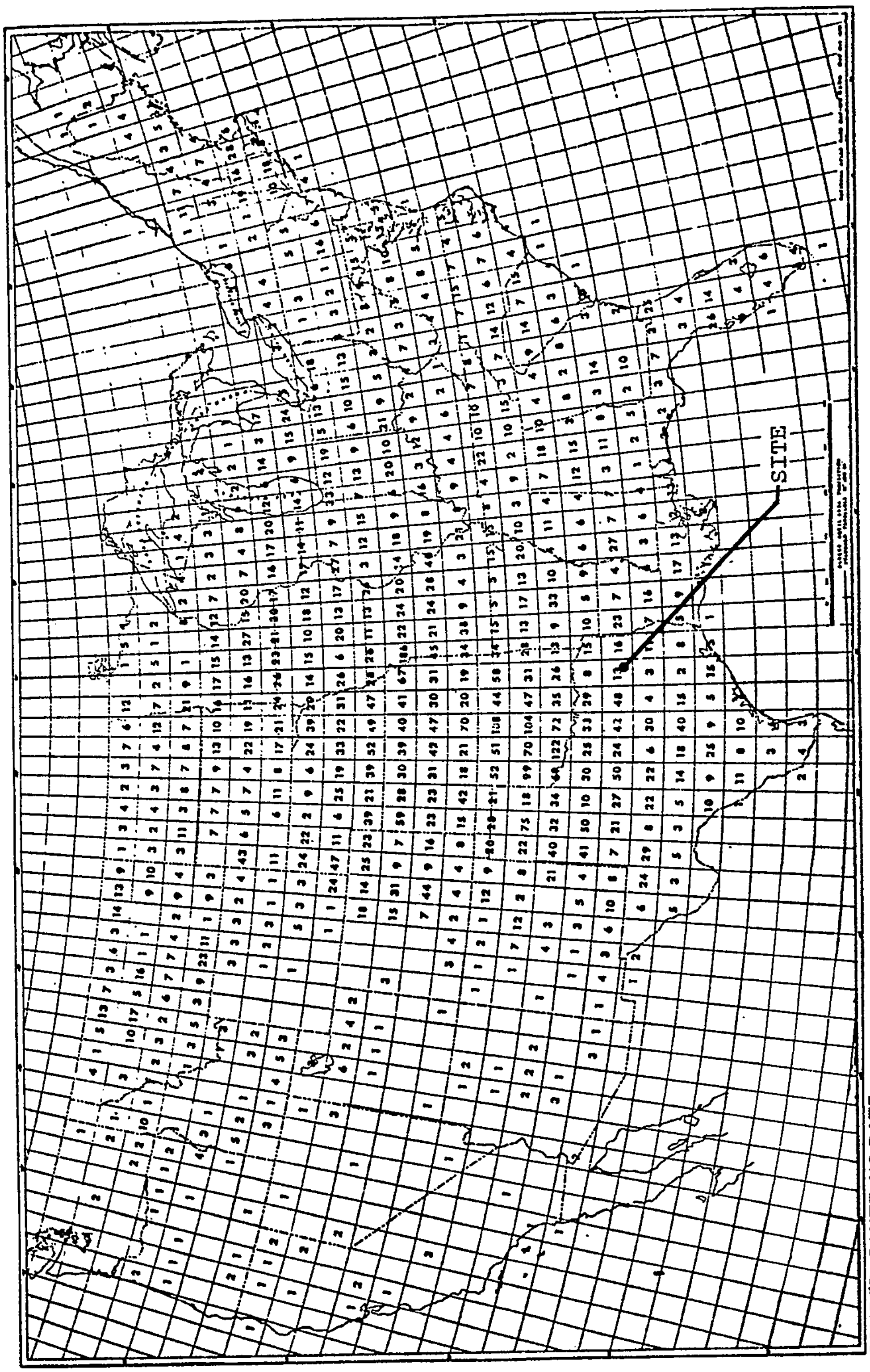



FIGURE 3.4-2 Rainfall intensity frequency curves for Greenville, Texas




SOURCE: PANTZ, NO DATE

FIGURE 3.4-3 Total tornadoes 1955-1967 by $1^{o}$ squares




SOURCE: PANTZ, NO DATE

FIGURE 3.4-4 Total number of hail reports 3/4 inch and greater, 1955-1967 by 1$^{o}$ squares

## 3.5 BACKGROUND AMBIENT SOUND LEVELS

Background ambient sound levels were estimated for Kleer Mine and its environs to assess the potential noise impact from the proposed action. The proposed storage facility is located about one mile south of the town of Grand Saline (Figure 3.2-4). Oil will be transported to and from the storage facility by a pipeline to the Texoma Winnsboro Station, through sparsely populated pastureland and areas of oak and shrubs (see Section 3.6). Nearby noise-sensitive land use areas for which noise estimates were made include the villages of Alba and Golden, within 3 and 2 miles, respectively, of the proposed route, and a number of residences or other structures within 1000 feet of the route and terminal points (Figure 3.5-1). The background sound levels were estimated using data from a similar facility (FEA, 1976) and published data relating ambient sound levels to population distribution (U.S. EPA, 1973). Ambient sound levels at noise sensitive locations along the proposed pipeline route were estimated using sound data at similar land uses.

Background ambient sound levels have been estimated in terms of equivalent sound level (see Appendix C) for daytime ($L_d$), equivalent sound level for nighttime ($L_n$), and equivalent day-night sound level ($L_{dn}$) for the following locations (Figure 3.5-1):

1. Center of site, Morton Salt Grand Saline Plant.
2. Town of Grand Saline.
3. Pasture lands.
4. Nearby villages such as Alba and Golden.

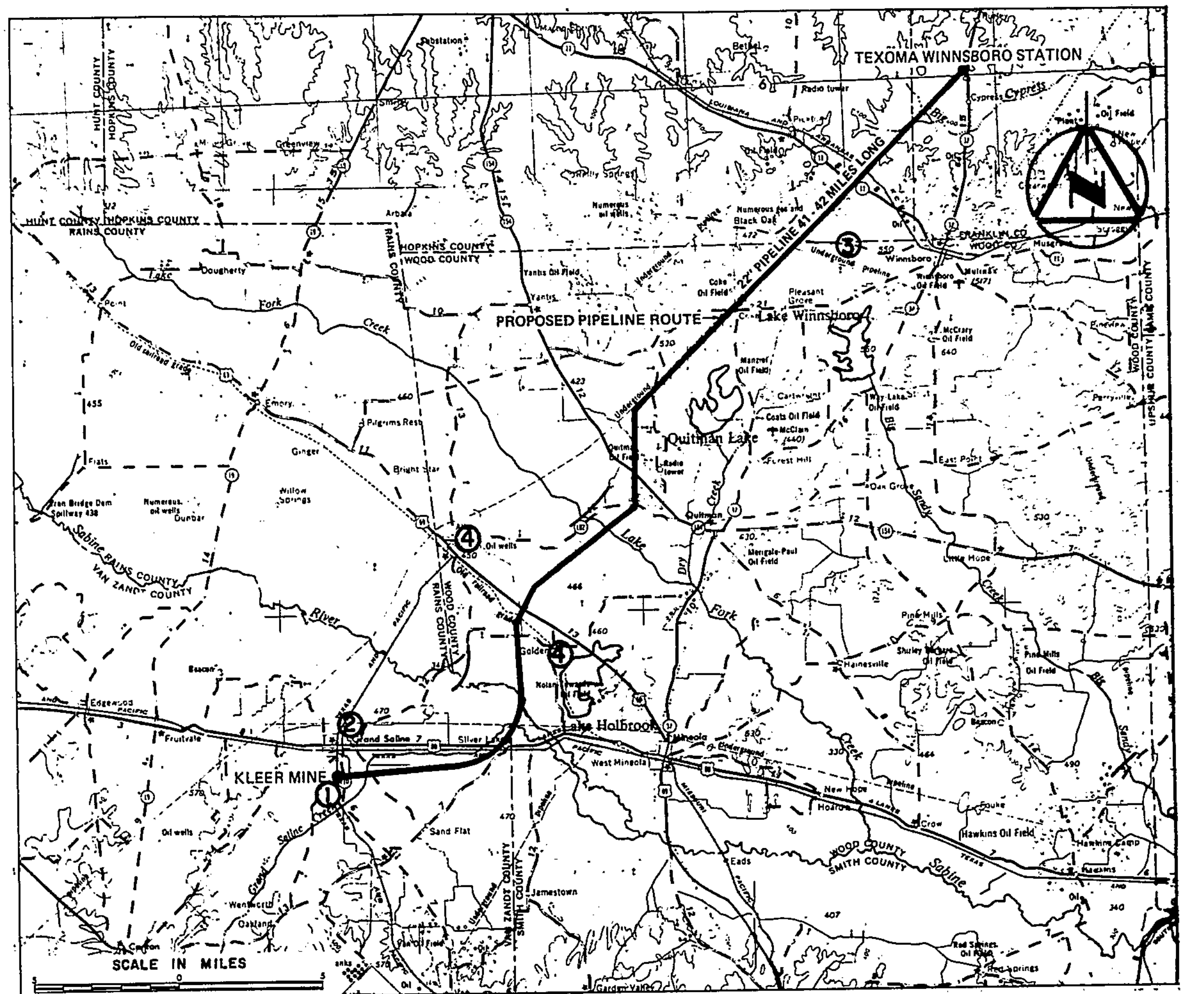
A summary of these sound levels in decibels (dB) is presented in Table 3.5-1.

These values may be compared with sound levels identified by the EPA as being requisite to protect the public health and welfare (see Appendix C). For example, outdoor ambient sound levels ($L_{dn}$) below 55 dB are not considered to degrade public health and welfare.

TABLE 3.5-1 Estimated background ambient sound levels (dB)

| | $L_d$ | $L_n$ | $L_{dn}$[a] |
|---|---|---|---|
| Center of Site | 66 | 68 | 74 |
| Town of Grand Saline | 54 | 48 | 56 |
| Pasture Lands | 45 | 35 | 45 |
| Nearby Villages | 49 | 39 | 49 |

[a] $L_{dn}$ values include 10dB penalty for nighttime activities.




BASE: USGS 1:250,000 MAPS FOR TYLER (1963) AND TEXARKANA (1972), TX.

① CENTER OF SITE, MORTON SALT GRAND SALINE PLANT

② TOWN OF GRAND SALINE

③ PASTURE LANDS

④ NEARBY VILLAGES OF ALBA AND GOLDEN

—— PROPOSED PIPELINE ROUTE

FIGURE 3.5-1 Background ambient sound level estimation areas

## 3.6 ECOLOGY

### 3.6.1 Terrestrial Ecology

#### 3.6.1.1 Land Resource Areas

The project area is characterized ecologically as predominantly tame (modified by man) pastureland, oak-savannah, and relatively pristine river flood plains that are dotted with shallow, high quality lakes. The area lies within the Coastal Plain Physiographic Province (see Figure 3.2-1). Within the province, local variations in geologic formations, topography, climate, and vegetation have interacted through time to produce a variety of soils and landforms that affect land use. Two land resource areas have been identified in the region (within 20 miles of the proposed site): the claypan and bottomland areas.

Claypan Area

The Claypan area, commonly called the "Post Oak Belt," is a gently rolling woodland area located in the transition zone between the East Texas Timberlands and the Blackland Prairie. It was originally a savannah; that is, a grassland with trees scattered throughout. Early settlers wrote of the tall bunchgrass and scattered trees.

Unwise land use practices, such as cultivation of land unsuited for agronomic production, and overgrazing by cattle, resulted in the disappearance of the native grass cover. Post oak and other trees invaded the area previously occupied by grass. The elimination of grass fires as an environmental factor by settlers gave the trees added protection and allowed them to survive. The resulting vegetation is referred to as "thicketization" rather than a forest. It is easy to identify the mature trees that were a part of the climax vegetation. The grass fires effectively pruned the lower branches, making it several feet to the first limb.

Soils of the Claypan area are thin, gray, slightly acid sandy loams over gray, mottled or red, firm, clayey subsoils. Some deep, sandy soils with less clayey subsoils exist. Claypan soils are generally droughty and less productive than the adjacent Blackland Prairies.

The major potential of the Claypan area is for dairy and beef cattle production, winter pastures, and deer hunting. Tame pasture and cool-season forage crops are prerequisites to successful beef and dairy operations. High beef prices have, in recent years, motivated landowners in this area to convert much acreage to tame pasture crops such as coastal Bermuda grass. Both coastal Bermuda grass and Coast Cross I require large amounts of fertilizer to produce nutritious forage on the highly leached soils which characterize this area. If fertilizer costs continue to increase and cattle prices remain depressed, much tame pasture may again be converted to other uses or simply abandoned.

Bottomlands

The Bottomlands include about 2.9 million acres of alluvial soils occurring along the major flowing rivers of Texas. The surface relief is subdued, generally sloping to the east and south; only the short, sharp slopes between benches break the broad sweep of the alluvial plain. Areas of undulating and dissected, coarse-textured soils occur where overflows are frequent. The Bottomlands may be divided into flood plains that flood frequently (except where dams or levee systems protect the land from overflow) and higher terraces, which are above ordinary flood crests.

Soils of the Bottomlands differ from the soils of other resource areas in that they are derived from alluvial sediments rather than from the surrounding upland materials. The soils of the Bottomlands have many common characteristics. They are slightly acid to alkaline and are youthful in their profile development. Soil texture ranges from fine sand loams to clays, although small inclusions of coarse sands occur. The sandy soils are very deep, and gully erosion is a problem where concentrations of water are discharged over a sharp bank or slope.

Climax vegetation in this land resource area is deciduous forest comprised of hydrophytic species. Although logging operations have changed the character of many riverbottom forests in northeast Texas, the Sabine River near Grand Saline remains in an essentially pristine state.

Because of flood hazards and the inherent hydric nature of the Sabine riverbottom, the primary land use is for recreation such as squirrel and duck hunting.

3.6.1.2 Local Habitats and their Ecosystems

Overview

The various terrestrial habitat types that could be either directly or indirectly influenced by the proposed project are described in this section. Community components are discussed both individually and collectively for complete community characterization. Habitat types in the immediate vicinity of the proposed storage location are shown on Figure 3.6-1. Much of the mine site is comprised of the Grand Saline Creek flood plain and salt marsh.

There is significant diversity of fauna and flora in the area. The tame pasture monoculture supports domestic cattle, a few deer, and some birds such as meadowlarks. The oak-savannah habitats are preferred by a large number of species. The only game birds in the oak-savannah are the mourning dove and the bobwhite. The hydric nature of the flood plains (Sabine River and Lake Fork Creek) has led to tree/shrub vegetation, predominantly willow, alder, and myrtle. Amphibians and reptiles abound in the moist flood plain environment. The eastern gray squirrel is an important game animal in this habitat, and white-tailed deer are present in limited numbers.

Cynodon (a tame pasture grass) is by far the most important floral species to man in this region since a large percentage of the local economy depends on the success of dairy and beef agribusiness (see section 3.9). (The perennial native bunchgrass may have once been most important, both for forage and soil stabilization.) Lumber production is unimportant in the region. Second in importance among vegetation species is probably the hickory or oak, which supply habitat and food for the eastern gray squirrel.

Study Approach

The scope of terrestrial studies was restricted to one site visit at each major habitat type and a review of pertinent literature. The only exception was the salt marsh habitat type, which was studied in more detail (see Appendix I).

Initially, all terrestrial habitat types in the project area were inventoried. From these data, major habitat types were selected, then literature dealing with these types was collected and assimilated. During the initial site visit, each habitat type was visited to check basic assumptions made from literature investigations. Unique or sensitive habitats were then identified and the unique aspects of these communities studied in some detail. This study approach provided familiarity with the large area crossed by the project and directed maximum effort to the areas most sensitive to project impacts.

Common names (where available) are used as the basis of discussion for both plant and animal species in the text. Lists of mammals, amphibians, reptiles, birds, plants, and fish likely to occur in the project area are given in Appendix D, including both common name and taxonomic nomenclature. Nomenclature guides are: soil - Soil Conservation Service (1975); vegetation - Correll and Johnston (1970); amphibians and reptiles - Conant (1958); mammals - Jones, Carter and Genoways (1973); and birds - American Ornithologist Union (1948, 1973).

Oak-Savannah Habitat

Soils - Woodtell and Freestone soils are predominant in the oak-savannah habitat. These soils series are members of the fine, montmorillonitic, thermic family of Vertic Hapludalfs (U.S. Soil Conservation Service, 1975c).

Vegetation - The oak-savannah area was originally characterized by a few mature trees scattered in a grassland matrix, but land management practices have removed the climax grasses and allowed rampant wood regeneration resulting in thickets. These thickets are dominated by post oak, blackjack oak, bluejack oak, and black hickory. The shrub stratum is characterized by farkelberry, southern blackhaw, wing-rib sumac, hawthorne, deciduous yaupon, and yaupon.

Amphibians and Reptiles - Considering the upland, somewhat xeric nature of the oak-savannah, this habitat type supports a diverse complement of amphibians and reptiles.

The marbled salamander is the most commonly encountered salamander and occurs in areas of especially heavy litter accumulation. The characteristic frog-like community component is eastern spadefoot. When conditions become too dry for members of this species, they burrow into the friable surface soils to protect their moist skin. The three-toed box turtle is the turtle most commonly found in the oak-savannah. Its preferred habitat is under rotting vegetation or logs.

Several lizards may be encountered in this habitat. The green anole occurs throughout the oak-savannah habitat type. It may be found on shrubs, trees, vines, or on the ground. The ground skink and southern prairie skink prefer areas of high litter accumulation; the prairie skink burrows and excavates into the soil in these areas. Because of habitat specificity, or the lack of same, abundance estimates for these lizard species may well be biased.

The most common snake that occurs in all areas of the oak-savannah is the eastern hognose, but the black racer, speckled kingsnake, rough earth snake, and southern copperhead are commonly found near or under logs or decaying stumps.

Mammals - Because of the heavy litter of decomposing oak leaves and reduced light penetration, there is, except for mast, little ground-level vegetation for small mammals to feed on. Consequently, few small rodents are commonly observed in the oak-savannah. The shrew is found under logs or in areas of deep litter accumulation. The woodrat may construct either a surface house or burrow underground. The fox squirrel occurs in large numbers, feeding primarily on the large mast crop. The striped skunk occurs in especially brushy areas and thrives near farmsteads and cropland. The red bat and pocket gopher are common but infrequently observed mammals. The white-tail deer is an important game animal occurring in this habitat.

Birds - In the typical oak-savannah, the grassland component provides the greatest available volume of habitat for birds. Grassland species such as the eastern meadowlark, savannah sparrow, vesper sparrow, and lark sparrow are dominant species. The meadowlark and lark sparrow are the only two grassland species that are present throughout the year. The savannah sparrow and vesper sparrow are abundant during winter and/or during migration.

In areas where shrubs have invaded, an additional habitat layer and, consequently, an increase in habitat volume, is available for birds. Possibly the most numerous species associated with the shrub layer in the oak-savannah are the loggerhead shrike, eastern bluebird, cardinal, and mockingbird. Each of these species is a resident that nests and searches for food among and around the shrubs. There are many migrant species associated with the shrub layer. The most common are the eastern kingbird and the scissortailed flycatcher.

Gamebirds found in the oak-savannah include the mourning dove and bobwhite. Both species are residents, although mourning dove populations are supplemented by migrants from more northern areas. Species ordinarily observed in the oak-savannah in the area of the site are included in Appendix D.

River Flood Plain

Although the Sabine River flood plain in this area is not delineated as part of the Bottomlands resource area on statewide maps, it shares many characteristics with areas recognized as bottomlands. This mapping omission is, in most instances, due to scale requirements for such a map.

Soils - The Gladewater soil series is monotypic in the Sabine River flood plain. This series is a member of the fine, montmorillinitic, nonacid, thermic family of Vertic Haplaquepts. These soils formed in deep clayey sediments. The $A_1$ horizon is very dark gray clay about 6 inches thick. The $B_{21g}$ horizon extends to a depth of 24 inches and is light brownish gray clay. The $B_{22g}$ horizon is gray clay and extends to a depth of 40 inches. The underlying $C_g$ horizon is gray clay stratified with clay loam and extends to a depth of 65 inches.

Vegetation - Due to the movement of water both within the stream and on the flood plain during and after heavy rains, many natural features occur in bottomland situations which create a diversity of habitats.

Most of the flood plain is inundated for much of the year. Major areas of inundation are small, meandering sloughs and oxbows, as well as more ephemeral, shallow depressions that are formed by floodwater. Trees preferring such a hydric situation and, therefore, dominating the flood plain, are black gum, willow oak, water oak, water hickory, bitternut hickory, American hop-hornbeam, and hawthorne. Flood plain areas that are not inundated for long periods of time are dominated by sweetgum, hop-hornbeam, American elm, overcup oak, Texas sugarberry, and red maple. Dogwood, redbud, red mulberry, American holly, coralberry, American beautyberry, and prickly ash are the primary shrub components of these areas.

The shrubby layer is characterized by hazel alder, buttonbush, and wax myrtle. The hydric nature of this area severely reduces herbaceous ground cover. Sedges, rushes, arrowhead, pluchea, and hydrolea are common ground-level herbaceous components. The herbaceous ground cover is much like that of the more mesic riverbottom areas, except that violets, pansies, and several species of fern occur (see Appendix D). Common vines include the Virginia creeper, mustang grape, poison ivy and oak, rattan, briar, and climbing hemp-weed.

Amphibians and Reptiles - The dark, moist environment typical of the Sabine River flood plain is preferred habitat for many amphibian and reptile species. The Gulf coast waterdog, lesser siren, three-toed amphiuma, and central newt are commonly encountered, but the waterdog and amphiuma are relatively less abundant than the newt. Salamanders that are primarily aquatic, but also utilize terrestrial streamside habitat, are the small-mouthed salamander, eastern tiger salamander, and dwarf salamander.

Many frogs occur in the Sabine River flood plain. The most common are the cricket frog, green treefrog, spring peeper, eastern gray treefrog, southern gray treefrog, upland chorus frog, bullfrog, bronze frog, and leopard frog. The woodhouse toad and eastern narrow-mouthed toad are commonly observed toads.

Several turtles are found in the area. The most common species is the red-eared turtle. The Mississippi mud turtle is occasionally observed. The snapping turtle and alligator snapping turtle are large, aggressive turtles that occur infrequently in this portion of the Sabine River.

Relatively few lizards or skinks frequent the flood plain. The ubiquitous broad-headed skink is the most common lizard in this habitat.

Several snakes are common in the flood plain. The numerically dominant group is probably the ill-tempered water snake genus Natrix. The red-bellied water snake, broad-banded water snake, and diamond-backed water snake are common; Graham's water snake occurs infrequently. Somewhat more docile snakes that spend most of their time near the water and frequently enter the water are the rough green tree snake and ribbon snake. These species are present in considerable numbers. Poisonous snakes that are commonly found in flood plain habitats include the timid southern copperhead and the aggressive western cottonmouth.

Mammals - Two mice species, the white-footed mouse and cotton mouse, are commonly encountered in the Sabine River flood plain. The more ubiquitous Florida woodrat is relatively less abundant. The eastern gray squirrel is locally abundant in areas where water oak and black gum are dominant or codominant. The gray squirrel is one of the more preferred game species in this area.

Nutria are commonly encountered and sometimes mistakenly identified as the much less common beaver.

Within the study area, the swamp rabbit may be found only in the river flood plain habitat. The white-tailed deer is also common to this habitat type, probably because man has not settled or altered it to any large extent.

Birds - The hydric nature of the bottomlands and reduced sunlight severely reduces herbaceous ground cover, thereby eliminating most of the grassland species found in the oak-savannah and tame pasture. However, most species found in the shrub areas of the oak-savannah are also found in the shrub area of the Bottomlands. In addition, the abundance of trees makes bottomlands prime habitat for many species of birds including a number of woodpeckers. Woodpecker residents normally observed in the study area's bottomlands include the common flicker, redbellied woodpecker, redheaded woodpecker, hairy woodpecker, downy woodpecker, and pileated woodpecker. Other common woodland residents are the tufted titmouse, Carolina chickadee, and blue jay. A myriad of woodland transients are also seen during migration, including several species of colorful wood warblers, such as the common yellowthroat, yellow-rumped warbler, and prothonotary warbler. While individuals of the latter species are present for only a short time, their colorful appearance and clear sweet songs make them a favorite among birdwatchers in the area.

Species associated with the streams, sloughs and ponded water in the area include the belted kingfisher, blue heron, green heron, and great egret. These species feed on a variety of aquatic organisms including fish, frogs, salamanders, water snakes, and small turtles. Many gamebirds are also found among the streams and sloughs. These include the wood duck, mallard, blue-winged teal, and green-winged teal. Only the wood duck is a resident; the other species of ducks are common in fall and winter. Other species associated with the bottomlands habitat type are listed in Appendix D.

Tame Pasture

Tame pastures are land where introduced grass species are seeded or sprigged after most native vegetation has been purposely killed and removed. In most instances, tame pastures are monocultures and present the same susceptibility to disease and pestilence as any other monocultural crop. The term "tame" pasture is used to describe these perennial forage crops because they often require irrigation, weed control, insecticide application, and other management practices. In order to maintain tame pastures, the operator must work against succession to maintain a vigorous grass stand. These areas are often called "improved" pasture.

Soils - Most tame pasture is established on areas that were previously oak-savannah, so it has a similar soil type.

Vegetation - Several tame pasture grasses have been utilized in the study area throughout the years. Dallis grass was one of the first tame pasture species used, followed by Rhodes grass and many others. Most of these proved unsuitable for the area. Bermuda grass (the most common varieties are Coastal Bermuda and Coast Cross I) and Bahia grass are currently the most preferred tame pasture grasses in this region; Bermuda grass accounts for most of the acreage.

It should be noted that anything except Bermuda grass is considered a "weed" and therefore considered undesirable. Common "weedy" vernal species include short ragweed, winter bentgrass, buffalo grass, little barley, rush, sour dock, plantain, fescue-grass, shepherd's purse, spurge, ryegrass, and annual bluegrass. Common autumnal "weeds" are finger-grass, croton, bitterweed, false ragweed, brownseed paspalum, ruellia, silver-leaf nightshade, and broomweed.

Tame pasture forage production is directly proportional (within limits) to fertilizer application rates. Production can vary from 4,000 to 20,000 kilograms/hectare/year (kg/ha/yr), depending on agronomic management practices. Extensive management practices such as mowing and pesticide application combine with low habitat diversity to severely limit the kinds and number of vertebrates in the tame pasture habitat type.

Amphibians and Reptiles - No amphibian or reptile species are commonly found in the tame pasture habitat. Occasional species are the ornate box turtle and six-lined racerunner. Food scarcity and lack of habitat diversity probably account for the scarcity of amphibians and reptiles.

Mammals - Extensive experience with small mammal trapping programs in similar areas indicate no mammal species commonly inhabit these pastures.

Birds - The tame pasture's monoculture and low foliage height tends to limit the number of different kinds of birds found there. Even many of the grassland species of birds are absent from the tame pasture because of the lack of seed-producing forbs and the low diversity of insects caused by management practices. The eastern meadowlark, savannah sparrow, and upland sandpiper are among the few species that are found. The eastern meadowlark is a resident; the savannah sparrow is a winter visitor; and the upland sandpiper is a migrant. Other species found in the tame pasture are listed in Appendix D.

Unique or Ecologically Sensitive Areas

In the study area, there are some areas that occupy relatively small acreages, but are worthy of a discussion because of their unique character and/or ecological sensitivity. Description of these areas is restricted to the specific feature(s) that give(s) these areas their special status.

Grand Saline Salt Marsh - As described in section 3.2 of this report, land over the center of the salt dome is lower than the surrounding area. This is an atypical feature; ground over the apex of most salt domes is generally elevated. Because of this unique drainage feature and ground-water-induced movement of some salts to the surface, an inland salt marsh has formed over the apex of the salt dome. It is uncertain how long this salt marsh has been in existence, but the Cherokee Indians made salt from the water associated with the marsh as early as 1834.

Previous experience and contacts with state and Federal agencies identify this as the only salt marsh within some 300 miles. Probably the nearest salt marshes are those along the Texas Gulf coast. The nearest inland salt marshes are along the Salt Fork of the Brazos River in the Texas panhandle, some 400 miles to the west.

Seventy percent of the marsh is vegetated. The marsh is characterized vegetationally by inland saltgrass; this species is monodominant throughout the entire marsh except in areas where potholes and pools occur. These potholes range from 6 to 100 feet in diameter and contain water from 6 inches to 3 feet deep. Vegetation in the potholes occurs in zones according to water depth. Spike rush displaces the saltgrass as the dominant species in the shallower areas of the pools. As water depth increases, the spike rush is replaced by bullrush. The final emergent species found in deeper water is cat-tail. When water depth increases to the point where emergent vegetation cannot survive, pondweed is the dominant vegetation. Most of the larger potholes have all the previously mentioned zones; some smaller ones may have only one or two.

Barren areas currently comprise about 30 percent of the marsh. These areas are normally higher in elevation, drier, and have more saline soils. The only extant vegetation on these areas are scattered aggregations of spurrie. During the process of drying, the soils develop noticeable white salt residues that crust on the surface. The centers of these crusted areas are totally devoid of vegetation, with spurrie occurring around the perimeter, many times relatively near saltgrass stands.

Benthic macroinvertebrates were sampled in the salt marsh. Species found were mostly of the opportunistic type and were species which are to be expected in the region. Therefore, no unique benthic populations appear to inhabit the site.

The unique character of the salt marsh attracts a unique bird population. Those associated with the marsh include several shorebirds and wading birds. Birds observed on the salt marsh during recent field trips include the killdeer, great blue heron, common snipe, spotted sandpiper, stilt sandpiper, solitary sandpiper, pectoral sandpiper, long-billed dowitcher, lesser yellowlegs, sora rail, blue-winged teal, and the rarely seen Wilsons' phalarope. Obviously, this marsh is an important parcel of wildlife habitat in the area. Drainage of the marsh or construction within the area would seriously limit the use of the marsh as wildlife habitat and perhaps seriously reduce the diversity of the east Texas environment. (See Appendix I for further details on the salt marsh.)

Seeps - Several seeps occur in the area and are locally referred to as "bogs" (Kral, 1955). The bog habitat forms in poorly drained shallow valleys that are collection basins for seepage waters. Water infiltrates the well-drained surface horizons of Freestone soils until it reaches the poorly-drained claypan layer. Water then moves along the surface of the clay layer until it seeps out in the form of a spring. The flow of these small springs is only slightly affected by seasonal fluctuations in rainfall. Consequently, water for plant growth is available year-round, resulting in high plant productivity. Abundant moisture and plant growth result in heavy organic matter accumulation, which forms organic acids upon decomposition. These acids lower the soil pH to a range of 5.0 to 5.5.

Seep habitats support several hydrophytic species such as the arrowhead, cattail, cardinal flower, wild iris, jack-in-the-pulpit and lizard tail. Among the most conspicuous community components are the ferns and orchids. Common ferns include cinnamon fern, royal fern, chair fern, and sensitive fern. Several orchids may be found, but the most common are fall ladies tresses, twayblade, little frog-spike, yellow fringe, and cranefly.

Although the aforementioned broadleaf herbaceous species are important floristic components, they are of less importance vegetationally than the rushes and sedges. Broomsedge is the dominant grass in these seeps. Sugarcane plumegrass, panicum, and rice cutgrass are distributed throughout the bog but do not produce extensive cover.

The margins give these seeps almost a zonal appearance. Trees that occur along the margins include black willow and southern red maple. Common shrubs are wax murtle, smooth alder, and elderberry. Broadleaf herbaceous species include white hibiscus, stinking fleabane, camphor-weed, turnsole, false dragonhead, button-weed, common lousewort, lobelia, goldenrod, and aster.

A myriad of grasses also occurs. The most abundant are winter bentgrass, broomsedge, Axonopus affinis, Digitaria violascens and many Panicum and Paspalum species. Occasional clumps of sphagnum moss can be found on wetter portions of the seep margins, but there is no moss in the center where conditions for its growth would seem better. On or beside these clumps of sphagnum are tiny rosetts of drosera. These occasional sphagnum-drosera clumps are the only reminders of the much described northern bogs.

### 3.6.2 Aquatic Ecology

The project area addressed in this section consists of a 20-mile wide corridor beginning at the site, approximately 1 mile south of Grand Saline, Texas, and extending northeast approximately 42 miles along the proposed pipeline route to the Texoma Winnsboro Terminal. The purpose of this section is to describe the existing aquatic environment in the project area, particularly those aspects that might be adversely impacted by the project. Gathering of baseline data was limited to accumulation and review of existing literature; interviews with Federal, state, university, and local personnel having knowledge of the area; and a site visit. Federal and state agencies and individuals contacted are listed in section 9.0.

#### 3.6.2.1 Streams

The largest stream in the project area is the Sabine River. This river is typically turbid and slightly alkaline in the vicinity of the project, with a meandering, well-defined channel. Average flow through the project area is approximately 1089 cfs. Water quality in the Sabine is generally good for aquatic biota (Texas Parks and Wildlife Dept., 1976).

Other streams in the project area include Lake Fork, Grand Saline, Little Caney, Caney, Big Cypress, and Running Creeks, and other small tributaries and headwater creeks. These smaller streams and creeks are characterized by meandering, poorly-defined channels obstructed by brush and debris. Stream flows vary seasonally; waters are generally clear to slightly turbid and range from slightly acidic to slightly alkaline (pH 6.5 to 7.5). Biological water quality in these streams has been reported as good to excellent (U.S. Army Corps of Engineers, 1975; Bonn, 1954), with the exception of Grand Saline Creek. According to the Texas Water Quality Board, the creek (which contains no sport fishing reaches) has been subject to periodic fish kills caused by sudden increases in salinity. This phenomenon is apparently a result of surface water runoff from the Van salt dome and oilfield, and from the Grand Saline salt marsh, following heavy precipitation. Neither Grand Saline nor little Saline Creek flow year-round.

Fish

Fish species probably occurring in the project area are listed in Appendix D, along with their general abundance in the area. Taxonomic nomenclature follows that recommended by the American Fisheries Society (Bailey, 1970). Generally, primary consumers in the project area that feed mainly on algae and other plant material are the stoneroller, gizzard shad, river carpsucker, and several of the shiners. Secondary consumers feed mainly on invertebrates, and in the project area are generally fish of the families Catostomidae, Ictaluridae, Aphredoderidae, Poecilidae, Cyprinodontidae, Atherinidae, Percidae, Sciaenidae, and most species of the family Cyprinidae. Tertiary consumers feed mainly on other fish and in the project area are individuals in the families Lepisosteidae, Amiidae, Esocidae, and the basses and crappie of the family Centrarchidae (Carlander, 1970; Hynes, 1972).

Benthic Invertebrates

Limited benthic invertebrate collections have been obtained from the Sabine River in the vicinity of the project area during the last several years. The Texas Water Quality Board has a station on the Sabine River, at the U.S. 80 highway crossing 4 miles west of Mineola, and benthos are collected periodically. In addition, Dr. J.D. McCullough of the Biology Department at Steven F. Austin State University provided information on a 1975 water quality and faunal survey of the river conducted by a graduate. Information on the kinds, numbers, and diversity of benthic invertebrates collected in the river near the project area is tabulated in Table 3.6-1.

Although information on the benthic invertebrate community of the Sabine River in the project area is generally qualitative in nature and limited in extent, oligochaetes and dipterans tended to dominate at all stations during collection periods. Ephemeropterans were collected at most stations and appeared to be a common component of the benthic community. Diversity seemed to decrease slightly in a downstream direction, although data were insufficient to document this definitively.

Information on benthic invertebrate communities of other streams in the project area is generally lacking. Some information on the benthos of Lake Fork Creek in the project area was collected in 1975 in the course of a water quality and faunal survey of that stream by personnel of the Sabine River Authority. However, these data were unavailable at the time of this writing (Tatum, 1976).

3.6.2.2 Lakes

Lakes in the project area include Franklin County (3450 acres), Winnsboro (1200 acres), Quitman (1000 acres), and Holbrook (595 acres), as well as numerous other smaller lakes, farm ponds, and oxbow lakes. Farm ponds are common and generally average less than 1 acre in size. Approximately 15 oxbow lakes occur in the area, the largest of which are Neil (25 acres), Burleson (20 acres), Butler (15 acres), and Cedar (10 acres). Several large reservoirs are being planned for construction in order to increase recreational opportunities (see section 3.3).

The larger lakes in the project area are fairly productive of game fish. A fairly extensive field survey of Lake Winnsboro was conducted by the Texas Parks and Wildlife Department in 1975. Although the final report covering these investigations has not been completed, Steve Smith, District Management Supervisor, provided information on the fish species composition and standing crop in the lake. These data are presented in Table 3.6-2. Recent data are apparently not available for the other large lakes in the project area. However, the relative abundance of game species observed in Winnsboro Lake are probably representative of those occurring in Franklin County, Quitman and Holbrook Lakes.

Farm ponds in the project area are abundant. Most of them have been stocked with game fish, mainly largemouth bass, bluegill sunfish, and channel catfish. The oxbow lakes in the project area have a cumulative surface area of approximately 110 acres. Major species include gars, blue catfish, channel catfish, black bullheads, yellow bullheads, green sunfish, white crappies, and freshwater drum (Texas Parks and Wildlife Dept., 1976).

3.6.2.3 Commercial and Recreational Fishing

Commercial fishing activity in the streams in the project area is minimal. This is due primarily to the limited public access and poor navigability during extended periods of low flow (U.S. Army Corps of Engineers, 1975). Commercial fishing in the lakes, ponds, and oxbow lakes in the project area appears to be insignificant, although quantitative information is lacking (Texas Parks and Wildlife Dept., 1976).

Sport fishing activity in the rivers and streams in the project area is generally limited. Public access is concentrated mostly on highway rights-of-way near bridge crossings. Private landowners control access to the majority of streams, limiting sport fishing primarily to the landowners and their invited guests. However, there are several state-controlled public fishing access areas on the Sabine River in the project area (Figure 3.6-2). Boat-launching sites, although unimproved at present, are available at several of these access areas. In the project area the river has been estimated to support approximately 80 sport fishing man-days per mile per year. Principal game species in the river (and in Lake Fork Creek) are the channel catfish, blue catfish, largemouth bass, spotted bass, yellow bass, white crappie, bluegill, longear sunfish, and several other sunfish. Sport fishing activity increases in intensity with distance downstream (Texas Parks and Wildlife Dept., 1976).

Sport fishing in the project area is primarily concentrated in the numerous lakes and ponds. Most of the larger lakes are public recreation areas and have an improved boat launch, boat and motor rentals, campgrounds, bait and tackle dealers, and other facilities (Texas Parks and Wildlife Dept., 1970). Fisheries resources are managed by the Texas Parks and Wildlife Department, whose field biologists conduct periodic surveys of the fish populations and stock game fish when required.

Sport fishing in the farm ponds is generally not extensive and has been estimated at an average of 11 man-days per acre annually. Public access to the ponds is restricted, and fishing activity is generally limited to the landowners and their guests (Texas Parks and Wildlife

Dept., 1976). Restricted public access limits sport fishing activities in the oxbow lakes also. Utilization of the lakes by fishermen has been estimated at 1600 man-days annually.

### 3.6.3 Threatened and Endangered Species

The list of Endangered and Threatened Wildlife and Plants in the September 26, 1975 Federal Register was used as the primary source to identify endangered and threatened species in the project area. The spring 1974 list of "Rare and Endangered Plants Native to Texas" published by the Rare Plant Center of the University of Texas at Austin was used as a supplementary source.

In the oak-savannah habitat, the only endangered or threatened plant species are the rough stem aster (*Aster scabricaulis*) and the dewberry (*Rubus duplaris* Shinners). The only records of *Aster scabricaulis* species are from Tyler and Van Zandt Counties; *Rubus duplaris* Shinners is known from nearby Freestone and Henderson Counties. One mammal and two avian endangered or threatened species may be found in this habitat. The gray wolf has been reported in Rains County but is now extinct in the project area. The peregrine falcon is a fall and winter migrant through the project area, but no sightings have been reported in Van Zandt, Wood, or Rains Counties. The Eskimo curlew is a spring migrant through the project area, but no collections of this species in Texas have been reported since 1897.

The oval ladies' tress is the only endangered or threatened plant species that may presently occur in the Sabine River flood plain in the project area. However, several species generally found in this habitat type were listed as "rare and endangered" when the Texas Organization for Rare and Endangered Species printed their original list. The southern bald eagle is generally considered to be a rare and endangered resident of the project area. However, this species has never been collected or observed within the project area, along the upper or middle portions of the Sabine River drainage, or along the middle Trinity River drainage. The peregrine falcon and Eskimo curlew are threatened or endangered species that migrate through the project area.

None of the aquatic species listed in Appendix D are considered endangered by the Office of Endangered Species and International Activities (U.S. Dept. of the Interior, 1974), and none is considered to be rare or endangered within the boundaries of Texas by the Texas Parks and Wildlife Department (1975).

TABLE 3.6-1 Kinds, numbers (in parentheses), and diversity indices of benthic invertebrates collected from three stations on the Sabine River in the vicinity of the project area

| Station Location | Source of Information | Collection Date | Kinds and Numbers (in parentheses) of Organisms Collected | Diversity |
|---|---|---|---|---|
| Sabine River where State Highway 19 crosses river | a | 1975 | Oligochaeta (11), Ephemeroptera (10), Plecoptera (1), Trichoptera (20), Diptera (22) | 2.00 |
| Sabine River at U.S. 80 crossing 4 miles west of Mineola | a | 1975 | Oligochaeta (17), Ephemeroptera (4), Plecoptera (3), Coleoptera (2), Trichoptera (25), Diptera (22), Mollusca (3) | 1.92 |
| Sabine River at U.S. 80 crossing 4 miles west of Mineola | b | 5/21/74 | Anisoptera (2), Mollusca (1), Diptera (1), Oligochaeta (5) | 1.66 |
| Same as above | b | 8/2/74 | Oligochaeta (3), Diptera (28) | 1.14 |
| Same as above | b | 11/25/74 | Oligochaeta (5), Ephemeroptera (3), Odonata (1), Diptera (16) | 1.95 |
| Same as above | b | 2/19/75 | Oligochaeta (12), Diptera (12) | 1.00 |
| Sabine River at State Highway 14 crossing, 2 miles south of Hawkins, Texas | a | 1975 | Entoprocta (1), Oligochaeta (30), Odonata (1), Coleoptera (7), Diptera (10) | 1.41 |

[a] Information provided by Dr. J. D. McCullough, Dept. of Biology, Stephen F. Austin University, Nacogdoches, Texas (Shannon-Wiener formulae used in calculation of diversity indice).

[b] Information provided by Linda B. Wyatt, Chief, Field Operations Division, Texas Water Quality Board, Austin, Texas (Formula used in calculation of diversity indice unknown).

TABLE 3.6-2 Species of fish and standing crop in Lake Winnsboro in 1975*

| Species | Number per Acre | Weight (lbs) per Acre |
|---|---|---|
| Spotted Gar | 4.88 | 5.30 |
| Bowfin | 0.23 | 2.23 |
| Threadfin Shad | 1780.47 | 6.67 |
| Gizzard Shad | 226.98 | 49.03 |
| Grass Pickerel | 7.21 | 1.25 |
| Golden Shiner | 103.95 | 4.94 |
| Ironcolor Shiner | 91.16 | 0.13 |
| Lake Chubsucker | 117.67 | 26.83 |
| Black Bullhead | 6.74 | 0.01 |
| Yellow Bullhead | 86.05 | 2.44 |
| ** Channel Catfish | 0.70 | 0.11 |
| Tadpole Madtom | 512.79 | 0.85 |
| Pirate Perch | 1.86 | < 0.01 |
| Golden Topminnow | 72.79 | 0.12 |
| Blackstripe Topminnow | 19.54 | 0.05 |
| Blackspotted Topminnow | 2.09 | 0.01 |
| Mosquitofish | 65.82 | 0.07 |
| Brook Silverside | 69.30 | 0.09 |
| ** Green Sunfish | 0.70 | 0.04 |
| ** Bluegill | 1256.05 | 23.93 |
| ** Warmouth | 338.37 | 3.96 |
| ** Spotted Sunfish | 119.53 | 1.03 |
| ** Redear Sunfish | 2530.70 | 60.84 |
| ** Longear Sunfish | 174.42 | 3.94 |
| ** Banded Pygmy Sunfish | 3.02 | < 0.01 |
| ** Hybrid Sunfish | 0.23 | 0.02 |
| ** Largemouth Bass | 136.28 | 32.65 |
| ** Black Crappie | 23.95 | 1.82 |
| ** Game Fish | 4593.02 | 128.35 |
| Other Fish | 3220.46 | 100.03 |
| TOTAL | 7813.48 | 228.38 |

* Information provided by Steve Smith, District Management Supervisor, Texas Parks and Wildlife Department, Tyler, Texas.

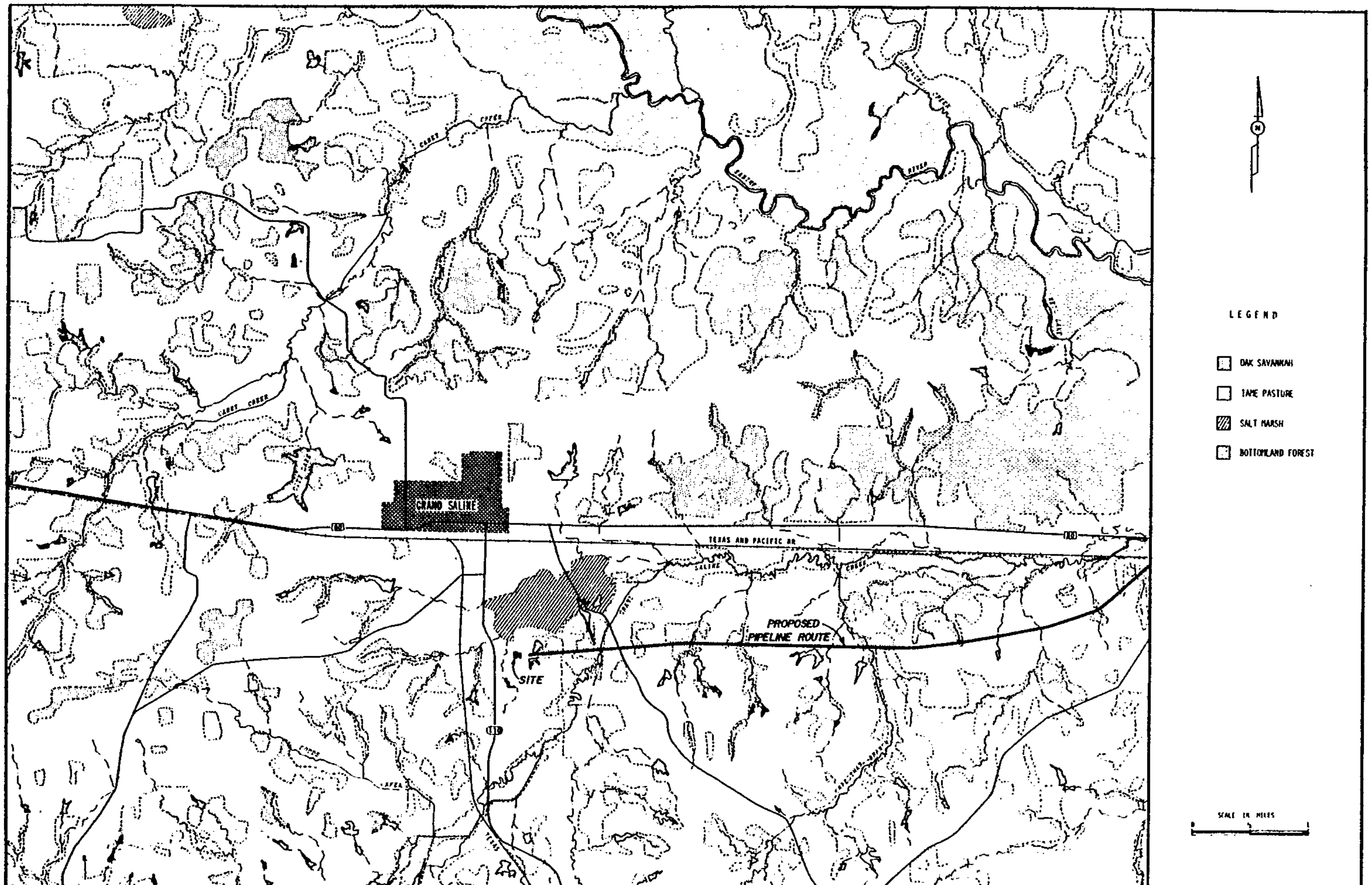
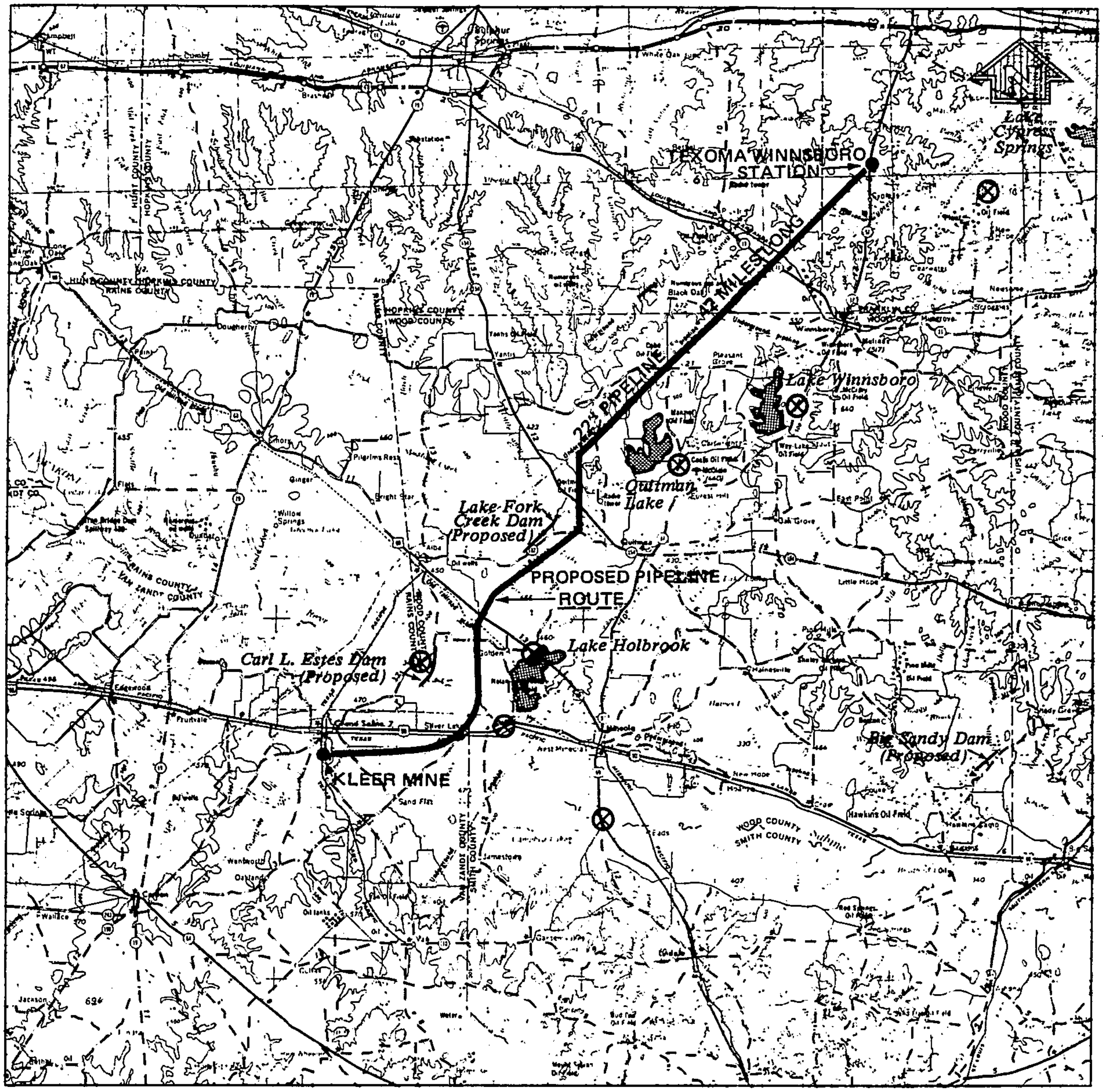



FIGURE 3.6-1
HABITAT TYPES IN THE
PROJECT AREA




BASE: USGS 1:250,000 MAPS FOR TYLER (1963) AND TEXARKANA (1972), TX.

⊗ - ACCESS POINTS

5 0 5 10
SCALE IN MILES

FIGURE 3.6-2 Public access points for boating/fishing

## 3.7 ARCHAEOLOGICAL AND HISTORICAL RESOURCES

A literature survey and site reconnaissance was conducted in April 1976, by the Archaeological Research Program (ARP) personnel of Southern Methodist University (SMU). Their summary report is presented in Appendix F.

In brief, the region contains artifacts from two prehistoric periods. People of the Archaic period (3500 B.C. to 500 A.D.) subsisted on a hunting and gathering economy. Their site occupations are marked by dart points, flakes, and chips. The neo-American period (500 A.D. to 1650 A.D.) is characterized by a sedentary, horticultural economy. This culture left signs of using the bow and arrow for hunting, and pottery for cooking and food storage.

Of the 43 sites located within about 200 meters of the proposed pipeline route, 24 are suspected to be worthy of subsurface investigation if they cannot be avoided during construction. Most of these are suspected Archaic period sites on which there has been limited or no known excavation. Further details of findings are given in Appendix F.

Two sites are registered as historically significant: Morton Salt Mine (mining by the Cherokee Indians is documented in the early 1800's) and the Rock Hill Baptist Church, located 10 miles north of Quitman. No other historic sites within the pipeline right-of-way are included on, or are in the process of being nominated to, the State or Federal Registers of Historic Places.

## 3.8 SCENIC AND NATURAL RESOURCES

### 3.8.1 Scenic Resources

The Kleer Mine site is located in the eastern portion of the Blackland Prairie, near the transition zone between the Blackland Prairie and the East Texas Timberlands. Consequently, the area is characterized by the gently rolling topography of the Blackland Prairie, a few scattered hills, and tame pasture grasslands. Oak-savannah and thickets generally surround these tame pastures and provide a refreshing visual diversity not generally associated with grassland areas. (Figures 2.1-2 and 2.1-3 present several aerial panoramas.) The hills support pine trees, which provide additional visual diversity, especially during fall and winter. Clean air and the generally quiet rural aesthetic qualities are also valuable assets of the region.

The Sabine River bottomlands provide extensive areas that have not been influenced by agronomic or industrial operations, in contrast to the highly developed agronomy of the Blackland Prairie. Access to the few existing scenic overlooks is limited by private ownership, and visual appreciation of this resource is correspondingly limited to a small number of visitors.

### 3.8.2 Natural Resources

Tyler State Park, approximately 50 miles east of Grand Saline, is the nearest park of 4 within the East Texas Planning Region (see section 3.9). No wildlife preserves, national forests, or other nature-oriented land use areas are located near the Kleer site.

Foremost in recreation areas are the region's major surface water resources: Cedar Creek Lake, Lake Palestine, Lake Tawakoni, Lake O' the Pines, Caddo Lake, and Toledo Bend Reservoir. Water skiing and fishing predominate on these lakes. Other than the lakes and 4 state parks, there are also municipal facilities available to city residents (ETCOG, 1972).

There are only minimal recreation service facilities available at present in the site area. Recreation areas are primarily used for fish and game purposes and for seasonal residences. Lake Tawakoni, located

20 miles northwest of the site on the western border of Rains County, has public campgrounds available for camping (tents and trailers). There are principal recreation areas located near Tyler and Quitman (site of the Governor Hogg Shrine). The East Texas Council of Governments (ETCOG) has recognized the need for more public recreation facilities due to the increase in tourist activity in the region. No planned development has been initiated at this time, however.

The "First Monday" agricultural trades day in nearby Canton is one of the primary recreation activities in Van Zandt County. It also provides additional economic activity for the county.

## 3.9 SOCIOECONOMICS

### 3.9.1 Regional Setting

The proposed project site is located almost entirely in the northeastern portion of Texas in the East Texas Planning Region. The region is centered about 100 miles east of the Dallas-Fort Worth metropolitan area and about 250 miles north of Houston, Texas, and contains over 6 million acres (see insert on Figure 2.1-1). Fourteen counties comprise this region:

| | |
|---|---|
| Anderson | Panola |
| Camp | Rains |
| Cherokee | Rusk |
| Gregg | Smith |
| Harrison | Upshur |
| Henderson | Van Zandt |
| Marion | Wood |

Morton Salt Company's Kleer Mine is located in Van Zandt County, 1 mile south of the town of Grand Saline (Figure 3.9-1).

A portion of the proposed action will be taken in Hopkins and Franklin Counties (outside the planning region) to connect the Kleer Mine storage cavern to existing distribution facilities at Texoma's Winnsboro Station. Some enlargement of the Winnsboro Terminal facilities will be required, as well as construction of about 8.5 miles of underground pipeline in the above-named counties.

Since the social and economic aspects of the East Texas Planning Region should be representative of Hopkins and Franklin Counties, and since relatively small expenditures will be made in these two counties, only the 14-county region was analyzed for this report.

#### 3.9.1.1 History

Three basic factors have dominated land use and economic activities in the northeastern region of Texas since the 1800's. The first was grazing and agriculture, which provided the initial thrust to the region for about 50 years. The second was petroleum, which boomed in the 1930's and has continued to be an important resource for the region.

Concurrent with the oil boom in the 1930's was the introduction of farm machinery for cotton farming. Industrial centers generally grew in the vicinity of the large oil fields and smaller farm-oriented centers grew to serve the plantations and farms. The World War II era produced the most concentrated growth in this region after the discovery of oil, with industry, agriculture and population centers all benefiting from the stimulus. Today the petroleum industry ranks as the most important industry in many areas of the region, although diversification (such as in manufacturing and agriculture) has lessened the complete dependence on oil as the primary economic resource (ETCOG, 1972).

With the advent of man-made reservoirs, tourism is now developing as a viable resource in the region, complementing land and petroleum resources. More and more tourist-oriented facilities are developed each year in the region to handle the increasing numbers of people. The land resource era is coming back to prominence as more and more room is needed to house the weekend vacationers and retirement settlers. The leisure growth areas are only beginning to develop in the region, but certain patterns can be discerned. The leisure population clusters are likely to grow in importance in the future since the area has many natural amenities and the price of land is still less than comparable acreage closer to other metropolitan areas (ETCOG, 1972).

#### 3.9.1.2 Land Use Patterns and Planning

The East Texas Council of Governments (ETCOG) is a voluntary association of local governments established June 8, 1970 under authority provided by the Texas Legislature in 1965. Its aim is to reinforce and strengthen local governments in east Texas, helping them provide more effective, efficient, and economical governmental services. Its purpose is to resolve common area-wide problems through cooperation and coordinated action.

ETCOG is not a government and does not possess powers of enforcement or taxation. It is a partnership organization through which local governments may combine their resources and talents to meet challenges beyond their individual capabilities. The council also exists to supplement the staffs of local governments in the region and provide services that will assist them in fulfilling their objectives.

The land use summary in Table 3.9-1 shows that the East Texas Planning Region is predominantly forest woodland (approximately 50 percent). Other large categories are pasture/rangeland (over 2 million acres) and cropland (about 500,000 acres). The forests of the region produce merchantable trees and protect the watershed. The rangeland is utilized primarily for grazing domestic livestock, 1 of the 3 major industries in east Texas. Between the years 1958 and 1967, pastureland in the region increased from about 1 million acres to over 2 million acres. During the same period, croplands decreased by two-thirds from 1.7 million to about 500,000 acres (ETCOG, 1972). Almost without exception, all crops are managed without irrigation; adequate moisture is provided by an average of 45 inches of annual rainfall.

Gregg and Smith Counties have the largest proportion of urban areas (Longview and Tyler are the main urban centers, respectively), whereas Camp, Marion, and Rains Counties have the least amount of urban development. Urban areas constitute an estimated 5 percent of the region; approximately 51 percent of the region's people live in these areas.

Linear urban development is under way in Gregg County at present. Much of the growth is occurring along principal traffic arteries between the cities. The same type of development is likely to take place in Henderson and Van Zandt Counties along major highways.

The region's present water resources provide the basis for a wide variety of recreational activities, particularly fishing, boating, hunting, and swimming. These activities are making increasing claims on the use of the region's lakes, streams, reservoirs, and rivers. As a result, there is a potential conflict between recreation and other water uses. Table 3.9-2 shows the use of the waters recommended by the Texas Water Quality Board.

There are no formalized land use planning or zoning regulations in the East Texas Planning Region.

### 3.9.1.3 Transportation System

The project region is served by one interstate highway (I-20), which connects the region with Dallas to the west and Shreveport, Louisiana, to the east (Figure 3.9-1). U.S. Highway 69 runs through the region connecting Tyler to points north and south. U.S. 79 connects Palestine and Henderson, and U.S. 287 connects Palestine to Corsicana. U.S. 84 connects Palestine to points east. U.S. 259 connects Longview, Kilgore, and Henderson to Nacogdoches, which is south of the region. U.S. 271 connects Tyler, Gladewater and Pittsburgh to points north. The Kleer Mine site is served by 2 major highways: U.S. Route 80, which runs east and west through Grand Saline connecting it to Dallas and Longview, and State Highway 110, which connects Grand Saline with Van and Tyler.

The roads are generally in excellent condition. This includes the many farm-to-market roads that connect the small communities in the region.

At the present time, there are only 2 airports served by regularly scheduled commercial flights--Pounds Field in Smith County and the Gregg County Airport in Gregg County. Each of these fields handles over 20,000 annual general aviation operations. Throughout the region, there are 14 public and 13 private airfields in use. Camp is the only county not served with public aviation facilities. There are 2 public airfields in Van Zandt County located near Myrtle Springs and Wills Point. There is also a private airport located near Edgewood.

The passenger service that once was a part of east Texas railroad services has been curtailed in the wake of Federal efforts to get railroads into better financial condition. The government-owned AMTRAC system does not serve the ETCOG region at present. Freight operations are still serving the industrial centers as well as some of the freight transfer points. These railroads are: the Kansas City Southern, Missouri-Pacific, Cotton Belt, Southern Pacific, and the Texas-Pacific, which serves Grand Saline and follows U.S. Route 80 through the region.

There are 5 major freight lines operating in the region. Utilizing the major cities as transfer and distribution points, these firms handle the largest part of the region's trucking. They are: East Texas Motor Freight, Missouri-Pacific Freight, Central Freight Lines, Red Arrow Lines, and Red Ball Lines. The only bus line that serves the region with both passenger and package freight service is Continental Trailways (ETCOG, 1972).

The region is criss-crossed by many oil and gas pipelines that connect the oil and gas fields with area refineries and with markets in other sections of the country. Pipelines are the major transportation mode for petroleum in the region.

3.9.1.4 Population Characteristics

Numbers and Density

The population of the ETCOG region increased from 413,000 (41 per square mile) in 1960 to 436,000 (44 per square mile) in 1970, an increase of 5.6 percent. During that same period, 5 counties lost population: Anderson, Cherokee, Harrison, Panola, and Rusk. Van Zandt increased in population by 3064 as a result of a net inmigration of 3228. Although the region is presently experiencing outmigration, ETCOG anticipates that this will diminish and be reversed by the end of the planning period due to retirement inmigration and economic growth (ETCOG, 1972). Table 3.9-3 shows the components of population change for the counties in the ETCOG region as compared to the region and state totals.

The median age is increasing in every county in the region with the exception of Henderson, Rains, and Smith Counties. The most significant changes occurring in the various age groups of the region's population are:

1. The decreasing proportion of children.
2. The increasing proportion of people of retirement age (65 and over).
3. The increasing proportion of young adults (see Figure 3.9-2).

The implications of this are that elementary school construction and service demands on the region's income and resources are reduced for the immediate future and more of the region's resources will be needed for medical services, retirement, housing, and recreational activities for the aged. Indications are that the young adult population will create a need for more colleges and libraries in the future (ETCOG, 1972).

The racial composition of the region's population has remained relatively unchanged. Its Caucasian population has varied between 72.6 percent (1960) and 76.4 percent (1970). In 1970, nonwhite inhabitants accounted for 23.6 percent of the region's population -- considerably more than the proportion for the state. Most of the nonwhite people are black. In 1970, Van Zandt County had the smallest proportion of nonwhite population (6.2 percent); Marion County had the largest (52.4 percent) (ETCOG, 1972).

Population projections developed for the ETCOG region anticipate a gain of 64,784 people by 1990, an increase of 14.9 percent over 1970. Table 3.9-4 gives the projections for the region and its constituent counties. Of the 9 counties that lost population between 1950 and 1970, only 7 are projected to continue that trend. Van Zandt and Wood Counties are expected to reverse that trend and increase their populations by 19.1 and 42.6 percent, respectively.

Occupation

The 1970 Census counted 157,232 employed persons in the counties comprising the ETCOG region. The principal occupations were: operatives (24,575); craftsmen, foremen, and kindred workers (24,313); and clerical and kindred workers (20,683). This trend generally holds true for most of the counties. The exceptions are Camp, Marion, and Van Zandt Counties, where the third largest occupation group is the service category; and Rains County, where the third largest group is in the category of farmers and farm managers. Table 3.9-5 gives a breakdown by occupational group for the ETCOG region and the counties that comprise it.

The smallest occupation groups in the region in 1970 were the farmers and farm managers (2888) and the farm laborers and foremen (2946). The counties generally follow this trend with the exception of Camp and Van Zandt Counties where transport equipment operatives formed the second smallest group; in Rains County where the smallest occupation group was the sales workers category; and in Wood County where private household workers comprised the smallest group.

## Income

The Effective Buying Income (EBI) of the region increased 68.9 percent in the 6 years between 1968 and 1974. The EBI increased from about $1 billion in 1968 to over $1.7 billion in 1974. (These figures do not reflect the effects of inflation during that period.) The regional increase was somewhat less than the state, which increased 78.1 percent during the same period. Camp County had the smallest increase in the region (only 23.4 percent), whereas Smith and Rains Counties more than doubled their EBIs. Van Zandt County ranks third with a 93.9 percent increase in its EBI since 1968 (Sales Management Magazine, 1975). Table 3.9-6 gives the EBIs for the state, region, and the counties within the region for the years 1968, 1970, and 1974, with the percent change from 1968 to 1974.

## Housing

There were 143,566 occupied housing units in the region in 1970. The largest share of these were located in Smith (31,023), Gregg (24,902), and Harrison (14,095) Counties. The smallest number of occupied housing units were located in Rains (1,378) and Camp (2,675) Counties.

The average number of persons per housing unit in the region was 2.9. This was somewhat lower than the state average of 3.2 persons per unit in 1970. None of the counties had an average number of persons per unit any higher than 3.1. Rains County had the smallest number of persons per unit (2.7) followed by Van Zandt and Wood Counties, which had 2.8 persons per unit.

The region had 75.4 percent of its housing units occupied by the owner. This was somewhat greater than the state, which had 64.7 percent of its occupied housing units occupied by the owner. All of the counties in the region had a higher percentage of owner-occupied housing units than the state at that time. Rains and Rusk Counties had the greatest percent of owner-occupied units (over 79 percent) whereas Smith (70.6 percent) and Gregg (71.4 percent) Counties had the smallest percentages.

Table 3.9-7 gives housing characteristics for the state, region, and the region's counties for 1970.

### 3.9.1.5 Economy

There were 157,232 persons employed in the various industrial sectors in the region in 1970. As is shown in Table 3.9-8, the manufacturing sector employed the greatest number of people: 37,161 (approximately 23 percent of the total employment). This was the trend in almost all the region's counties with the exception of Rains County where the agricultural sector showed the most employment. Manufacturing in the region had the highest concentration in Smith (9200 employees), Gregg (6794), and Harrison (4661) Counties. The metals industry was the largest group in the manufacturing sector, accounting for roughly 23 percent of the sector's employment.

Retail trade accounted for over 17,000 employees in the region and comprises the second largest sector. The construction sector employed over 12,000 people in the region at that time. The mining sector, which includes oil and gas extraction, employed over 5000 people in the region and was concentrated in Gregg (1539), Rusk (921), and Smith (977) Counties.

Many people were employed in the various service categories in 1970. The combined private and public service industries (including education and public administration) employed 46,493 persons (a total of the last 12 items in Table 3.9-8) in 1970.

Although it does not account for all the employed persons in the region, the "County Business Patterns" for 1973 gives a good indication of which industrial sectors are the most active in terms of employment. Table 3.9-9 shows the employment breakdown by industry group of 1973. The allocations are similar to the 1970 census figures. Of the 111,292 employees reported, 38,150 were employed in the manufacturing sector. Retail trade was the second largest sector employing over 23,000 people in 1973. The services sector was, once again, a substantial segment of the economy with 17,312 employees reported (U.S. Bureau of the Census, 1974).

Retail sales in the region totalled approximately $1.2 billion in 1974. This was an increase of 71 percent over the 1968 total retail sales of $725 million. Retail sales for the state (as a whole) showed a greater increase (88 percent) during the same period. However, 6 counties in the region showed gains in retail sales substantially higher than the regional and state percentages. Van Zandt County showed the highest relative increase (163 percent) with total retail sales increasing from $23.5 million in 1968 to $62 million in 1974. In Marion County, on the other hand, retail sales decreased by 27 percent during the same period. Table 3.9-10 gives total retail sales for the state, region, and counties in the region for 1968, 1970, and 1974. The percent change in retail sales between the years 1968 and 1974 is also calculated.

ETCOG has made projections of the value of agricultural production for the region and its constituent counties (see Table 3.9-11). The value of the region's agricultural production is projected to increase from a 1970 total of $113 million to $148 million in 1980, and on to $228 million in 1990. Van Zandt County is the leader in agricultural production with almost $13 million in production value accounting for 11 percent of the regional total in 1970. Marion County is lowest with only $1 million in agricultural production in 1970.

Oil was first discovered in the region in 1917 in Panola County and was eventually discovered in all the region's counties by 1955. As of January 1, 1975 over 6 billion barrels (bbls) of crude oil have been produced in the region at the rate of 450,000 bbls per day. Annual crude oil production for the region is over 165-million bbls. Table 3.9-12 shows crude oil production for the region and its counties. Gregg County has been the largest producer of crude oil since its discovery in that county in 1931 (over 2 billion bbls). Rusk County is second, having produced over 1.5 billion bbls since 1930. Annually, Gregg County produces the most oil (51 million bbls). Wood County is the second largest producer annually, with production of over 46 million bbls each year. Rains County is the smallest oil producer with a total crude oil production of only 129,000 bbls developed at a rate of less than 5000 bbls annually (State of Texas, 1975).

### 3.9.1.6 Government

The proposed oil storage facility is located near the town of Grand Saline, Texas, in Van Zandt County. The proposed pipeline route, from the site to terminal facilities in Winnsboro, would cross diagonally through Wood County (one of the 14 counties in the ETCOG region). The project might be subject to taxation by the counties and the various administrative districts within those counties (depending on ownership and tax systems).

## 3.9.2 Local Setting

The project site is located near the town of Grand Saline, Texas, in Van Zandt County. The county is located on the western border of the 14-county ETCOG planning region. Although the pipeline and proposed terminal also lie in Wood, Franklin, and Hopkins Counties, most of the activity affecting socioeconomic conditions is expected to occur in Van Zandt County.

### 3.9.2.1 History

Van Zandt County was named for Republic of Texas leader Isaac Van Zandt. The county was created and organized from a larger Henderson County in 1848.

### 3.9.2.2 Land Use Patterns and Planning

Van Zandt County has a total inventory of 544,320 acres, the bulk of which (63 percent) is in pasture/rangeland. About 14 percent (77,000 acres) is in cropland. Table 3.9-1 gives a summary of land use in the county. There are a total of 3072 acres of water and 16,268 acres that are in urban use in the county.

At this time, there are no zoning regulations in Van Zandt County or in the town of Grand Saline (or elsewhere in the project region). The site is located south of town in a rural pasture and cropland area.

### 3.9.2.3 Transportation Systems

Grand Saline is located in the northeast portion of Van Zandt County at the intersection of U.S. Route 80 and State Highway 110. U.S. Route 80 runs east and west and connects Grand Saline with Dallas to the west and Longview to the east. State Highway 110 connects Grand Saline with Tyler, the largest city in the region, to the southwest.

There are 2 public airfields in the county, located near Myrtle Springs and Wills Point. No regularly scheduled commercial flights are offered, however. The nearest airport with regularly scheduled commercial flights is Pounds field in Smith County. Outside the region, the nearest large airport is the Dallas-Fort Worth airport located less than 100 miles west of Grand Saline.

Freight service for the local area is provided by various trucking firms (see section 3.9.1.3) and the Texas-Pacific Railroad, which runs along U.S. Route 80 on the outskirts of Grand Saline (ETCOG, 1972).

3.9.2.4 Population Characteristics

Numbers and Density

The population of Van Zandt County increased from 19,091 (22 per square mile) in 1960 to 22,155 (26 per square mile) in 1970. This was due in large part to a net inmigration of 3228, since deaths outnumbered births by 144 during the period (ETCOG, 1972). The population of Grand Saline grew from 2100 in 1960 to 2257 in 1970, an increase of 7 percent (U.S. Bureau of the Census, 1970).

The median age for the county increased slightly from 38.1 in 1960 to 38.4 in 1970. The average number of persons per family has gradually decreased from 2.9 in 1960 to 2.8 in 1970. The region had an average number of persons per family of 3.04 in 1970, lower than the state average of 3.2 persons per family (ETCOG, 1972). Van Zandt had the smallest proportion of nonwhite population in the region with only 6.2 percent in 1970.

Projections developed by ETCOG show Van Zandt County increasing in population between 1970 and 1990. The population in 1980 is projected to be 24,526 and is expected to grow to nearly 27,000 by 1990 (ETCOG, 1972).

Occupation

In 1970, the Bureau of the Census recorded 8177 employed persons in Van Zandt County. The largest occupational groups were the operatives with 1437 employed, and the craftsmen, foremen, and kindred workers with

1405 employed. The smallest group was the private household workers with only 165 employed as such in 1970. Table 3.9-5 gives the complete occupational breakdown for Van Zandt County in 1970.

Income

Sales Management Magazine estimated the effective buying income (EBI) for Van Zandt County at $92 million in 1974. This represented a 94 percent increase over the 1968 EBI ($47 million). The percent increase was substantially higher than the 69 percent increase shown by the region (see section 3.9.1.4) and the 78 percent increase shown by the state as a whole between 1968 and 1974. Among the 14 counties in the region, Van Zandt ranked third in percent increase in EBI with only Smith and Rains Counties showing higher increases. Per capita EBI in Van Zandt County in 1974 was $3348, considerably below that of the state of Texas ($4182).

Housing

Van Zandt County had a total of 7847 occupied housing units in 1970, of which 78 percent were owner occupied. This was somewhat higher than the state, which had 65 percent of its occupied housing units occupied by the owner. The county had an average of 2.8 persons per housing unit, an average lower than most of the counties in the region and the state as a whole, which had 3.2 persons per occupied housing unit (U.S. Bureau of the Census, 1970; see Table 3.9-7).

### 3.9.2.5 Economy

Economic Base

The economy of Van Zandt County is based on oil production, tourism, agribusiness and light manufacturing. The county produces an average of $80.2 million in oil, gas, salt, and clay minerals (State of Texas, 1975). The 1973 value of minerals produced was $87.1 million. In 1973, the county produced 16.9 million bbls of crude oil. The county also marketed 21.8 billion cubic feet of natural gas. There were $24.6 million in receipts from agriculture in 1973, with $20.4 million contributed by livestock and livestock products. The 1973 production included 71,000 tons of hay and 21.2 million pounds of milk. Hogs, poultry products, oats, wheat, vetch, cotton, tomatoes, corn, sweet potatoes, and cantaloupes were also produced. Canton is the agribusiness center for the county. The clothing industry employs over 300 people throughout the county and other principal industrial products include petroleum products, salt, and farm supplies (Municipal Advisory Council of Texas, 1975).

Local employers near Grand Saline include the Morton Salt Company Mine, which employs over 200 people and two clothing manufacturers which, combined, employ over 150 people.

Employment

In 1970, the Bureau of the Census counted 8177 employed people in Van Zandt County. The manufacturing sector employed the most people (1640) in the county following the regional trend (see section 3.9.1.5). Unlike most counties in the region, however, the metal industries group was quite small, employing only 52 people. The textile and fabricated textile products was the largest group in the manufacturing sector, employing 536 people in 1970 (U.S. Bureau of the Census, 1970).

The combined retail sectors employed over 1000 employees in 1970 and constituted the second largest employment sector. The construction sector was the next largest group (as is the case in the region), employing over 900 people in 1970 (U.S. Bureau of the Census, 1970).

The 12 service categories shown in the census figures for 1970 account for approximately 2000 employed people in Van Zandt County. These include the various personal services, hospitals, schools, professional services, and public administration and constitute a major source of employment for the county, as it does for the region (see Table 3.9-8).

The 1973 County Business Patterns showed a similar trend in employment in 1973. Once again, the manufacturing sector was a major employer with 25 percent of the reported employees. The combined retail trade sectors constituted over 30 percent of the employed people and the services category employed 18 percent of the employees reported. Table 3.9-9 shows the employment breakdown for Van Zandt County as reported by the U.S. Bureau of the Census (1974).

3.9.2.6 Government

Jurisdictions

Kleer Mine is located south of Grand Saline, Texas, in Van Zandt County and is subject to taxation by the county but not by the town of Grand Saline, since it is outside the city limits.

Sources of Public Revenue

The Morton International Salt Company is one of the principal taxpayers in the county, with an assessed valuation of over $600,000 in 1974. However, the bulk of the county's tax base came from oil and gas properties that had a combined assessed valuation of over $41 million. This was approximately half of the county's total assessed valuation in 1974 ($79.4 million). As of February 1975, the county had an outstanding general obligation debt of $853,407 and had never defaulted in payment (Municipal Advisory Council of Texas, 1975).

The 1976 budget for Van Zandt County shows total resources and expenditures of $3.5 million. The general fund accounts for approximately $444,000 of the total and the officers' salary fund accounts for another $344,000. The remainder of the budget is primarily for the various road and bridge funds. Because of the county road bonds passed in 1974, the outstanding bonded indebtedness increased to just over $1 million in 1976 (Van Zandt County, 1975).

The Grand Saline budget for fiscal year 1975 shows total revenues of approximately $287,000 coming from various taxes and services (such as water and sewage) provided by the city. Disbursements in 1975 totalled approximately $242,000 of which $123,500 was for the general fund, with the remainder spent on water, sewage, and debt service. The balance (approximately $40,000) was used to purchase a new fire truck for the community.

The city of Grand Saline had an assessed valuation of $2,849,590 in 1973. Principal taxpayers included the electric, telephone, and gas utilities which had a combined assessed valuation of over $188,000

(Municipal Advisory Council of Texas, 1974). The Morton International Salt Company owns property within the city limits of Grand Saline and contributed over $6000 to the city in 1975 (City of Grand Saline, 1974).

Public Services and Facilities

Public safety in the project area is provided in part by the county sheriff. His office is a state agency even though he is responsible only to the county. The ETCOG region has an average of 10 deputies per county selected by the sheriff. The city of Grand Saline has a city marshall appointed by the mayor. The fire department in Grand Saline is volunteer and has recently acquired a new fire truck.

There are 6 school districts in Van Zandt County with an average daily attendance of slightly over 5000 students in 1971-72 (ETCOG, 1972). The Grand Saline Independent School District serves the project area and had a net debt of approximately $500,000 in 1974 (Municipal Advisory Council of Texas, 1974). The school districts are primarily funded by the state (usually 70 to 80 percent), with the remainder made up by local taxation. There are no colleges in Van Zandt County, although the region has 12 junior colleges and two 4-year colleges.

Van Zandt County has two medical facilities. The Cozby-Germany General Hospital is located in Grand Saline and has 40 beds. The Baker Clinic is located in Wills Point and has 10 beds (ETCOG, 1972).

3.9.2.7 Aesthetics

The local project setting is predominantly rural pasture land interspersed with rolling hills which are forested with a heavy growth of pines and occasional hardwoods. The Morton Mine facilities can be seen from the outskirts of Grand Saline and contrast with the surrounding pasture land.

TABLE 3.9-1 Land use summary - acres

| County | Cropland | Pasture Range | Forest Woodland | Other Land | Total Inventory | Water Areas | Urban | Total |
|---|---|---|---|---|---|---|---|---|
| Anderson | 64,260 | 183,191 | 389,500 | 16,733 | 653,684 | 4,310 | 28,278 | 686,272 |
| Camp | 22,037 | 41,733 | 50,577 | 520 | 114,867 | 5,430 | 6,648 | 126,945 |
| Cherokee | 59,391 | 180,722 | 395,669 | 6,552 | 642,334 | 5,840 | 27,096 | 675,270 |
| Gregg | 8,125 | 44,977 | 84,179 | 814 | 138,095 | 2,320 | 39,745 | 180,160 |
| Harrison | 55,943 | 127,349 | 353,100 | 2,097 | 538,489 | 1,258 | 24,021 | 563,768 |
| Henderson | 42,888 | 310,219 | 193,800 | 32,554 | 579,461 | 16,780 | 20,463 | 616,704 |
| Marion | 10,571 | 33,055 | 176,084 | 1,350 | 221,060 | 10,560 | 7,338 | 238,958 |
| Panola | 31,042 | 138,636 | 346,863 | 9,888 | 526,429 | 10,130 | 15,067 | 551,626 |
| Rains | 32,315 | 69,993 | 33,170 | 1,032 | 136,510 | 13,440 | 2,962 | 152,912 |
| Rusk | 24,027 | 242,563 | 303,800 | 6,470 | 576,860 | 7,180 | 16,600 | 600,640 |
| Smith | 60,871 | 261,678 | 230,917 | 6,281 | 559,747 | 9,480 | 36,405 | 605,632 |
| Upshur | 33,857 | 100,001 | 219,200 | 3,383 | 356,441 | 1,917 | 12,896 | 371,254 |
| Van Zandt | 77,152 | 354,271 | 86,462 | 7,095 | 524,980 | 3,072 | 16,268 | 544,320 |
| Wood | 40,869 | 156,557 | 218,754 | 19,777 | 435,957 | 4,133 | 21,222 | 461,312 |
| TOTAL: | 563,348 | 2,244,945 | 3,082,075 | 114,546 | 6,004,914 | 95,850 | 275,009 | 6,375,773 |

Source: ETCOG, 1972.

TABLE 3.9-2 Recommended water uses in the region*

| Basin and Zone | Contact Recreation | Domestic Raw Water Supply | Industrial Supply | Noncontact Recreation | Fishing | Aesthetics | Irrigation |
|---|---|---|---|---|---|---|---|
| Sabine River | | | | | | | |
| Zone VI | X* | X | X | X | X | X | X |
| Cypress Creek | | | | | | | |
| Cypress Creek | X | X | X | X | X | X | X |
| Caddo Lake | X | X | X | X | X | X | X |
| Neches River | | | | | | | |
| Zone VI | X | X | X | X | X | X | X |
| Angelina River | X | X | X | X | X | X | X |
| Trinity River | | | | | | | |
| East Fork | X | X | X | X | X | X | X |

* X indicates the use the Texas Water Quality Board felt the water ought to serve.

Source: ETCOG, 1972.

TABLE 3.9-3 Components of population change

| Area | 1960 Population | 1970 Population | Population Change 1960-1970 | Births 1960-1970 | Deaths 1960-1970 | Natural Increase | Net Migration |
|---|---|---|---|---|---|---|---|
| STATE | 9,579,677 | 11,196,730 | 1,671,053 | 2,244,631 | 844,196 | 1,400,435 | 216,618 |
| REGION | 413,167 | 436,119 | 22,952 | 75,230 | 49,788 | 25,442 | -2,490 |
| COUNTIES | | | | | | | |
| Anderson | 28,162 | 27,789 | - 373 | 4,478 | 3,343 | 1,135 | -1,508 |
| Camp | 7,849 | 8,005 | 156 | 6,759 | 4,878 | 1,881 | - 193 |
| Cherokee | 33,120 | 32,008 | -1,112 | 4,992 | 3,866 | 1,126 | -1,112 |
| Gregg | 69,436 | 75,929 | 6,493 | 14,235 | 6,841 | 7,394 | - 901 |
| Harrison | 45,594 | 44,841 | - 753 | 7,080 | 4,599 | 2,481 | -3,234 |
| Henderson | 21,786 | 26,466 | 4,680 | 3,728 | 2,960 | 768 | 3,912 |
| Marion | 8,049 | 8,517 | 468 | 1,097 | 1,032 | 65 | 403 |
| Panola | 16,870 | 15,894 | - 976 | 2,028 | 1,763 | 265 | -1,241 |
| Rains | 2,993 | 3,752 | 759 | 284 | 434 | - 150 | 909 |
| Rusk | 36,421 | 34,102 | -2,319 | 5,022 | 4,213 | 809 | -3,128 |
| Smith | 86,350 | 97,096 | 10,746 | 17,912 | 8,449 | 9,463 | 1,161 |
| Upshur | 19,793 | 20,976 | 1,183 | 2,864 | 2,310 | 554 | 629 |
| Van Zandt | 19,091 | 22,155 | 3,064 | 2,447 | 2,591 | - 144 | 3,228 |
| Wood | 17,653 | 18,589 | 936 | 2,304 | 2,509 | - 205 | 1,141 |

Net Total Migration was computed according to the formula "$M = P_2 - P_1 - B + D$" ($M$ = Migration, $P_2$ = 1970 Population, $P_1$ = 1960 Population, $B$ = Births, from 1960 to 1970, $D$ = Deaths from 1960 to 1970)

Source: ETCOG, 1972.

TABLE 3.9-4 Population forecast - ETCOG region

| County | 1950 | 1960 | 1970 | 1980* | 1990* | % Change 1950-1970 | % Change 1950-1990 |
|---|---|---|---|---|---|---|---|
| Anderson | 31,875 | 28,162 | 27,789 | 27,428 | 28,525 | -12.8 | -10.5 |
| Camp | 8,740 | 7,849 | 8,005 | 8,157 | 8,402 | - 8.4 | - 3.9 |
| Cherokee | 38,694 | 33,120 | 32,008 | 30,888 | 31,815 | -17.3 | -17.8 |
| Gregg | 61,258 | 69,436 | 75,929 | 81,927 | 87,908 | 23.9 | 43.5 |
| Harrison | 47,745 | 45,594 | 44,841 | 45,334 | 47,102 | - 6.1 | - 1.3 |
| Henderson | 23,405 | 21,786 | 26,466 | 29,960 | 33,915 | 13.1 | 44.9 |
| Marion | 10,172 | 8,049 | 8,517 | 8,960 | 9,802 | -16.3 | - 3.6 |
| Panola | 19,250 | 16,870 | 15,894 | 15,687 | 16,189 | -17.4 | -15.9 |
| Rains | 4,266 | 2,993 | 3,752 | 4,326 | 5,338 | 12.0 | 25.1 |
| Rusk | 42,348 | 36,421 | 34,102 | 32,534 | 34,291 | -19.5 | -19.0 |
| Smith | 74,701 | 86,350 | 97,096 | 106,709 | 116,313 | 30.0 | 55.7 |
| Upshur | 20,822 | 19,793 | 20,976 | 22,088 | 24,010 | 0.7 | 15.3 |
| Van Zandt | 22,593 | 19,091 | 22,155 | 24,526 | 26,905 | - 1.9 | 19.1 |
| Wood | 21,308 | 17,653 | 18,589 | 25,796 | 30,388 | -12.8 | 42.6 |
| REGION | 424,213 | 416,167 | 436,119 | 464,320 | 500,903 | 2.8% | 18.1% |

* Forecast as of 1972.

Source: ETCOG, 1972.

TABLE 3.9-5 Occupation of employed persons

| | Region | Anderson | Camp | Cherokee | Gregg | Harrison | Henderson | Marion | Panola | Rains | Rusk | Smith | Upshur | Van Zandt | Wood |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL EMPLOYED | 157,232 | 9,215 | 2,552 | 11,113 | 28,715 | 15,653 | 9,125 | 2,614 | 5,178 | 1,144 | 12,156 | 38,367 | 6,837 | 8,177 | 6,386 |
| Prof., Tech., Kindred Workers | 17,627 | 863 | 197 | 1,292 | 3,533 | 1,939 | 914 | 173 | 490 | 112 | 1,257 | 4,818 | 595 | 792 | 652 |
| Nonfarm Mgrs, Admin. | 14,055 | 858 | 177 | 881 | 2,872 | 1,289 | 755 | 280 | 434 | 121 | 930 | 3,695 | 491 | 596 | 676 |
| Sales Workers | 10,847 | 559 | 171 | 562 | 2,640 | 995 | 607 | 138 | 256 | 19 | 644 | 3,126 | 344 | 540 | 246 |
| Clerical, Kindred Workers | 20,683 | 1,194 | 223 | 1,363 | 3,770 | 2,185 | 1,220 | 263 | 496 | 121 | 1,455 | 6,022 | 777 | 799 | 795 |
| Craftsmen, Foremen, Kindred Workers | 24,313 | 1,302 | 379 | 1,618 | 4,526 | 2,341 | 1,592 | 414 | 930 | 215 | 2,012 | 5,368 | 1,319 | 1,405 | 892 |
| Nontransport Operatives | 24,575 | 1,451 | 529 | 1,882 | 4,249 | 2,557 | 1,486 | 311 | 897 | 131 | 1,977 | 5,347 | 1,223 | 1,437 | 1,098 |
| Transport Equip. Operatives | 7,821 | 557 | 122 | 555 | 1,189 | 797 | 417 | 246 | 252 | 37 | 682 | 1,765 | 356 | 384 | 462 |
| Nonfarm Laborers | 8,939 | 527 | 179 | 709 | 1,437 | 930 | 524 | 197 | 463 | 32 | 908 | 1,805 | 482 | 430 | 316 |
| Farmers, Farm Mgrs | 2,888 | 262 | 58 | 186 | 78 | 110 | 226 | 51 | 137 | 166 | 233 | 422 | 154 | 407 | 398 |
| Farm Laborers, Foremen | 2,946 | 255 | 133 | 352 | 94 | 168 | 158 | 10 | 193 | 55 | 188 | 689 | 138 | 343 | 170 |
| Nonhousehold Service Workers | 17,120 | 1,090 | 309 | 1,307 | 3,303 | 1,639 | 1,028 | 353 | 436 | 100 | 1,308 | 4,092 | 755 | 879 | 521 |
| Private Household Workers | 5,418 | 297 | 75 | 406 | 1,024 | 703 | 198 | 178 | 194 | 35 | 562 | 1,218 | 203 | 165 | 160 |

Source: U.S. Dept. of Commerce, Bureau of the Census, 1970.

TABLE 3.9-6 Effective buying income: 1968, 1970, 1974

| County | 1968 ($000) | 1970 ($000) | 1974 ($000) | % Change 1968-1974 |
|---|---|---|---|---|
| Anderson | $ 65,926 | $ 78,189 | $ 92,204 | 39.9 |
| Camp | 18,842 | 20,485 | 23,260 | 23.4 |
| Cherokee | 72,502 | 85,448 | 114,161 | 57.5 |
| Gregg | 215,955 | 248,962 | 346,829 | 60.6 |
| Harrison | 103,352 | 126,119 | 165,266 | 59.5 |
| Henderson | 71,104 | 69,475 | 97,323 | 36.9 |
| Marion | 13,077 | 18,704 | 20,430 | 56.2 |
| Panola | 34,892 | 43,937 | 53,413 | 53.1 |
| Rains | 5,721 | 8,091 | 12,104 | 111.6 |
| Rusk | 73,455 | 96,448 | 115,163 | 56.8 |
| Smith | 199,320 | 292,061 | 422,951 | 112.2 |
| Upshur | 42,573 | 55,475 | 80,337 | 88.7 |
| Van Zandt | 47,480 | 60,985 | 92,067 | 93.9 |
| Wood | 48,968 | 58,519 | 76,002 | 55.2 |
| REGION | 1,013,167 | 1,265,630 | 1,711,510 | 68.9 |
| STATE | $ 28,496,603 | $ 34,309,519 | $ 50,769,311 | 78.1 |

Source: Sales Management Magazine, 1975.

TABLE 3.9-7 Regional housing characteristics, 1970 (occupied units)

| County | Total Number | Avg. Persons per Unit | Owner Occupied (%) |
|---|---|---|---|
| Anderson | 9,300 | 2.9 | 73.9 |
| Camp | 2,675 | 2.9 | 74.2 |
| Cherokee | 10,478 | 3.0 | 72.3 |
| Gregg | 24,902 | 3.0 | 71.4 |
| Harrison | 14,065 | 3.1 | 73.6 |
| Henderson | 8,852 | 2.9 | 75.1 |
| Marion | 2,810 | 3.0 | 74.9 |
| Panola | 5,310 | 2.9 | 78.5 |
| Rains | 1,378 | 2.7 | 79.3 |
| Rusk | 11,620 | 2.9 | 79.6 |
| Smith | 31,023 | 3.1 | 70.6 |
| Upshur | 6,718 | 3.1 | 77.6 |
| Van Zandt | 7,847 | 2.8 | 78.4 |
| Wood | 6,588 | 2.8 | 75.7 |
| REGION | 143,566 | 2.9* | 75.4* |
| STATE | 3,433,573 | 3.2 | 64.7 |

* Average of county figures.

Source: U.S. Bureau of Census, 1970.

TABLE 3.9-8 Industry of employed persons for counties: 1970

| INDUSTRY | COUNTIES Anderson | Camp | Cherokee | Gregg | Harrison | Henderson | Marion | Panola | Rains | Rusk | Smith | Upshur | Van Zandt | Wood | Region Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Employed, 16 years old and over | 9,215 | 2,552 | 11,113 | 28,715 | 15,653 | 9,125 | 2,614 | 5,178 | 1,144 | 12,156 | 38,367 | 6,837 | 8,177 | 6,386 | 157,232 |
| Agriculture, forestry, and fisheries | 568 | 261 | 647 | 340 | 404 | 437 | 83 | 384 | 239 | 548 | 1,494 | 355 | 822 | 643 | 7,225 |
| Mining | 431 | 24 | 75 | 1,539 | 171 | 251 | 63 | 241 | - | 921 | 977 | 144 | 279 | 357 | 5,473 |
| Construction | 665 | 81 | 936 | 2,092 | 1,190 | 1,041 | 239 | 661 | 191 | 1,035 | 2,656 | 527 | 997 | 527 | 12,838 |
| Manufacturing | 1,599 | 726 | 2,797 | 6,794 | 4,661 | 2,111 | 668 | 1,106 | 229 | 2,616 | 9,200 | 1,902 | 1,640 | 1,112 | 37,161 |
| Furniture and lumber and wood products | 133 | 83 | 1,042 | 64 | 353 | 47 | 225 | 176 | - | 508 | 547 | 173 | 52 | 120 | 3,523 |
| Metal industries | 79 | 408 | 137 | 1,475 | 2,053 | 108 | 204 | 172 | 21 | 232 | 2,823 | 711 | 192 | 139 | 8,754 |
| Machinery, except electrical | 63 | 13 | 162 | 1,680 | 248 | 84 | - | 88 | 56 | 236 | 1,566 | 165 | 153 | 84 | 4,598 |
| Electrical machinery, equipment, and supplies | 62 | - | 31 | 39 | 106 | 618 | 10 | 9 | - | 24 | 78 | 37 | 149 | 39 | 1,202 |
| Transportation equipment | 5 | 16 | 128 | 574 | 111 | 108 | - | 93 | 71 | 269 | 254 | 146 | 65 | 39 | 1,879 |
| Other durable goods | 587 | 40 | 501 | 322 | 444 | 369 | 29 | 123 | 6 | 554 | 689 | 176 | 94 | 99 | 4,033 |
| Food and kindred products | 218 | 83 | 116 | 435 | 170 | 72 | 77 | 154 | 11 | 81 | 492 | 88 | 79 | 98 | 2,174 |
| Textiles and fabricated textile products | 216 | 50 | 331 | 483 | 283 | 209 | 36 | 45 | 40 | 254 | 670 | 233 | 536 | 324 | 3,710 |
| Printing, publishing, and allied industries | 59 | 5 | 54 | 221 | 102 | 76 | 17 | 23 | - | 65 | 360 | 25 | 37 | 24 | 1,068 |
| Chemicals and allied products | 32 | 3 | 40 | 1,148 | 662 | 149 | 37 | 25 | 6 | 145 | 148 | 67 | 159 | 15 | 2,636 |
| Other nondurable goods (incl. not specified mfg. indus.) | 145 | 25 | 255 | 353 | 129 | 271 | 33 | 198 | 18 | 248 | 1,573 | 81 | 124 | 131 | 3,584 |
| Railroads and railway express service | 636 | 40 | 69 | 246 | 334 | 65 | 11 | 24 | - | 13 | 629 | 71 | 34 | 207 | 2,379 |

TABLE 3.9-8 Continued

| INDUSTRY | COUNTIES Anderson | Camp | Cherokee | Gregg | Harrison | Henderson | Marion | Panola | Rains | Rusk | Smith | Upshur | Van Zandt | Wood | Region Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trucking service and warehousing | 125 | 41 | 153 | 412 | 195 | 152 | 60 | 78 | - | 166 | 455 | 112 | 133 | 76 | 2,158 |
| Other transportation | 33 | 11 | 36 | 312 | 77 | 58 | 37 | 41 | 30 | 97 | 163 | 63 | 53 | 41 | 1,052 |
| Communications | 142 | 4 | 102 | 364 | 119 | 194 | 11 | 20 | 19 | 207 | 563 | 56 | 86 | 52 | 1,939 |
| Utilities and sanitary services | 137 | 40 | 321 | 430 | 409 | 234 | 71 | 163 | 29 | 246 | 477 | 189 | 120 | 146 | 3,012 |
| Wholesale trade | 247 | 191 | 351 | 1,196 | 455 | 160 | 105 | 148 | 18 | 314 | 1,850 | 226 | 318 | 298 | 5,877 |
| Food, bakery, and dairy stores | 269 | 65 | 248 | 658 | 346 | 296 | 69 | 163 | 54 | 304 | 1,015 | 88 | 218 | 168 | 3,961 |
| Eating and drinking places | 275 | 80 | 214 | 1,058 | 364 | 222 | 102 | 67 | 36 | 226 | 883 | 181 | 195 | 154 | 4,057 |
| General merchandise retailing | 168 | 36 | 285 | 678 | 306 | 255 | 20 | 117 | 5 | 164 | 881 | 108 | 162 | 55 | 3,240 |
| Motor vehicle retailing and service stations | 362 | 123 | 339 | 1,022 | 422 | 290 | 88 | 179 | 13 | 535 | 1,227 | 254 | 353 | 155 | 5,362 |
| Other retail trade | 553 | 158 | 612 | 2,102 | 889 | 538 | 166 | 202 | 19 | 706 | 2,359 | 239 | 441 | 334 | 9,318 |
| Banking and credit agencies | 86 | 27 | 158 | 375 | 308 | 108 | 15 | 51 | 3 | 134 | 693 | 84 | 112 | 108 | 2,262 |
| Insurance, real estate, and other finance | 134 | 48 | 119 | 747 | 255 | 241 | 33 | 51 | 6 | 205 | 1,208 | 97 | 183 | 99 | 3,426 |
| Business and repair services | 186 | 31 | 163 | 827 | 429 | 147 | 53 | 77 | 20 | 450 | 944 | 186 | 147 | 152 | 3,812 |
| Private households | 306 | 72 | 403 | 1,102 | 652 | 174 | 137 | 211 | 29 | 574 | 1,286 | 202 | 157 | 181 | 5,486 |
| Other personal services | 361 | 72 | 343 | 1,171 | 584 | 408 | 146 | 142 | 13 | 427 | 1,567 | 214 | 281 | 252 | 5,981 |
| Entertainment and recreation services | 41 | - | 35 | 203 | 52 | 69 | 16 | 22 | - | 35 | 202 | 15 | 53 | 41 | 784 |
| Hospitals | 349 | 66 | 1,172 | 525 | 295 | 144 | 60 | 188 | 13 | 340 | 1,445 | 104 | 286 | 144 | 5,131 |

TABLE 3.9-8 Continued

| | COUNTIES | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INDUSTRY | Anderson | Camp | Cherokee | Gregg | Harrison | Henderson | Marion | Panola | Rains | Rusk | Smith | Upshur | Van Zandt | Wood | Region Total |
| Health services, except hospitals | 270 | 50 | 203 | 693 | 318 | 219 | 42 | 98 | 11 | 272 | 1,135 | 153 | 197 | 144 | 3,805 |
| Elementary, secondary schools, and colleges - government | 462 | 83 | 570 | 1,379 | 747 | 572 | 99 | 275 | 59 | 697 | 1,694 | 251 | 366 | 256 | 7,510 |
| Elementary, secondary schools, and colleges - private | 89 | 37 | 230 | 715 | 692 | 115 | 40 | 90 | 36 | 137 | 863 | 599 | 58 | 272 | 3,973 |
| Other education and kindred services | 19 | - | 21 | 103 | 26 | 11 | - | 8 | - | 26 | 136 | 14 | 27 | 9 | 400 |
| Welfare, religious and nonprofit membership organizations | 110 | 38 | 146 | 341 | 181 | 134 | 50 | 57 | 15 | 251 | 477 | 36 | 76 | 92 | 2,054 |
| Legal, engineering, and miscellaneous professional services | 180 | 26 | 131 | 486 | 271 | 204 | 29 | 84 | 6 | 228 | 796 | 100 | 141 | 102 | 2,784 |
| Public administration | 412 | 121 | 234 | 805 | 501 | 275 | 101 | 230 | 51 | 282 | 1,092 | 217 | 242 | 209 | 4,772 |

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*Source: U.S. Bureau of the Census.*

TABLE 3.9-9 Employment by industry group

| | Region | Anderson | Camp | Cherokee | Gregg | Harrison | Henderson | Marion | Panola | Rains | Rusk | Smith | Upshur | Van Zandt | Wood |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL | 111,292 | 5,078 | 1,539 | 7,988 | 26,678 | 12,571 | 5,455 | 1,077 | 2,264 | 182 | 5,900 | 34,353 | 1,724 | 2,992 | 3,491 |
| Agricultural Services, Forestry, Fisheries | 319 | -D- | -D- | 18 | 36 | 17 | 22 | - | 17 | -D- | 9 | 158 | 6 | 27 | 9 |
| Mining | 5,680 | 441 | -D- | 25 | 2,192 | 212 | 124 | -D- | 228 | -D- | 635 | 1,338 | 24 | 108 | 353 |
| Contract Construction | 7,019 | 259 | -D- | 402 | 2,017 | 772 | 435 | 29 | 353 | 17 | 381 | 1,875 | 117 | 281 | 81 |
| Manufacturing | 38,150 | 1,371 | 849 | 2,947 | 7,363 | 6,648 | 1,773 | 175 | 539 | -D- | 1,474 | 13,020 | 514 | 736 | 741 |
| Transportation and other Public Utilities | 6,353 | 252 | 89 | 585 | 1,865 | 452 | 395 | 40 | 71 | 22 | 366 | 1,791 | 122 | 110 | 193 |
| Wholesale Trade | 6,730 | 393 | 44 | 237 | 1,956 | 549 | 188 | -D- | 88 | - | 505 | 2,437 | 36 | 98 | 193 |
| Retail Trade | 23,455 | 1,305 | 352 | 2,106 | 5,921 | 1,811 | 1,275 | 414 | 531 | 69 | 1,193 | 6,115 | 463 | 937 | 963 |
| Finance, Insurance, and Real Estate | 5,544 | 240 | 80 | 267 | 1,194 | 500 | 563 | 34 | 93 | 22 | 213 | 1,912 | 143 | 130 | 153 |
| Services | 17,312 | 801 | 49 | 1,337 | 4,001 | 1,578 | 645 | 236 | 334 | 7 | 1,087 | 5,615 | 292 | 547 | 783 |
| Unclassified Establishments | 581 | -D- | 125 | 64 | 133 | 32 | 35 | - | 10 | 6 | 37 | 92 | 7 | 18 | 22 |

Source: U.S. Bureau of the Census, 1974

Note: Regional sectoral figures do not include disclosures

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

TABLE 3.9-10 Total retail sales 1968, 1970, 1974

| County | 1968 ($000) | 1970 ($000) | 1974 ($000) | % Change 1968 to 1974 |
|---|---|---|---|---|
| Anderson | $ 41,139 | $ 40,863 | $ 64,589 | 57.0 % |
| Camp | 10,121 | 12,323 | 21,862 | 116.0 |
| Cherokee | 36,883 | 48,625 | 86,231 | 133.8 |
| Gregg | 191,021 | 176,800 | 315,010 | 64.9 |
| Harrison | 77,037 | 59,326 | 91,258 | 18.4 |
| Henderson | 29,771 | 26,652 | 76,089 | 155.6 |
| Marion | 12,529 | 11,024 | 9,136 | - 27.1 |
| Panola | 19,847 | 17,731 | 31,334 | 57.9 |
| Rains | 1,984 | 5,191 | 4,999 | 152.0 |
| Rusk | 42,120 | 47,778 | 72,269 | 71.6 |
| Smith | 190,867 | 168,460 | 325,481 | 70.5 |
| Upshur | 16,118 | 16,151 | 36,133 | 124.2 |
| Van Zandt | 23,578 | 33,756 | 62,089 | 163.3 |
| Wood | 32,511 | 24,243 | 43,031 | 32.4 |
| REGION | 725,526 | 688,923 | 1,239,511 | 70.8 % |
| STATE | $18,003,622 | $19,279,604 | $33,794,610 | 87.7 % |

Source: Sales Management Magazine, 1975.

TABLE 3.9-11 Value of agriculture production projection by county

| County | 1970 | 1980 | 1990 |
|---|---|---|---|
| Anderson | $ 8,136,000 | $ 10,817,795 | $ 15,187,851 |
| Camp | 5,477,000 | 7,333,371 | 10,197,314 |
| Cherokee | 9,138,000 | 11,897,748 | 16,544,006 |
| Gregg | 1,556,000 | 2,002,091 | 2,577,110 |
| Harrison | 5,829,000 | 7,905,433 | 11,088,423 |
| Henderson | 10,242,000 | 15,485,724 | 23,665,480 |
| Marion | 1,233,000 | 1,549,721 | 2,034,424 |
| Panola | 12,644,000 | 16,446,219 | 22,912,720 |
| Rains | 3,655,000 | 5,784,134 | 9,635,255 |
| Rusk | 11,952,000 | 15,291,890 | 21,758,565 |
| Smith | 12,623,000 | 18,332,072 | 26,974,903 |
| Upshur | 8,680,000 | 12,057,176 | 17,693,557 |
| Van Zandt | 12,933,000 | 19,689,840 | 29,159,464 |
| Wood | 9,721,000 | 13,513,111 | 19,246,498 |
| REGION TOTAL | $113,219,000 | $148,106,325 | $228,675,570 |

Source: ETCOG, 1972.

TABLE 3.9-12 Regional oil production

| County | Production Discovered | Annual Total Barrels | BBLS Per Day | Total Crude Production to Jan. 1, 1975 (BBLS) |
|---|---|---|---|---|
| Anderson | 1929 | 8,194,255 | 22,450 | 224,214,189 |
| Camp | 1940 | 691,186 | 1,894 | 15,215,697 |
| Cherokee | 1926 | 2,572,679 | 7,048 | 39,212,335 |
| Gregg | 1931 | 51,604,819 | 141,383 | 2,450,803,212 |
| Harrison | 1928 | 1,468,725 | 4,024 | 53,410,676 |
| Henderson | 1934 | 10,066,941 | 27,581 | 100,300,713 |
| Marion | 1910 | 748,108 | 2,050 | 43,919,989 |
| Panola | 1917 | 781,073 | 2,140 | 42,273,034 |
| Rains | 1955 | 4,920 | 13 | 129,167 |
| Rusk | 1930 | 19,697,012 | 53,964 | 1,546,389,513 |
| Smith | 1931 | 4,281,914 | 11,731 | 175,846,696 |
| Upshur | 1931 | 2,583,637 | 7,078 | 258,026,398 |
| Van Zandt | 1929 | 16,438,040 | 45,036 | 418,625,533 |
| Wood | 1941 | 46,165,290 | 126,480 | 722,794,006 |
| REGION TOTAL | | 165,298,599 | 452,872 | 6,091,161,158 |

Source: State of Texas, 1975.

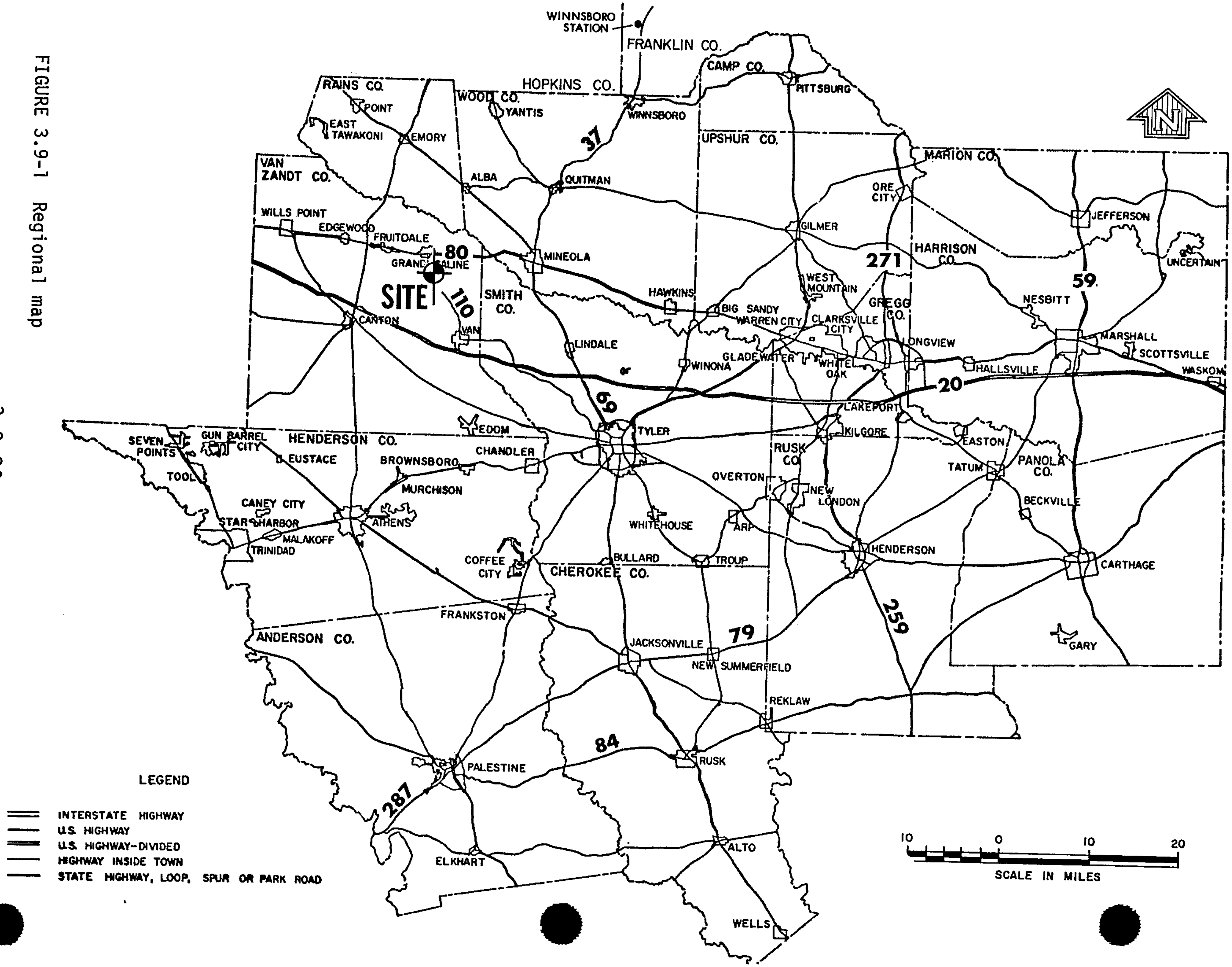


FIGURE 3.9-1 Regional map

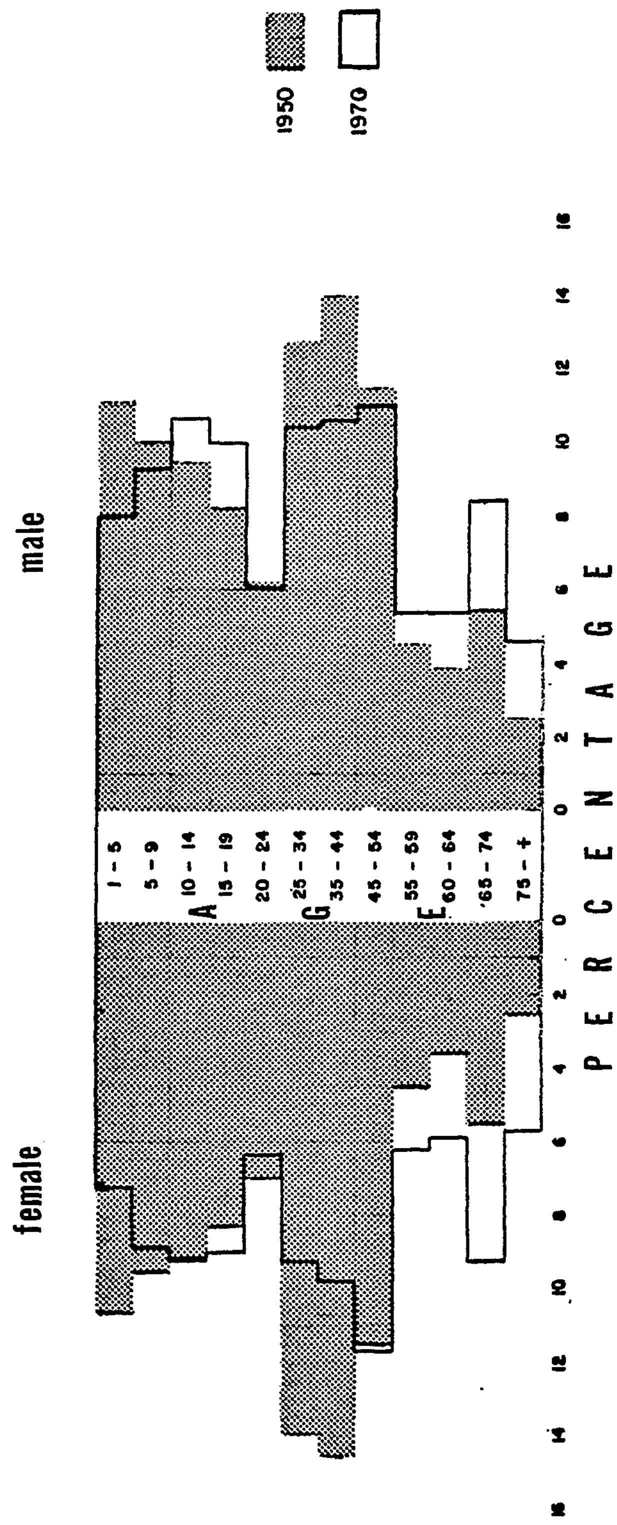


FIGURE 3.9-2 Age-sex composition of region:1950 and 1970

## 3.10 ENVIRONMENTAL SETTING OF OIL TRANSPORTATION ROUTE

As no new facilities will be constructed to transport oil from the Gulf to Winnsboro, emphasis in this section is placed on environmental features which may affect the transport of oil, specifically oil spill hazards and atmospheric emissions.

Oil to be stored at Kleer Mine is expected to originate at the Gulf Coast, either as foreign or domestic crude. The method of transportation is assumed to be as follows (See Figure 2.3-8):

(1) Oil is offloaded to 30 MDWT tankers in the Gulf south of Sabine Lake at the Texas-Louisiana border;
(2) Oil is transported by tanker through Sabine Lake, up the Neches River to Nederland, Texas;
(3) Oil is transferred from tanker to surface storage tanks in the Texoma Terminal at Nederland;
(4) Oil is pumped through the 26-inch diameter Texoma Pipeline north from Nederland through east Texas to Winnsboro Terminal.

Marine transport utilizes the heavily traveled Sabine Lake and Neches River corridor to the Texoma Terminal at Nederland. The lower river delta is rimmed by salt, brackish and fresh marshes which are important habitat for water fowl and fur animals and provide valuable nursery grounds for many commercial fishery species. To the east of Sabine Lake is the Sabine National Wildlife Refuge. Oil spilled in nearby coastal waters could reach these sensitive wetlands by river or tidal current.

The northwest shore of Sabine Lake and the lower Neches River are heavily developed. Traffic levels are high, maintenance dredging is common, and the banks are heavily industrialized. Oil spilled in the river would be quickly carried into Sabine Lake, however, and have extensive environmental impact on estuarine waters and marshes to the south and east.

Lands along the Sabine Lake and Neches River from Port Arthur to Beaumont, Texas are densely developed. Air pollutant emissions are high. Of particular interest to the transport of oil are the high ambient concentrations of non-methane hydrocarbons and photochemical oxidants. During January to September, 1976 at Nederland, Texas, national hydrocarbon standards were exceeded 136 times and photochemical oxidant standards were exceeded 286 times (Butts, 1976).

Southeast Texas is very level, much of it barely above sea level. Weather is humid subtropical with a strong marine influence. Rainfall is heavy, averaging over 50 inches a year. The principal natural hazard which may affect oil transport is the danger of tropical storms and hurricanes which move into the area from the Gulf causing heavy seas, high winds, and much coastal flooding.

North of Nederland, the Texoma Pipeline is currently in operation. Excess capacity would be used to transport additional oil for storage at Kleer Mine.

The pipeline passes through generally level to rolling terrain (less than 500 feet elevation) in the Coastal Plain from Nederland to Winnsboro. Vegetation ranges from coastal marsh grass at the coast to oak-hickory-pine and southern mixed forest associations further north. Annual average rainfall decreases to the north, from more than 50 inches around Nederland to approximately 40 inches at Winnsboro.

The pipeline crosses many streams and rivers; major crossings are the Neches River (twice, just north of Nederland and again at the Tyler - Angelina County border) and the Sabine River in Gregg County just south of Longview. The route does not cross any national forests, parks or wildlife refuge lands. Aquifers are generally of the unconsolidated sand and gravel type.

There are no significant potential natural hazards along the pipeline route. The project is located in a region that is considered aseismic (Zone 0, or no reasonable expectancy of earthquake damage, on U.S. Department of Commerce Seismic Risk Maps). Also, foundation conditions are considered stable (e.g., karst topography does not occur).

Except for transfers to storage tanks at Winnsboro Terminal, pipeline transportation of oil will have negligible emission of atmospheric pollutants. Ventilation and atmospheric dispersion conditions are generally good at Winnsboro.

SECTION 4.0

# ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTIONS

## 4.1 INTRODUCTION AND SUMMARY

The actions that may cause environmental or social impacts are construction and operation of the proposed oil storage and pipeline facility and preparation of a new mine at Kleer Mine. Expected and potential impacts (both positive and negative) are described in more detail in the remainder of section 4.0. Potentially significant impacts that may occur relate to the possibility of a major oil spill; the release of approximately 29 tons of hydrocarbons per day from marine transport operations in the Gulf of Mexico and Neches River, 300 pounds per day from the tank farm at Nederland, Texas and 85 pounds per day from Winnsboro Terminal; sedimentation is downstream impoundments as a result of pipeline construction, annoyance of nearby residents as a result of construction noise, potential alteration or contamination of a unique salt marsh on Grand Saline salt dome, and the possible layoff of a substantial number of Morton employees if the decision is made to temporarily close the mine.

Oil spill damage potential is described in detail in section 4.3.8. The expected annual average volume of oil release is very small (less than 80 barrels over the entire transportation system from the Gulf of Mexico to Grand Saline, Texas) and does not pose a significant threat to the human or natural environment. Maximum credible spill incidents (60,000 barrels from tankers in the Gulf; 10,000 barrels from Texoma pipeline; 5000 barrels from the spur pipeline between Winnsboro and Kleer Mine) could severely pollute the local area ( up to several hundred acres of land or water). However, the statistical frequency of occurrence of such a spill based on historical data, is extremely low.

Hydrocarbon emissions from transport, transfer and storage of crude oil between the Gulf of Mexico and Kleer Mine may result in ambient concentrations exceeding 160 $ug/m^3$ under worst case conditions at the following locations: (1) Gulf of Mexico, south of Sabine Lake for a distance of approximately 10.3 miles downwind of VLCC transfer location; (2) Nederland, Texas tanker terminal: for a distance of 7.8 miles downwind; (3) at the Winnsboro Terminal: for a distance of less than 1/4 mile downwind. These emissions would occur for relatively brief periods during each fill operation (emissions would occur only at Winnsboro during withdrawal). High ambient hydrocarbon concentrations would slightly extend the area over which the air quality standard is exceeded.

Estimates of erosion potential within the watersheds crossed by the pipeline indicate that no more than 0.1 percent of the storage capacity of any downstream lake or impoundment might be filled with sediment over a period of years as a result of pipeline construction.

Construction noise at Kleer Mine may cause some annoyance to area residents within one-half mile of the site (maximum 6 dB noise increase for nearest resident). Continuous day/night average sound levels may reach 59 dB; occasional short duration noise levels from rock blasting may reach 91 dB at 1000 feet and 83 dB at 0.5 mile (the most representative distance to nearby residential areas). Construction will be completed in less than a year, however.

The Grand Saline salt marsh has been identified as a unique habitat in this part of Texas. Though the planned construction activities will not directly affect any productive areas of the marsh, care will be required to avoid alteration of drainage quantity and quality reaching the marsh from construction sites to the south and west. Also, special attention may be necessary to keep possible oil spills from reaching productive areas of the marsh. Though a total of 650 acres will be affected at least temporarily by pipeline and terminal construction, no other unique or regionally significant impacts are expected.

If the decision is made to develop the oil storage facility without closing the mine temporarily, there will be no significant adverse effects on the mine owner or workers as a result of the project. If, however, the decision were made to expedite oil storage, Kleer Mine would be closed for an estimated 40 weeks. If the mine and processing plant are affected, a total of perhaps 150 workers would be temporarily without work. As many as 60 of the affected employees could be expected to find employment in the construction phase of the project. The remainder would be without work, or possibly underemployed, until salt production began at the new mine.

## 4.2 SITE PREPARATION AND CONSTRUCTION

Preparation of an oil storage facility at the Kleer Mine involves modification of existing mine facilities to receive oil, development of a new salt mine, construction of a 42-mile pipeline, and modification of the Texoma-Winnsboro Terminal. No new construction is required to deliver oil from the Gulf of Mexico to Winnsboro Terminal.

Modification of the existing mine (for both development options) includes converting the existing service shaft to a pump shaft; sealing the production shaft; removing certain aboveground facilities such as the headframe and hoisting equipment; constructing an electrical power substation, piping, and manifolds; and regrading and tunnelling the mine caverns to promote oil drainage.

Construction of a pipeline distribution system involves installation of 42 miles of a 22-inch diameter steel pipe between Kleer Mine and the Texoma-Winnsboro Terminal, and construction of two 90,000-barrel storage tanks, with associated piping, metering, and instrumentation, at Winnsboro Terminal. A brief summary of pipeline construction methodology is provided in section 5.2.3.1.

Development of a new mine involves excavating new service and production shafts; constructing headframe and hoisting equipment and a new salt conveyor system; preparing sufficient working faces in the mine; and installing new crushing and screening equipment below ground. Further information on site preparation and construction can be obtained from section 2.0.

The following sections describe the expected and potential effects of construction of the proposed project. For clarity, effects are treated within major disciplines (geology, hydrology, air quality, and so forth).

### 4.2.1 Geology and Soils

The Kleer Mine oil storage project is not expected to have any significant effect on geology or topography. No seismic hazards are liable to affect mine stability. There will be no removal or reworking of large quantities of material either at the surface or underground, except for material to be excavated in construction of the shafts and pipeline trench. Surface disturbance is expected to be less than 10 acres at the mine, 636 acres along the pipeline corridor, and 1 acre at Winnsboro Terminal. Assuming that excavated materials from the near-surface are regraded and reseeded in the manner described in sections 5.2.2.2 and 5.2.3.2, following sound construction practices, soil erosion during construction will be small (see section 4.2.2.1). However, there will be some erosion of bare ground after construction before new plant growth begins.

Shaft drilling and sinking are common practices. There are two large diameter shafts at the existing mine. The two shafts into the new mine will be excavated to depths of over 700 feet. The shaft construction techniques proposed are designed to prevent shaft collapse and ground water migration during shaft sinking. New mine development will be restricted to minimum distances of over 300 feet from the existing mine caverns to eliminate any interference effects.

Waste salt derived from preparing the access shafts will be used for production or will be placed in the existing mine and stabilized. Other materials will be suitable for surface disposal or will be disposed of underground in the present mine workings, along with the waste salt. The total earth disposal volume from 2 shafts is less than 5000 cubic yards, comparable to a 1-acre landfill less than 5 feet high. The material will be placed on the barren site of previous spoils to minimize the impacted acreage. It will be stabilized by the use of soil amendments and revegetation. Material excavated from the pipeline trench will be retained for backfilling after system pressure checks. Soil profiles will be inverted as a result of excavations and backfilling.

Economically significant mineral deposits at Grand Saline are restricted to hydrocarbons and salt. Deposits of sulfur that characterize the caprocks of some salt domes are absent at Grand Saline. Also, gravels are of poor quality and are too deep for economic extraction. Development of lignite and clay deposits along the pipeline corridor will not be affected by the project.

Neither the hydrocarbon nor salt resources at Grand Saline appear to be threatened, either temporarily or permanently, by the oil storage program. The existing oil and gas wells are sufficiently distant from the mine workings to eliminate any present or foreseeable interaction between them. If further development of the immediate vicinity is deemed appropriate, additional wells can be drilled directionally to safely avoid the workings.

### 4.2.2 Hydrology

#### 4.2.2.1 Surface Water

The construction phase of the project will impact the surface waters of the Grand Saline area mainly because of construction of the pipeline across several watersheds. In general, these impacts will be:

1. Increased sedimentation.
2. Increased infiltration.
3. Decreased water quality.

Excavation and refilling of the pipeline trench will disturb about 140 acre-feet of the natural soil along the pipeline route (Table 4.2-1). An estimated 20 percent of this material, or about 28 acre-feet of soil, may be subject to loss by erosion . This eroded material will gradually enter the streams of the watersheds crossed by the pipeline, be carried as a bed and suspended load, and finally be deposited in the nearest downstream reservoir. In addition, temporary causeways required in soft-bottom streams for movement of construction equipment will cause some siltation and increased turbidity in the streams.

The disturbed soil in the pipeline trench will be less compact than the undisturbed material, thus causing a temporarily higher infiltration rate in the part of the stream catchments along the pipeline trench. However, this impact is insignificant to both the local and regional environment.

A potentially significant hydrologic impact will be the increased sedimentation in the existing reservoirs. In the Comprehensive Basin Study, Sabine River and Tributaries, the SCS estimated that erosion losses averaged 1.0 to 1.5 acre-feet per square mile in this subbasin (U.S. Army Corps of Engineers, 1967).

Toledo Bend Reservoir - Located over 100 miles downstream of the project on the Sabine River, this reservoir could receive about 8 acre-feet of additional sediments due to project construction. This is 0.7 percent of present annual accumulation and 0.001 percent of total original storage capacity. This extra sedimentation will be approximately distributed among the various subwatersheds as shown below:

| | | |
|---|---|---|
| 1. | Grand Saline Creek to Sabine River | 4.4 acre-feet |
| 2. | Cottonwood Creek to Sabine River | 2.2 acre-feet |
| 3. | Cedar Lake Creek to Sabine River | 0.6 acre-feet |
| 4. | Sabine River directly | 0.8 acre-feet |

Lake Fork Reservoir - This reservoir is now under construction and could receive approximately 8.4 acre-feet of additional sediments (less than 0.001 percent of storage capacity) due to project construction. The distribution of these sediments is approximately:

| | | |
|---|---|---|
| 1. | Slum Branch | 2.2 acre-feet |
| 2. | Rainwater Creek | 2.4 acre-feet |
| 3. | Caney Creek | 0.2 acre-feet |
| 4. | Seary Branch - Taylor Branch - Bell Branch system | 1.8 acre-feet |
| 5. | Briar Branch | 1.8 acre-feet |

Quitman Reservoir - This reservoir will receive 6.6 acre-feet of additional sediments from Brushy Creek, Glade Branch Creek, and Dry Creek due to the project. This is 83 percent of the present annual sediment accumulation and 0.09 percent of the total original storage capacity.

Lake Winnsboro - Two watersheds (Little Sandy Creek and Big Sandy Creek) will contribute about 1.4 acre-feet of sediments to the reservoir. This is 18 percent of the present annual sediment accumulation and 0.02 percent of the total original storage capacity.

Lake Cypress Springs - This reservoir is located in the Big Cypress Creek Watershed of the Red River Basin. There will be an increase in sedimentation of about 3.3 acre-feet or 0.005 percent of original storage capacity, as a result of project construction. The contributing creeks are Wilcox Branch, Big Cypress Creek, Little Cypress Creek, and Loon Creek.

A comparison of estimated annual and cumulative sediment volumes with storage volumes of the affected reservoirs indicates that the most significant impacts will be to Quitman Reservoir. Although nearly a full year of normal sediments could be deposited because of the project, this is only 0.1 percent of the reservoir's total storage capacity.

The effects of increased sediment accumulation on the project life and storage capacity of each reservoir would be minimal. The project life for each of the reservoirs (Toledo Bend, Lake Fork, Quitman, Lake Winnsboro and Lake Cypress Springs has been estimated by the U.S. Army Corps of Engineers to be about 100 years. In the case of Quitman Reservoir, which would be the reservoir most affected by pipeline construction, erosion would add in the worst case situation, less than an additional one-year accumulation of sediments to the reservoir. This accumulation would thus reduce the expected project life of the reservoir of about 1 percent. Mitigative erosion control measures (Section 5.1.1) such as stream bank stabilization backfilling of trenches and revegetation procedures (Section 5.1.1) would markedly reduce this impact. Most of the adverse impacts of erosion on the area reservoirs can also be minimized by these mitigative measures.

During the erosion-sedimentation process, the turbidity and suspended solids in the creeks and rivers crossed by the pipeline will temporarily increase; this is not considered to be a significant impact on water quality, except perhaps immediately downstream of the pipeline crossings. Only a very localized portion of the bottom sediments of the Sabine River will be disturbed by dredging. There will be minor adverse effects on BOD, dissolved oxygen, pH, nutrients, and turbidity. No toxic materials or heavy metals are expected to be introduced into the water column.

The surface drainage pattern will not be altered significantly by the surface facilities of the project. No significant amounts of surface water will be consumed during construction (see Section 4.2.2.2).

Site excavation and construction at Kleer Mine and Winnsboro Terminal will not directly affect any surface water resources. There is some potential for turbid runoff reaching the Grand Saline salt marsh at Kleer Mine. This will be minimized by proper placement of excavated materials and by normal soil stabilization procedures (see Section 5.0).

4.2.2.2 Ground Water

The construction of the pipeline and other surface facilities will be restricted to small areas and will involve relatively minor quantities of near-surface materials. The pipeline will generally be placed above ground water levels, and therefore will not affect ground water movement. Because of the original low permeabilities of most of the surface materials, reworking by the pipeline construction will not greatly affect their ability to absorb water. Exceptions would be the coarser sands; but since the pipeline will cross little or none of these sands, there will be no noticeable effect on the recharge and ground water movement in the Carrizo-Wilcox aquifer (Table 4.2-2).

As previously described, site preparation will include construction of two shafts. The new mine production shaft will be conventionally excavated after freezing the unconsolidated sediments and porous caprock above the impermeable salt. In addition to providing stability to the materials, freezing will render them impermeable to water inflow (or outflow) until after the permanent shaft lining is in place. Therefore, the ground water regime will be entirely isolated from any disturbances resulting from the sinking of these two shafts.

The new mine service shaft is expected to be excavated by conventional large-diameter drilling techniques. Instead of freezing, the walls of the hole will be maintained by the drilling mud. To prevent ground water inflow, the mud will have a density that is just sufficient to offset the local hydrostatic head. The mud will remain in the shaft until the unstable portions are cased with permanent lining. Therefore, the only effect on ground water will be minor amounts of drilling mud that may locally migrate short distances into permeable horizons. The mud will be chemically inert, nontoxic, and formulated to reduce migration, which is conventional practice for drilling water wells.

For about 1 year during construction and modification of the site, an estimated maximum of 35 gallons per minute (gpm) of fresh water will be required for drilling mud, concrete, washing, and general human consumption. This water may be taken from the existing well at the mine (depth of 170 feet). In any case, the withdrawal is not large enough to affect the supply of fresh water available in the aquifer (see Section 3.3.2).

### 4.2.3 Air Quality

The State Implementation Plan does not yet contain detailed projected levels of air quality by region. From 1973 data, the existing air quality at the nearest station in the vicinity of the site (Tyler) can be summarized as good (Section 3.4.3).

The quality of the air near the site will be affected slightly during site preparation and construction. The two largest potential effects are particulate matter (dust) and diesel exhaust emissions (SO2, $NO_x$, CO, hydrocarbons) resulting from the use of the construction equipment. Most of the construction activity at the mine site (installation of bulkheads, grading of mine floor, etc.) will be underground. Therefore, the surface pipeline system construction will be the major cause of pollutant emissions to the surrounding air.

#### 4.2.3.1 Sources and Kinds of Emissions

The quality of the air during construction will be affected by pollution from general construction vehicles and light-duty general use vehicles. The kinds and amounts of pollutants from these sources are discussed below.

General Construction Vehicles

During site preparation, there will be excavation activity, drilling, and underground blasting and construction. A number of machines will be used. The diesel and gasoline engines will emit hydrocarbons (HC), $SO_2$, CO, $NO_x$, and particulates. The quantities of pollutants emitted during construction depend upon the following factors: number, type, and model year of vehicles; speed; duty cycle; and cold operation cycle. The effects on air quality also depend on local meteorological conditions. The emission factors for the construction equipment that will be utilized have been taken from the U.S. EPA Compilation of Air Pollutant Emission Factors (December, 1975). The total emissions were calculated using the EPA emission factors, and estimates of the amount and projected use of construction equipment. Section 4.2.4 describes the construction equipment required for the construction activity. The equipment is assumed to be in use 20 hours per day and to have a duty load of 2,000 working hours per year. In addition, it is assumed that equipment will be used at 2/3 maximum power output during construction.

Light-Duty General Use Vehicles

Air quality will be affected by vehicular traffic other than that directly related to construction. It is assumed that 10 general use vehicles will be in use during construction, each running at 100 miles per day at a variety of speeds. Table 4.2-3 presents calculated emissions, by pollutant, expected to result from all construction equipment. The emissions include miscellaneous devices such as welding equipment, ventilation equipment, and generators. These emissions are assumed maximum 1-hour rates. The largest portion (greater than 50%) of the emissions given in the table will result from the equipment used in the drilling operations.

Fugitive Dust

In addition to the particulate concentrations resulting from the operation of equipment, dust emissions will result from construction activities at the site. The dust will be associated with land clearing, blasting, excavation, cut and fill operations, and other activities. The amount of dust will vary from day to day, depending on activity and the weather. A large portion of the dust will be due to equipment traffic on temporary roads. Field measurements at apartment and shopping center construction sites have yielded an estimate of 1.2 tons (1,089 kg) of dust per acre of construction per month of activity. This estimate is fairly representative for the Kleer site because it was determined for a semiarid climate. This is approximately 50 percent of the emission rate given in Table 4.2-3.

4.2.3.2 Impacts on Air Quality

The impact of the computed emissions on general air quality depends on the existing ambient air quality and the dispersal characteristics of the atmosphere, both of which are discussed in Section 3.4. Atmospheric calculations were made using methods recommended by the Environmental Protection Agency (Turner, 1969) and averaged over appropriate time intervals.

Incremental increases in air pollutant concentrations resulting from the Kleer Mine project construction equipment are given in Table 4.2-4. The concentrations were calculated using construction area emission rates (Table 4.2-3), assuming an area source model and an area having dimensions of 250 meters on a side. The downwind concentrations were computed at a point 500 meters downwind under "F" stability and a wind speed of 2.0 meters per second. Because all pollutants released during the construction will be essentially ground releases, all concentrations given in Table 4.2-4 are lower at greater distances. Therefore, the incremental increase in concentration at 0.5 km from the site is the maximum increase in concentration likely to be attained offsite.

Although the maximum 24-hour measurements for suspended particulates at Tyler, Texas are well below the primary and secondary standards, the geometric mean is above the standards (Tables 3.4-7, 3.4-8, and 3.4-9). Particulates from construction will add to the local levels. However, if ambient particulate concentrations near Grand Saline are similar to those at Tyler, the contribution to ambient levels due to the project would be minor.

No noticeable odors are expected to be created by construction.

### 4.2.4 Noise

The following sections describe the analysis of possible acoustical impacts at locations and residences near the Kleer Mine construction site. Sound levels from construction activities (not including detonation) are summarized in Table 4.2-8. It is estimated that construction activities will take place over a period of 1 to 1.5 years. Sections 4.2.4.1 through 4.2.4.3 specify the noise levels associated with the major construction equipment. Using the assumption of hemispherical sound radiation, these sound levels are extrapolated to nearby locations off the site to determine the effect on ambient sound levels (Sections 4.2.4.4 and 4.2.4.5). Definitions of terms are provided in Appendix C.

#### 4.2.4.1 Construction of New Mine

The holes for installation of refrigeration pipes will be drilled using large drilling equipment. It is estimated that 2 drills may be operating simultaneously on the site. The sound level data of this equipment are presented in Table 4.2-5. The equivalent sound level ($L_{eq}$) contribution of this activity is estimated to be 67 dB at 500 feet. Assuming that drilling activity is continuous throughout a 24-

hour day, the daytime and nighttime equivalent sound levels ($L_d$ and $L_n$) contributions are both estimated to be 67 dB at 500 feet.

A refrigeration plant typically consists of a 100- to 150-HP reciprocating compressor, a 24-inch diameter condenser, and a suction trap. These units will be enclosed in a building. Equipment manufacturers estimate operating sound levels inside the refrigeration building of 89 to 102 dBA, resulting in an equivalent sound level ($L_{eq}$) contribution of 37 dB at 500 feet. The refrigeration process will be continuous throughout a 24-hour day. $L_d$ and $L_n$ contributions are both estimated to be 37 dB at 500 feet. According to the schedule on Figure 2.3-2, the refrigeration process will operate for a period of about 6 months.

Noise-producing surface equipment associated with the conventional drilling and blasting required for the mine may include 1 ventilation blower, 3 air compressors, 2 trucks, a crane, 1 or 2 concrete trucks, and probably a batch plant (Table 4.2-6). The $L_{eq}$ contribution for these phases of construction is estimated to be 69 dB at 500 feet. Construction activity will be continuous throughout the 24-hour day. The $L_d$ and $L_n$ contributions are estimated to be 69 dB at 500 feet.

Underground noise generators from the production shaft construction include drills, explosives, and excavation equipment. The audible sound level above the existing ambient sound level due to underground construction activity is considered to be negligible.

It is estimated that there will be 1 to 3 detonations of 50 to 300 pounds of dynamite each day. Since the overpressure created from detonations depends on both the amount used and the depth at which it occurs, it is difficult to estimate the sound pressure level created from this activity. Overpressure from surface blasting is expected to produce impact sound levels of 91 dB at 1000 feet and 83 dB at 0.5 miles. As shaft sinking operations reach 10 to 20 feet or more below ground level, sound levels will be greatly reduced.

Because of its smaller diameter, the service shaft will be drilled rather than mined. Large-diameter drill rigs employed for such work are typically powered by two or three 400- to 600-HP electric motors. In relation to the other construction noises that will be occurring simultaneously with the service shaft, the drilling of the service shaft will produce insignificant noise levels.

#### 4.2.4.2 Conversion of Present Mine

Most of the construction activity for conversion, such as conversion of the existing service shaft to a pump shaft, installation of bulkheads, and channelization along the mine floor to improve drainage, will be conducted underground. The audible sound level above the existing ambient sound level due to underground construction activity is expected to be negligible.

#### 4.2.4.3 Construction of Pipeline and Terminal

An estimated 2 trucks, 1 backhoe, 1 welding machine, 1 scraper, 3 wheel-mounted cranes and 2 air compressors will be needed for construction of the pipeline and terminal. If rock is encountered along the route, the use of 2 impact hammers, 2 rock drills, 1 loader and a detonator will be required. If frequent blasting is necessary, the use of a rock saw will be considered as an alternate method. Sound level data associated with this construction equipment are presented in Table 4.2-7. Pipeline construction activity is generally scheduled for 10 hours in the daytime. Equivalent sound level ($L_{eq}$) contributions in pasture land at 500 feet from the construction activity are estimated to be 68 dB; in rocky areas, 72 dB. The $L_d$ contribution at 500 feet through pasture land and rock is 66 and 70 dB, respectively. Blasting required for removal of rock along the pipeline route is estimated to produce instantaneous sound levels of 91 dB at 1000 feet.

#### 4.2.4.4 Ambient Sound Levels

In order to estimate the ambient sound levels during construction, the sound level contributions discussed in the previous sections (see summary in Table 4.2-8) were extrapolated, using hemispherical sound radiation theory, and combined with the background ambient sound levels. The assumption of hemispherical radiation does not include attenuation due to foliage, air, or ground absorption, and is therefore conservative.

The construction at the mine site is assumed (for the worst case) to occur concurrently with construction of the pipeline, which would occur between weeks No. 59 and 89 for the Option 2 schedule (Figure 2.3-2). Ambient sound levels are estimated for the worst case situation;

that is, where pipeline construction activity is closest to the mine. The results of this computation are presented in Table 4.2-9.

The results indicate that, except at the construction site and during blasting, the increase in ambient equivalent sound levels is small. At the town of Grand Saline, ambient $L_d$ and $L_n$ are estimated to increase by a maximum of 2 and 4 dB, respectively. During the noisiest phase of pipeline construction, where rock removal equipment is used, ambient $L_d$ at pasture lands 1 mile from the construction activity will be increased by about 6 decibels. Noise emitted from the use of explosives in the removal of rocks during pipeline construction may be high. However, overpressure created from detonation is of such a short duration as to not significantly contribute to the ambient equivalent sound level.

4.2.4.5 Impacts on Residents

An evaluation was made of the noise levels that will be heard by nearby residents during construction of the proposed facility, using background ambient sound levels, for the situation where all construction activities take place at the mine site concurrently. The impact assessment presented in this section is based on Federal guidelines and state regulations.

The Federal Environmental Protection Agency (EPA) has issued guidelines that suggest that annual day/night average ambient sound levels below an $L_{dn}$ of 55 dB do not degrade the public health and welfare (see Appendix C). During the noisiest phase of construction, the $L_{dn}$ at the town of Grand Saline is estimated to increase from 56 to 59 dB (Table 4.2-9). This anticipated increase in ambient sound level may cause some annoyance. It is estimated that 3 percent of the exposed population might be highly annoyed. However, the construction activity will be of a temporary nature, which should minimize the annoyance caused by the change in ambient sound climate. At the villages of Alba and Golden, the ambient $L_{dn}$ is estimated to be about 50 dB during the construction period (an increase of only 1 dB), which is below the EPA suggested criteria of 55 dB ($L_{dn}$).

Areas beyond 1/2 mile of the site will not experience any increase in ambient sound levels. Residents within 2000 feet of the proposed pipeline route may experience annoyance due to daytime construction sounds and rock excavation blasting. The frequency of these blasts will depend on the quantity of rock encountered near the surface along the route. Impulse noise levels from blasting at 1000 feet may be as high as 91 decibels. This overpressure level will occur for a very short duration and thus does not provide hearing damage risk; an impulsive noise level less than 140 dB is acceptable by OSHA standards.

The state of Texas has no noise regulations limiting the noise level the from proposed activity.

### 4.2.5 Ecology

Within the Kleer Mine project area, no detailed wildlife inventories have been undertaken to establish population indices or densities. The scarcity of this type of information for the Grand Saline area makes quantification of ecological impacts with current methods impossible. Due to the paucity of any quantitative population data, estimates of wildlife impacts are subjective and must be based on field observations and general background knowledge of the site. Because of this, descriptions of impacts are based on expected disruption to the major physical habitat types.

#### 4.2.5.1 Terminals

Construction of the terminal facilities at Kleer Mine and Winnsboro Terminal will entail the commitment of approximately 3 acres of land for the project life, plus the temporary alteration of approximately 2 more acres for access roads and staging areas. In addition, development of new salt mine facilities will affect another 10 acres at Kleer Mine. All of this land is presently used for industrial purposes except for a small tract of undetermined size at the Winnsboro Terminal.

Although the project facilities at Kleer Mine require only about 13 acres, they are located adjacent to the Grand Saline salt marsh (see Appendix I and Figure 2.2-1). The salt marsh is a result of upward movement of ground water over the flank and caprock of the salt dome (Figure 3.3-4). The resulting saline habitat covers more than 300 acres in a shallow depression on the dome. The marsh is an unusual and unique habitat type for the area. The proposed surface facilities could alter freshwater flow to the marsh from the drainage area to the west. The removal of much of the fresh water which drains into the marsh could increase salinity and extend the dry period, thus changing the ecology of the marsh.

A field study was conducted to determine the characteristics of the marsh and to suggest methods for avoiding serious disruption. Present knowledge indicates that the marsh is unusual because of its saline soils and salt-tolerant plant species. It is also of some value as a resting spot to bird life. However, no important populations of fish or mammals were found to inhabit the site, probably because of the wide variation in water level and the location adjacent to the town of Grand Saline and the Morton Kleer Mine. (See Appendix I for results of the field study.)

4.2.5.2 Pipeline

Terrestrial Ecology

The effects of pipeline construction are of two types. The first is the temporary effect of initial access road and right-of-way clearing, excavation, and installation. The second is the effect of continued maintenance of cleared access roads and rights-of-way for the duration of the project. Acreage affected by these temporary and project-life impacts are indicated by habitat and soil type in Table 4.2-2 (access road acreage is expected to be small because of the several road crossings). Recovery of half the initial (temporary) rights-of-way is expected to take place gradually. Shrubs will return within a few years; trees will take upwards of 10 to 20 years to provide cover. Use of the area by animal and bird life will change as plant succession alters the habitat. Approximately half of the pipeline length is already affected by an existing 20-inch Mobil pipeline (straight section on Figure 2.1-1) and will thus require less clearing of vegetation. The boundary between the cleared corridor and the natural vegetation will provide some increased diversity of habitat to the area throughout the life of the project. The piles of vegetation debris will also improve habitat for small mammals, including rabbits.

Since the pipeline right-of-way is well south of the Grand Saline salt marsh, no specific discussion is included on construction effects in the marsh. Primary concerns are maintaining natural drainage patterns and preventing large quantities of sediment from reaching the marsh from the construction sites.

<u>Oak-Savannah Habitat Type</u> - Pipeline right-of-way construction will directly impact a total of 636 acres (42 miles of pipeline, 125-foot initial right-of-way). Approximately 257 acres will be through the oak-savannah habitat (Table 4.2-2). The construction impacts in the oak-savannah habitat will be vegetation destruction and mixing disturbance of the soil surface.

Destruction of all vegetation will have a long-term (more than 20 years) detrimental effect on habitat quality. Secondary succession following pipeline construction would generally require between 30 and 50 years to restore wooded areas to their current status. However, regrowth of trees will probably be delayed for the life of the project since most pipeline corridors in the area are maintained to prevent woody plant encroachment.

Although loss of the trees will reduce both the mast crop and potential habitat for many animal and bird species, the loss of the shrubby layer will have a particularly adverse effect on habitat quality for the white-tailed deer, an important game species. Shrubs such as the American beauty berry form the bulk of this animal's diet. The "clean" corridors created by pipeline construction will make deer hunting easier. Hunters can wait for animals to cross the corridor rather than pursue them in the often dense oak-savannah thickets.

Disturbance of the soil surface presents some erosion hazard in all areas of the oak-savannah, but the hazard is especially acute on side slopes and narrow ridges characterized by the Woodtell series. There is ample evidence in the area of rill and sheet erosion on small piles of excavated soil. If appropriate mitigating measures are instigated (see section 5.2.2), there should be no long-term habitat damage resulting from soil surface disturbance or mixing of the soil horizons. In fact, studies conducted in conjunction with surface mine reclamation in northeast Texas have concluded that mixing the surface horizons actually improves their plant growth properties. Mixing the coarse textured surface horizons with fine textured subhorizons eliminates the fragipan, increases water holding capacity, and redistributes nutrients required for plant growth.

<u>Bottomland Habitat</u> - Approximately 61 acres of this habitat will be disturbed by initial pipeline construction (Table 4.2-2). Most will be within the Sabine River flood plain to the northeast of Kleer Mine (Figure 2.1-1). The destruction of woody and shrub habitat components would be similar to those discussed in the oak-savannah. However, the herbaceous strata would be permanently modified because all extant species are adapted for growth in moist, low light intensity environments. Removal of all overstory components would increase light penetration and wind movement. Both factors would alter the microhabitat within the pipeline corridor to a more xeric (dry) type.

Disturbance of the soil surface will have little overall impact, but loss of horizon integrity will have adverse effects in the bottomland. Soil subhorizons are often saturated and, consequently, have poor aeration. Reduced aeration inhibits structural or textural development. When these soils are brought to the surface, 2 to 5 years may be required for the development of structural characteristics that will support plant growth.

Because the riverbottom is flooded from 3 to 10 times annually, there is a possibility that flooding will occur during some phase of pipeline construction in the Sabine River flood plain. If such a situation occurs and the conventional dry-land method of pipeline construction is used, the adverse soil-related impacts previously discussed would be amplified. (For a description of methods of pipeline construction, see section 5.2.3.1.) In addition, erosion of soil banks and downstream sedimentation could be significant. It is probable that the push-ditch method of construction would have to be used in this habitat type during flood conditions, thus confining terrestrial ecological impacts to the right-of-way plus perhaps a 1/2-acre push site per crossing.

Tame Pasture Habitat Type - Approximately 318 acres of tame pasture habitat will be crossed by the pipeline. Because this habitat type lacks any appreciable woody component or any unique flora, pipeline construction should cause only temporary (1-to 3-year) detrimental impacts. Permanent loss of vegetation and creation of deep gullies could result in high erosion potential in steep areas if care is not taken to stabilize and revegetate these areas immediately after construction.

## Aquatic Ecology

The proposed pipeline corridor will intersect the Sabine River, Lake Fork Creek, Big Cypress Creek, and other small creeks and tributaries to Winnsboro and Quitman Lakes. This will result in impacts to the aquatic biota that may only be quantified on the basis of detailed construction plans and a field inventory of the habitat near each crossing. However, these impacts will probably be local in nature and limited in extent. Disruption of stream bottoms and margins by dredging will probably result in the loss of some local fish habitat due to the destruction of microhabitats, such as pools and riffles. Benthic invertebrate diversity and abundance will also be influenced by changes in the substrate. Increases in turbidity and sediment load, although probably temporary in nature, may be detrimental to the aquatic organisms as far as 1.5 to 2.5 miles downstream from the site of activity. Although direct mortality of fish due to sediment increases will probably be minimal, indirect adverse impacts through loss of food organisms or smothering of eggs and larval fish may be locally significant. The extent of the impact of these sedimentation increases will depend on the time of the year, velocity of the stream, sinuosity of the stream course, and substrate type. Assuming worst case conditions, aquatic populations should recover within 18 to 26 months.

### 4.2.6 Archaeological and Historic Resources

A preliminary reconnaissance of the proposed pipeline corridor and terminal was conducted to determine the existence of important cultural sites and the possible effects on these resources that would result from the project. Results of this survey are summarized in section 3.7 and Appendix F. Should a site be located within the final right-of-way, it will be investigated by subsurface means prior to or during construction, under the supervision of appropriate state authorities, in accordance with Federal regulations (Public Law 93-291). Thorough excavation, re-routing, or simple documentation will be conducted in accordance with state recommendations. Thus, no significant adverse effects of construction on cultural resources are anticipated.

### 4.2.7 Socioeconomic Environment

The oil storage program, as scheduled in Figure 2.3-1 with relocation option 1 (no interruption of salt mining), will not affect the current work force at the Morton salt mine. Although work will be initiated to convert the existing service shaft to a pump shaft while mining is in progress, an emergency access and escape way will be provided at all times by means of a manhole through the concrete bulkhead. As soon as the old mine closes, the new mine is scheduled to become operational. Construction modifications of the old mine and opening of the new mine will be accomplished by other workers.

Based on the total estimated costs, construction will require approximately 21,000 man-weeks of labor. After some minor on-site efforts associated with surveying and geotechnical studies, the main influx of workers begins about week 47 and corresponds with initiation of work on the 2 shafts (Table 2.3-1). Approximately 250 workers will be required at that time if option 1 is selected. They will be involved primarily in drilling the new service shaft and installing the refrigeration systems for the new production shaft. These tasks should be completed around week 70 (Figure 2.3-1). However, in order to stabilize the work force and reduce future peaks, this level could be maintained by early initiation of mine grading and cleaning, opening the new mine, and installing surface facilities. This employment level at the mine is therefore anticipated to last until about week 97, at which time construction of the pipeline to Winnsboro Terminal would require an additional 90 to 110 workers, bringing the total construction force to 300. Pipeline construction is anticipated to last until around week 120. At this time, the total project work force will drop to 100 or so until project construction is completed around week 140.

The option 2 schedule for new mine development would be the same as option 1 (Figure 2.3-2). The difference between options 1 and 2 is shown on Figures 2.3-1 and 2.3-2 to be a simultaneous initiation of field work for both new mine development and mine conversion for option 2. As shown in Table 2.3-1, the work force for option 2 would remain at about 355 for the duration of the construction period. This option provides 14 million more barrels of oil in storage by the end of the ESR (January 1, 1979) than option 1. It also affects plant operations for Morton because it would interrupt salt production for about 40 weeks.

Extra production needed to continue plant processing operations at normal levels for 40 weeks' downtime is about 192,000 tons (110,000 cubic yards). This salt would have to be stored aboveground or shipped in from other mines as needed. Since a dry storage facility for 110,000 cubic yards could probably not be provided within a reasonable time, supply from other mines or a 40-week shutdown would be necessary. The analysis of impacts for option 2 assumes a worst case, or 40 weeks of plant shutdown.

#### 4.2.7.1 Land-Use Impacts

The land above the Kleer Mine is unimproved and is used in part for grazing. Morton Salt Company owns considerable surface acreage and mineral rights beyond the perimeter of the existing mine (section 2.2.1). Developing surface facilities for the oil storage program and new facilities for the relocated mine will have a minor effect on land use in the area. There are no zoning regulations in Van Zandt County, and it is unlikely that any substantial changes in land use will occur as a result of the project.

The proposed pipeline route to Winnsboro is approximately 42 miles in length. Assuming an average width of 125 feet, the initial right-of-way will involve approximately 640 acres, nearly 60 percent of which will be in Wood County. The pipeline route passes through some forested woodland in Wood County, but primarily crosses tame pasture and rangeland, some of which is over known oil fields between Quitman and Winnsboro. The route also follows that of an existing 20-inch Mobil pipeline for about half of its length. The impacts on land use in Wood County (and to the remainder of the pipeline route) would be negligible. The project should not alter current land use in any significant manner.

No legally designated areas of open space or recreation would be affected by the project.

4.2.7.2 Transportation

As no major access roads are anticipated, the addition of new crude oil transportation facilities will be the primary impact on local transportation modes. The 22-inch pipeline will have a capacity of 200,000 barrels per day. The east Texas oil fields are currently traversed by numerous small and large diameter pipelines. Due to the large number of pipelines in the area, the SPR pipeline will have little effect on the regional crude oil transporting capabilities in the near future. It will satisfy the need for a dedicated pipeline capable of distributing oil stored at Kleer Mine in case of an oil supply interruption.

During the construction phase, impacts on the highway system will center on State Highway 110, which provides access to the project site. The increase in commuter traffic may require additional traffic surveillance by the County Sheriff's Department during the construction period. Many of the nonlocal workers commuting to Grand Saline will likely travel on U.S. Route 80 into Grand Saline and from there to the site on State Highway 110. Due to the good condition of these roads and the relatively small size of the construction force, little disruption of the local traffic is anticipated, even though there will be a noticeable increase in traffic during the commuting hours.

4.2.7.3 Population

Numbers and Location

The project will have little effect on the permanent population of Grand Saline, Van Zandt County, or the region. For development option 1 (no mine shutdown), Grand Saline will receive a daily influx of an additional 250 to 300 workers for a period of about 1 year. This number will decrease to around 200 workers (excluding 100 pipeline workers) for a period of around 5 months, and to 100 workers for the following 5 months. Consequently, Grand Saline will experience a temporary increase in daytime population of approximately 10 to 12 percent for about 1 year, decreasing to 6 percent or less during the following year. The increase will be a daytime phenomena, as most of the workers are expected to commute from their homes in the surrounding area.

For option 2 (temporary mine shutdown), approximately 350 workers will be required for a period of 64 weeks. Of these, 100 will be employed in pipeline construction for 5 months. Approximately 60 percent of the work force is expected to commute locally; the remainder will commute from the Ft. Worth-Dallas area. Thus, there should be almost no effect on resident population.

Occupation

The project will create a demand for construction laborers in the surrounding area and may attract people in other occupation categories. During construction, the number of construction laborers will likely increase in Van Zandt County. A secondary effect of construction activity near Grand Saline will be the increased demand for retail trade services such as eating establishments, grocery stores, and service stations. Consequently, there may be a temporary increase of workers in the various service occupations. The increased demand is not expected to generate significant capital investment in facilities to provide these services since the work force will be in the area less than 2 years.

Income

The project is estimated to have a total gross field labor payroll of $7.3 million (Table 2.3-1, both development options). This assumes an average gross labor cost of $346 per man-week for the 21,000 man-weeks. Deductions such as federal and state taxes will be approximately 30 percent of the gross payroll, leaving approximately $5 million in disposable income for the project employees over the project period. For option 1, the most labor-intensive work will occur between the weeks 47 and 120, when the mine conversion and relocation and the pipeline construction are in progress (a period of approximately 1.5 years). Disposable income in the first year of this activity could come to approximately $3.02 million, $1.59 million of which is estimated to be earned by local permanent residents. This amount would constitute a minor addition to income in Van Zandt County (equivalent to 1.7 percent of the effective buying income of the county in 1974, Table 3.9-6). The following year would produce an additional total disposable income of approximately $2.07 million. The additional disposable income resulting from the project will not be concentrated in Grand Saline, but will be diffused throughout the various communities in the area (as far as Dallas-Fort Worth) where the employees reside.

Under option 2, construction employment and wages will be almost identical to conditions under option 1 (Table 2.3-1). However, shutdown of the Morton salt mine and processing plant for 40 weeks will have some adverse effects on the Morton work force (200 to 220 workers). Since solution mining can continue and some plant maintenance will be necessary, it is estimated that approximately 150 employees will be temporarily laid off and that 60 of these will find work on the mine construction crews.

Thus, for the case of temporary mine shutdown (option 2), an estimated 90 mine workers will be without employment (or underemployed) for approximately 40 weeks. This may reduce the total local earnings by as much as $0.62 million ($0.47 million in disposable income). Unemployment benefits would partially offset this effect. Even though an estimated 60 mine workers will find employment in project construction, this represents an opportunity loss of 60 jobs, or an additional $415,000 in total earnings to the local economy. Thus, the net economic effect of the project for option 2 is the difference between the construction earnings ($7.3 million, from Table 2.3-2) and the lost mine employee and opportunity earnings ($1.04 million), or a net increase of $6.3 million in wages (compared to $7.3 million for the no mine shutdown option). There is also a possibility that the mine owner would have difficulty regaining profitable contracts for salt delivery after such a long absence from the market.

Morton officials estimate that 75 percent, or about 165, of their employees at Kleer live within 5 miles of the mine. Within the 5-mile radius of the mine, population is estimated to be about 4500, with about 1250 heads-of-households. If Morton were to shut down temporarily, as in option 2, the 110 local jobs lost (75 percent of 150) would affect 9 percent of the primary wage earners. Perhaps 45 of these would find work on the project construction crews.

Secondary effects will occur to the local economy as a result of the project because money spent locally by construction workers becomes income to others in the nonbasic employment (service) sectors. There is a potential for several hundred temporary induced jobs in the local area as a result of project construction. Should the mine be shut down temporarily, the opportunity for secondary jobs will be reduced by roughly 50 percent.

Housing

It is estimated that between 60 and 70 percent of the construction workers will be hired locally due to labor availability; the remainder should come from the Dallas-Fort Worth area (within 50 miles). Each of the major construction phases will require the importation of seasoned specialists, which at any time may compose 20 to 30 percent of the total work force; these would likely come from the Dallas-Fort Worth area. A small number of nonlocal employees may choose to rough it in site trailers or to take transient housing in the surrounding communities. However, most are expected to commute to the site during the construction period; therefore, there is expected to be negligible effect on local housing availability.

4.2.7.4 Economic Changes

The project will increase the construction employment in the regional and local area. The construction sector represented 8 percent (12,838) of the regional employment, and 12 percent (997) of local employment in 1970 (see section 3.9.1.5). Though most of the employees will likely reside within the local region (or within the region, e.g., Dallas-Fort Worth), the impacts on the regional industrial work force will be minor. The peak employment of 300 to 350 workers on the project would represent about 2.3 to 2.7 percent of regional construction employment.

The economic activity induced by the project will be centered in the Grand Saline area and will be manifested primarily in the retail and miscellaneous service sectors that will serve the project work force (see section 4.2.7.3, Income). From there it will be diffused throughout the region as the workers spend their earnings in their respective communities. The increase in retail trade will last as long as the construction work continues, after which economic activity in the Grand Saline area will return to about its pre-project level.

4.2.7.5 Government Sector

Because the construction work force is expected to commute from their present homes, no significant increase in demand for public services is anticipated as a result of project construction. In section 4.2.7.2 it was noted that the increase in commuter traffic to the project site may require additional surveillance during the commuting hours. However, no additional manpower is likely to be needed.

Due to the lag between assessment and the imposition of taxes, the counties involved (Van Zandt and Wood) will not likely receive any significant revenues from property taxes during the construction period. Even after completion of construction, however, Van Zandt and Wood Counties will receive property taxes on only the new mine facilities unless some assets within the storage facility are privately owned. In the interim period between Federal takeover and new mine development, one year's property taxes may be lost on the existing salt mine facilities, representing approximately 0.8 percent of Van Zandt County's tax revenues.

Grand Saline will benefit from the increase in sales tax revenues as a result of the portion of construction payroll that is spent in town during the construction period. Texas has no income tax. However, Federal taxes will increase in proportion to the additional income generated by the project ($7.3 million for option 1, $6.3 million for option 2).

4.2.7.6 Aesthetic and Cultural Impacts

The additional surface facilities that are needed for the new mine and for the storage program will detract somewhat from the visual quality of the rural landscape. These facilities will be adjacent to the existing mine facilities at the site, however.

Along the pipeline route, there will be a temporary disturbance to pasturelands and long-term effects on wooded land. Much of the pipeline route follows an existing pipeline corridor, which is already cleared of woody vegetation. Additional effects due to the project should not be significant.

The town of Grand Saline and any staging areas along the pipeline right-of-way will experience an increase in activity during the peak construction period of slightly over a year. The influx of working-age men in the area will alter the makeup of the population in and around the community. However, since most workers are likely to commute, the cultural impacts will be minor and limited to the daytime hours.

Should the Morton Mine be closed temporarily to expedite oil storage, the loss of jobs for local residents would adversely affect the social welfare of their families. Alternative employment may not be readily available in the area, though many of the workers would probably remain in the area until the mine reopens. Lifestyles would obviously be adversely affected during the intervening 40-week period, though unemployment compensation would partially mitigate both the economic and social effects.

TABLE 4.2-1 Estimate of sedimentation potential during construction

| Name of the Watershed | Length of the Pipeline in Watershed (feet) | Volume of the Disturbed Soil (acre-feet) | Estimated Volume of the Disturbed Soil Subject to Erosion-Sedimentation Process (acre-feet) | Steamflow Velocity (ft/sec) |
|---|---|---|---|---|
| 1. Grand Saline Creek | 37,700 | 22 | 4.4 | 0.88 |
| 2. Sabine River | 7,200 | 4 | 0.8 | 1.00 |
| 3. Cedar Lake | 6,00 | 3 | 0.6 | - |
| 4. Cottonwood Creek | 19,300 | 11 | 2.2 | 0.97 |
| 5. Alum Branch - Fork Reservoir | 20,000 | 11 | 2.2 | 0.37 |
| 6. Rainwater Creek - Fork Reservoir | 20,300 | 12 | 2.4 | 0.26 |
| Caney & Dry Creeks - Fork Reservoir | 2,000 | 1 | 0.2 | 0.26 |
| 7. Seary Branch - Taylor Branch - Bell Branch - Fork Reservoir | 15,300 | 9 | 1.8 | - |
| 8. Brushy Creek - Quitman Reservoir<br>Glade Branch - Quitman Reservoir<br>Dry Creek - Quitman Reservoir | 58,000 | 33 | 6.6 | 1.40 |
| 9. Briar Branch - Fork Reservoir | 16,000 | 9 | 1.8 | - |
| 10. Little Sandy Creek - Lake Winnsboro<br>Big Sandy Creek - Lake Winnsboro | 12,300 | 7 | 1.4 | 0.70 |
| 11. Wilcox Branch - Lake Cypress Spring<br>Big Cypress Cr. - Lake Cypress Spg.<br>Loon Creek - Lake Cypress Spring<br>Little Cypress Cr. - Lake Cypress Spg. | 28,700 | 16 | 3.3 | 0.70 |
| | | 138 | 27.7 | |

TABLE 4.2-2 Habitat and soil types impacted by pipeline route

| Location | Soil Association[a] | Habitat Type[b] | Distance (miles) | Acreage Temporary[c] | Acreage Permanent[d] |
|---|---|---|---|---|---|
| Terminals | | | | | |
| Kleer | Nahatche | Bottomland | - | 10-12 | 10-12 |
| Winnsboro | Woodtell-Freestone | Oak-savannah & Tame Pasture | - | 1-2 | 1-2 |
| | | TOTAL | - | 11-14 | 11-14 |
| Pipeline | Nahatche | Bottomland | 0.5 | 7.6 | 3.6 |
| | Gladewater | Bottomland | 3.5 | 53.0 | 25.4 |
| | Woodtell-Freestone | Oak-savannah & Tame Pasture | 25.5 | 386.3 | 185.4 |
| | Bernaldo-Kirby | Oak-savannah & Tame Pasture | 12.5 | 189.4 | 90.9 |
| | | TOTAL | 42.0 | 636.3 | 305.3 |

[a]Source: General soil maps of Van Zandt, Wood, Hopkins, and Franklin counties, USDA, SCS, Temple, Texas. Nahatche and Gladewater soils are clay loam and wet; Woodtell-Freestone and Bernaldo-Kirby soils are sandy clay loam.

[b]Habitat type normally associated with soil types in the absence of intensive land use disturbance.

[c]Based on initial clearing of 125-foot right-of-way for pipeline installation.

[d]Based on maintaining a 60-foot right-of-way all along pipeline route for maintenance access.

TABLE 4.2-3 Total emissions from site construction (in grams/hour) from the storage facility and pipeline construction

| Pollutant | Emission |
|---|---|
| Particulates | 3,000 gm/hr |
| CO | 34,000 gm/hr |
| Hydrocarbons | 4,500 gm/hr |
| $SO_2$ | 4,200 gm/hr |
| $NO_x$ | 56,000 gm/hr |

TABLE 4.2-4 Incremental increase in pollutant concentration 0.5 km downwind from site construction (source area: .25 km x .25 km)

| Pollutant | Federal and State Standards | ($\mu g/m^3$) | Calculated downwind concentration ($\mu gm/m^3$) |
|---|---|---|---|
| Particulate | Annual mean | 75 | 1.6 |
| | 24 hr max | 260 | 48 |
| CO | 8 hr max | 10,000 | 637 |
| | 1 hr max | 40,000 | 907 |
| HC | 3 hr max | 160 | 99 |
| $NO_2$ | Annual mean | 100 | 3 |
| $SO_2$ | Annual mean | 80 | 2.2 |
| | 24 hr max | 305 | 66 |

Note: Downwind concentration increases of durations greater than one hour were estimated by methods recommended by Turner (1969).

TABLE 4.2-5 Refrigeration system installation and operation equipment

| Equipment | Number | A-Weighted[1] Sound Level at 50 feet (per unit) | Sound Level at 500 feet | Usage Factor[b](1) |
|---|---|---|---|---|
| Installation | | | | |
| Drill | 2 | 98 | 78 | 0.04 |
| Operation | | | | |
| Reciprocating Compressor | 1 | a | a | 1.0 |
| Condenser | 1 | a | a | 1.0 |
| Suction Trap | 1 | a | a | 1.0 |

[a]Total indoor A-weighted sound level 89-102 dBA. Assumed attenuation of building -25 dB.

[b]Fraction of time equipment is operating at its noisiest mode.

(1)"Background Document for Proposed Portable Air Compressor Noise Emission Regulations," U.S. Environmental Protection Agency, EPA-550/90/9-74-016 (October 1974).

TABLE 4.2-6 Shaft excavation equipment

| Equipment | Number | A-Weighted[(1)] Sound Level at 50 feet (per unit) | Sound Level at 500 feet | Usage Factor[a(1)] |
|---|---|---|---|---|
| Ventilator Blower | 1 | 71[b] | 51 | 1.0[c] |
| Air Compressor | 3 | 81 | 61 | 1.0 |
| Truck | 2 | 88 | 68 | 0.16 |
| Mobile Crane | 1 | 83 | 63 | 0.16 |
| Concrete Trucks | 2 | 85 | 65 | 0.4 |
| Concrete Batch Plant | 1 | 83[b] | 63 | 1.0[c] |

[a]Fraction of time equipment is in its noisiest mode of operation.

[b]Dames & Moore files.

[c]Estimated.

(1)"Background Document for Proposed Portable Air Compressor Noise Emission Regulations," U.S. Environmental Protection Agency, EPA-550/90/9-74-016 (October 1974).

TABLE 4.2-7 Pipeline construction equipment

| Equipment | Number | A-Weighted[1] Sound Level at 50 feet (per unit) | Sound Level at 500 feet | Usage Factor[a(1)] |
|---|---|---|---|---|
| Truck | 2 | 88 | 68 | 0.16 |
| Backhoe | 1 | 85 | 65 | 0.4 |
| Welding Machine | 1 | 83[b] | 63 | 0.5[b] |
| Scraper | 1 | 88 | 68 | 0.08 |
| Crane | 3 | 83 | 63 | 0.16 |
| Air Compressor | 2 | 81 | 61 | 0.1[b] |
| Impact Hammer | 2 | 88 | 68 | 0.5 |
| Rock Drill | 2 | 98 | 78 | 0.02 |
| Loader | 1 | 84 | 64 | 0.3 |

[a]Fraction of time equipment is operating at its noisiest mode.

[b]Estimated.

(1)"Background Document for Proposed Portable Air Compressor Noise Emission Regulations," U.S. Environmental Protection Agency, EPA-550/90/9-74-016 (October 1974).

TABLE 4.2-8 Summary of sound level contribution from construction activities - estimated at 500 feet from center of activity (dB)

| Activity | Sound Level $L_{eq}$ | $L_d$ | $L_n$ |
|---|---|---|---|
| Installation of Refrigeration Pipes | 67 | 67 | 67 |
| Operation of Refrigeration System | 37 | 37 | 37 |
| Shaft Excavation | 69 | 69 | 69 |
| Pipeline Construction (through pasture lands) | 68 | 66 | - |
| Pipeline Construction (through rocky areas) | 72 | 70 | - |

TABLE 4.2-9 Ambient sound level during construction (dB)

| Distance from Site | Background Ambient | | | Construction Ambient 1[a] | | | Construction Ambient 2[b] | | |
|---|---|---|---|---|---|---|---|---|---|
| | $L_d$ | $L_n$ | $L_{dn}$[e] | $L_d$ | $L_n$ | $L_{dn}$[e] | $L_d$ | $L_n$ | $L_{dn}$[e] |
| Center of Site | 66 | 68 | 74 | 72 | 72 | 78 | 73 | 72 | 79 |
| Town of Grand Saline | 54 | 48 | 56 | 55 | 52 | 59 | 56 | 52 | 59 |
| Pasture Lands[c] | 45 | 35 | 45 | 49 | 35 | 48 | 51 | 35 | 50 |
| Nearby Villages[d] | 49 | 39 | 49 | 50 | 39 | 50 | 50 | 39 | 50 |

[a] Construction of pipeline with conventional methods.

[b] Construction of pipeline through rocky areas.

[c] Estimated at 1 mile from pipeline route at a distance from mine site.

[d] Estimated at the Village of Golden.

[e] $L_{dn}$ values include 10dB penalty for nighttime activities.

## 4.3 ENVIRONMENTAL IMPACTS OF OPERATION AND OIL STORAGE

### 4.3.1 Impacts on Geology and Mineral Resources

The Kleer Salt Mine is owned and operated by Morton Salt Company. Following conversion to an oil storage facility, salt mine operations will continue in a new location adjacent to the existing facilities (section 2.4) at the same level of production and with the same basic methods of operation.

#### 4.3.1.1 Mineral Resources

The storage of oil in existing caverns is a well-established technology as evidenced by the historical safe operation of cavern storage of gaseous and liquid petroleum in Europe, Scandinavia, and the United States. The present mine has no known faults or significant leakage into the cavern and, due to the impermeable nature of the salt and the pressures of ground water surrounding the dome, the probability that oil will seep out of the storage cavern is extremely low. Some minor loss of the mineral salt resource will occur due to the absorption of the oil onto the walls, roof, and floor of the cavern (see section 7.4). For similar reasons, some loss of recoverable oil will occur. In a mixed state, these resources will not be useful for the present market. However, if and when the market values of the salt and/or oil reach levels making recovery of these resources attractive, techniques such as solution mining and distillation processes could be used to separate the oil from the salt and make both of these resources available for use.

As incorporated in the development plan (section 2.4) salt mining will be continued at a new mine without interruption (option 1), or within about 40 weeks of operations in the existing mine (option 2). Based on current production rates, Morton's minable resources at the minus 300-foot level are ample for more than the life of the oil storage project. Because of possible regulatory restrictions, mining may not be possible at levels beneath the storage space until it is no longer used for oil storage. However, after that time, there is nothing to deter deeper mining. Therefore, although the reserves below the present workings will be temporarily unavailable, no permanent impact or other irreversible effect on salt resources or mining is anticipated.

#### 4.3.1.2 Seismic Stability

The site is located in an area with no reasonable expectancy of earthquake damage (section 3.2). The mine will be designed to resist fluid overpressure that may result from seismic acceleration. The room and pillar development pattern will act as an extensive baffle system to resist the movement of fluid due to horizontal shaking. This nonintentional design feature and the negligible level of seismic activity anticipated for the region indicate that no impact can be expected from seismic activity.

#### 4.3.1.3 Structural Stability

The cavern appears to be stable and does not show any indication of pillar distress. The lithostatic pressure exceeds 500 psi. The salt pillars carry a load of roughly 850 psi, based on a typical recovery factor of 40 percent. This is well below the crushing strength for this type of rock. Any secondary fracturing that may have been caused by blasting or mine production work is probably shallow and would not account for a significant strength reduction in the pillar rock mass.

Internal mine pressures that could affect cavern stability might occur in the event of a large underground explosion. Oil explosion maximum overpressures are estimated at 10 atmospheres, or 150 psi (Macreagh, 1976). Most of the mine is developed below approximately 600 feet of overburden and carries an approximate overburden (lithostatic) pressure of more than 500 psi. An explosion-related overpressure would not exceed the lithostatic pressure in any portion of the existing mine and, therefore, would not be of sufficient strength or duration to damage the mine roof.

### 4.3.2 Hydrology

#### 4.3.2.1 Impacts on Surface Water

Water requirements of the existing mine facilities are primarily for sanitary purposes, drinking, mining, and fire prevention. These waters are presently supplied from a single local well, drawn from a deep ground water aquifer. Water requirements for the new mine (and to supply the negligible requirements of the storage facility) will be similarly supplied, without impact on surface waters.'

Cavern Storage

During operations of the oil storage program, which will include both initial filling of the cavern with oil and future withdrawal of the oil during a national emergency (estimated to occur once every 5 years), impacts to the surface water and on water use will be minimal. Domestic water required will be taken from the existing well or from a new well drilled at the mine site.

Since no water will be introduced into the cavern, either purposely or accidentally (see also section 4.3.2.2), any impacts will be limited to the possible effects of accidental oil spills at the surface, described in detail in section 4.3.8.

Surface Facilities (and Pipelines)

There is expected to be no discharge of wastes to surface waters at the terminal or along the pipeline route. The major potential impact to the surface water is from the possibility of small or large oil spills at the surface, as discussed in detail in section 4.3.8.

Flooding

In section 3.3.1.5, the 100-year return flood level at Grand Saline is predicted to be no greater than 365 feet MSL. The major surface facilities including the shaft collar and surface metering equipment, are located at elevation 390 feet MSL and will be unaffected by any conceivable storm water level. Pipelines will be subject to inundation in flood plain areas, but as they will be buried to an acceptable depth below the surface and above the normal water table, there will be no interaction with the environment during operation.

4.3.2.2 Impacts on Ground Water

New Salt Mine

Operating the new mine will have negligible impacts on the ground water. Ground water use at the existing mine is small and will not be altered at the newly constructed site.

Cavern Storage

Despite a hydrostatic head on the caprock of up to 200 feet, the mine workings are dry, illustrating the virtual impermeability of the salt. The mine and its shafts presently compose a hydrologically closed system, unconnected to the local or regional ground water regime. Therefore, any future effects of oil storage on ground water will require an alteration of existing conditions.

The following paragraphs evaluate the various plausible alterations. In summary, the only realistic situation recognized as a possible impact on ground water would involve shaft collapse and associated rupture of intake and discharge pipes. However, this hazard would be small and can be mitigated by filling the sump to the level of the pipes with water, thereby creating a water seal.

As described in section 4.2, none of the modifications to the mine interrelate with the ground water system. Furthermore, the absence of water inflow makes disposal of untreated oil-polluted water that indirectly could affect ground water unnecessary. No situations are perceived which involve purposeful pumpage of waste oil or untreated polluted water from the workings to the ground water system during storage. Therefore, any potential impact would involve a loss of the integrity of the mine and/or its appurtenant structures resulting in an accidental outward migration of oil. Such migration requires both a driving force and a passageway. Potential driving forces consist of either buoyant uplift by insurgent ground water or pressures induced by decreased available volume or oil vaporization. Decreased volume could possibly result from temporary overpressures from barometric fluctuations, tidal gravimetric changes, earthquake-generated seismic pulses, long-term plastic mine closure, or intrusion by water or gas. These possible volume changes will be accounted for in establishing the size of the unfilled space in the workings. (If improperly accounted for, seals could be broken and oil pushed up the pump shaft, possibly reaching the surface, depending on the amount of volume change. No catastrophic loss would be expected.) Vapor pressures in the cavity over the stored oil will be monitored and should not exceed 1.5 atmospheres, since vapors will be flared during cavern filling. The existing hydrostatic pressure and the impermeability of the salt rock will thus prevent release of vapors from the cavern into surrounding aquifers. Therefore, the remaining possible significant driving forces are water and gas inflows.

Mining and other past explorations at Grand Saline indicate that significant amounts of water and gas are absent within the salt plug. Therefore, the only passageways that appear pertinent to water and gas influx are those that extend beyond the boundaries of the salt. Potential man-made avenues include shafts, other intake and discharge pipes, and oil and gas wells. Other potential passageways that have been considered are fractures created by accidental explosion, faults reactivated by earthquakes, and a possible upward growth of a rubble chimney that could result from mine collapse.

All wells in the vicinity of the mine are separated from the oil storage space by several thousands of feet (Figure 2.2-1). The brine wells have known dimensions and do not pose any potential threat to the storage facility.

The cavern geometry, past mine experience, and the present stability of the mine indicate that massive collapse which could cause a rubble chimney is virtually impossible. The ratio of working heights to pillar spacings indicate that any substantial collapse would arch a short distance above the present roof. This distance would be approximately that of the working widths, or about 50 to 70 feet at most. Such a collapse height is of little significance compared to the hundreds of feet of impermeable salt that exist above any possible collapse. Consequently, any conceivable roof collapse could not result in a passageway for oil to migrate from the dome to the surface or to ground water aquifers.

The latest known subsidence related to the salt dome occurred on April 20, 1976, about 1 mile north-northwest of the site. The subsided area was very small and was the result of overmining by brine wells. There was no relationship to the present underground caverns.

There is no likelihood of significant explosion-induced fracturing. As mentioned in section 4.3.8, the possibility of an underground explosion is very remote. That discussion further shows that, should an explosion occur, its maximum overpressure would be no greater than 150 psi or about 30 percent of the lithostatic pressure on the storage space. Because of the very low flame velocities associated with oil explosions, the high relative confining pressures of the rock column are sufficient to preclude cavern expansion and associated fracturing. Inflow from reactivated faults is also not a consideration at Kleer Mine, simply because of the absence of such faults in any of the workings.

Therefore, the only passageways recognized as potentially pertinent to water or gas inflows are intake, discharge, and vent lines in the shafts, and the shafts themselves. Since no evidence of the presence of significant amounts of gas is known in the sediments above the salt in the vicinity of the shaft, potential impacts are reduced to those involving water inflows within the shaft and its appurtenant structures.

Potential sources for water inflows through the shaft are twofold: either from the surface, in the form of flood water, or from prolific ground water, which could result from shaft failure. The first possibility is prevented by the presence of the collar seal and shaft plug, shown as a construction modification on Figure 2.2-3, and by the elevation of the shaft opening and lack of surface flooding potential (section 3.3). The sole remaining potential impact, then, involves shaft collapse or leakage in the soft saturated strata above the salt, where the amounts of water inflow could likely be quite voluminous, probably enough to entirely fill the shaft in a few hours. If, in turn, the pipes through the shaft plug are broken at or above the plug, then water in the shaft would be free to mingle with any oil in the ruptured pipes, and sink into the mine, allowing upward migration of oil into the flooded shaft. However, once enough water enters the cavern to fill the sump up to the bottom of the pipes, no more oil can escape from storage. Therefore, the total amount of oil escaping the caverns would be that displaced by the few tens of barrels of water required to partly fill the sump.

Once in the shaft, the oil lacks a driving force to migrate any further. The water level in the shaft would rise to the local piezometric surface, about 15 or 20 feet below the shaft collar, and thus would not impose a surface oil spill hazard. The worst result would be minor local oil intrusion into aquifers that may be bared by shaft lining failures. Once the shaft water reaches the piezometric surface, the hydrostatic heads of both the aquifer and the shaft will be equal and the water flow from such an aquifer will cease to drive the oil/water mix upward in the shaft.

Should the above situation occur, the escaping oil would rise to the top of the water in the shaft and could be recovered. If, for some reason, the oil in the shaft is forced into the surrounding sediments, the impact would be minimal, and could be quickly corrected because of the low hydraulic conductivity of all materials except the salt water-bearing caprock.

Pipeline and Surface Facility Operation

As described in section 4.3.8, the possibilities of a large surface oil spill are remote. Furthermore, the effects of such spills on ground water are considered to be even more remote. If they were to occur, the effects would be restricted to the locale of the spill, in part because of the low permeabilities of most of the materials in which the pipeline will be built. Sufficient amounts of very low permeability materials are readily available to line the pipeline trench in areas where higher permeabilities exist. Furthermore, because of its density, oil of any uncontrolled spill at the surface could percolate no deeper than the water table or to some higher impervious layer. Although lateral migration could then occur, the ground water regime would remain unaffected.

Waste Water Discharge

There will be no significant discharge of waste to the ground water. Sanitary wastes from the operating personnel will be routed to a septic tank system or to a portable chemical treatment facility.

### 4.3.3 Impacts on Air Quality

The Texas State Implementation Plan has not yet been developed to detail projected levels of air quality by region, but the primary standards are expected to be met by the end of 1976 in all areas except the coastal regions of southeast Texas, as discussed below. In many regions, the secondary standards will also be met. From 1973 data, the existing air quality in the vicinity of the storage site can be summarized as good (Section 3.4.3).

#### 4.3.3.1 Leakage from System Piping and Flaring of Gases Displaced from the Storage Cavern

Operation of the oil storage facility will affect local air quality due to flaring and leakage of the oil during filling and withdrawal activities. Some small vapor leakage may occur from the system of pipes, manifolds, and valves during the filling and withdrawal of the oil. Leakage of this kind will be tightly controlled and will be of small consequence. Odors which may result from these small spills will not be noticeable except in the immediate vicinity of the leaked gases or oil. In addition to reducing the potential for explosion, flaring will also reduce odors emanating from the caverns by converting the hydrogen sulfide gases into odorless sulfur dioxide (see Appendix E).

Preliminary estimates of leakage and flaring from the mine have been determined and are presented in Appendix E. For a fill rate of 50,000 barrels per day, hydrocarbons in the amount of 75 pounds per day (lbs/day) (0.40 grams per second) and hydrogen sulfide in amounts of 0.075 lbs/day (0.0004 gm/sec) are expected to be lost from leakage. Twenty-six lbs/day (0.135 gm/sec) of $H_2S$ would be emitted from an unflared cavern, and 50 lbs/day (0.27 gm/sec) of $SO_2$ will result from flaring the displaced hydrogen sulfide vapors.

Concentration estimates were made of resulting downwind vapors under the assumption that flaring of vapors will be emitted at a height of 20 meters and pump leakage will be released at ground level. The concentration estimates were made using methods recommended by the U.S. Environmental Protection Agency (Turner, 1969). These estimates are very conservative in that they assume a ground level concentration under "F" stability (stable) conditions and a wind speed of 2.0 meters per second. In addition, no allowance was made for wind variability.

Figures 4.3-1 through 4.3-3 show the estimated downwind concentrations for an assumed fill rate of 50,000 bbls/day of oil. The concentrations of $SO_2$ on Figure 4.3-1 assume 0.27 gm/sec of emissions from flaring. The highest ground-level concentration of $SO_2$ is 4.2 micrograms per cubic meter ($\mu g/m^3$), which is well below the 3-hour concentration (365 $\mu g/m^3$) and the annual (80 $\mu g/m^3$) standards. The concentrations of hydrocarbons at Kleer (lower curve, Figure 4.3-2) result from pipe system leakage; therefore, a ground release mode was assumed. The highest concentration of hydrocarbons at ground level is 194 $\mu g/m^3$ at a distance of 300 meters downwind of the site, which is slightly above the 3-hour primary air quality standard of 160 $\mu g/m^3$ (Figure 4.3-2). The $H_2S$ concentration on Figure 4.3-3 would result from the filling of the mine without flaring of displaced vapor. The maximum concentration of $H_2S$ that could be realized even if the vented gases were not flared, is 3.6 $\mu g/m^3$ one km downwind from the site; there are no state standards for $H_2S$ in Texas. State air quality standards are given in Table 3.4-7.

4.3.3.2 Hydrocarbon Vapor Emitted During Oil Transport

Another source of air pollutants associated with the proposed oil storage facility is hydrocarbon vapors emitted during transportation of the oil to and from the storage cavern. Principal locations of vapor emissions are the following: (1) VLCC - tanker transfer station in Gulf of Mexico south of Sabine Lake; (2) tanker transport of oil up the Neches River to Nederland, Texas; (3) transfer of oil from tankers to surface storage tanks at Nederland; (4) temporary storage of oil at Winnsboro Terminal (Figure 2.3-8). Estimates of total emissions, emission rates, and atmospheric concentrations of hydrocarbons are provided in this section; further details on calculation methods are provided in Appendix E.

Hydrocarbon emissions are summarized in Table 4.3-1 for the principal sources. The major emissions occur near the coast as a result of tanker transfer activities. These would occur for very brief periods only during fill operations. Using a sector spread model for atmosphere dispersion (Appendix E), with stable ("F" stability) air, the ground-level concentration of hydrocarbons would exceed 160 $\mu g/m^3$ (primary 3-hour standard) as far as 10.3 miles from the Gulf of Mexico VLCC transfer point and up to 7.8 miles from the Nederland, Texas tank terminal (Figure 4.3-4).

Transport of oil by pipeline involves negligible hydrocarbon losses. However, surface storage tanks will emit hydrocarbons through venting of fixed roof tanks or as leakage past the annular seal around the perimeter of floating roof tanks. For example, using the API formula for standing storage losses from floating roof tanks (EPA, 1976) and assuming crude oil with a true vapor pressure of 2 psia (section 2.3) and an 8 mi/hour average wind speed, two 130-foot diameter floating roof storage tanks would emit a total daily loss of approximately 85 pounds of hydrocarbons to the atmosphere during periods of oil storage in the tanks. Atmospheric concentrations in the vicinity of the tank farms would exceed 160 $\mu g/m^3$ (.24 ppm) no further than 0.5 miles downwind (Table 4.3-1 and Figure 4.3-4). Emissions would be attributable to the Kleer Mine project only for brief periods during each fill at Nederland. However, at Winnsboro emissions would occur for approximately 600 days during each cavern fill (at 50,000 barrels/day fill rate) and for 150 days during each withdrawal. Total hydrocarbon emissions during the project lifetime (5 fill/withdrawal cycles) are estimated to be 7550 tons (50,190 barrels of oil equivalent) during fill and 32 tons (213-barrel equivalent) during withdrawal, assuming the tanks contain oil throughout the transfer operations and disregarding distribution of oil (presently undetermined) to refinery centers during withdrawal.

4.3.3.3 Effects on Ambient Air Quality

The potential for adverse project impacts on ambient air quality due to the Kleer Mine SPR project appears to be greatest in Orange and Jefferson Counties, Texas because of the emission of substantial quantities of hydrocarbon vapors during marine transport and handling of crude oil. The air pollutants which could be most affected are non-methane hydrocarbons and ozone.

Recent data are available to document ambient concentrations of hydrocarbons and ozone in the near vicinity of expected project emissions (Butts, 1976). At Nederland, Texas (Jefferson County), during the period from January through September, 1976, concentrations of non-methane hydrocarbons exceeded the 3-hour primary national standard of 160 $\mu g/m^3$ (.24 ppm) a total of 136 times; ozone concentrations exceeded the 1-hour primary standard of 0.08 ppm 286 times. The highest concentration of hydrocarbons was measured at 5.50 ppm; mean was 0.017 ppm. High concentration of ozone was 0.209 ppm; mean was 0.033 ppm.

At West Orange, Texas (less than 15 miles northeast of Nederland), comparable measurements for hydrocarbons for the first 6 months of 1976 revealed standards violations 89 times, a high level of 1.20 ppm, and a mean of 0.28 ppm. One year's data at West Orange for ozone indicated a high of 0.166 ppm and a mean of 0.30 ppm.

These data indicate a consistent occurrence of very high concentrations of non-methane hydrocarbons and photochemical oxidants in southeast Texas (Table 3.4-10). It should be noted, however, that even in rural areas and in the Gulf of Mexico up to 100 miles offshore, background levels of both oxidants and non-methane hydrocarbons have been measured in excess of national ambient air quality standards (U.S. Department of Transportation, 1976). Because the national standard for photochemical oxidants has not been achieved, southeast Texas is considered a non-attainment area for oxidants. As indicated in Section 4.3.3.2, locally high rates of hydrocarbons will be emitted from tankers along the Texas coast. The 3-hour standard of 160 $\mu g/m^3$ may be exceeded as far as 10.3 miles downwind in the nearshore Gulf waters and as far as 7.8 miles at Nederland (disregarding ambient levels). Total annual emissions may be as high as 1480 tons.

Much of the hydrocarbon vapors emitted from the tankers will be methane or ethane, generally non-reactive fractions. Also, the emissions will occur only intermittently over a period of 600 days; emissions would occur on about 50 days during each cavern fill operation. However, local levels of hydrocarbon concentrations may be adversely affected by the project, at least temporarily, and may cause adverse regional impacts to photochemical oxidant concentrations.

Atmospheric emissions along the Texoma pipeline route are limited to the terminal at Winnsboro. The quantities to be released are quite small (Table 4.3-1). Disregarding ambient levels (no ambient air quality data is available), hydrocarbon concentrations due to the project would exceed NAAQS no further than 0.25 miles downwind. These emissions would occur for a period of 600 days per fill period. At the storage site, all significant vapor emissions will be flared.

Thus, there is a potential for significantly increased hydrocarbon and photochemical oxidant concentrations in coastal Texas as a result of the project. The effect would be short-term and intermittent. Levels of $SO_2$, $H_2S$, and particulates should not be significantly affected.

Neither vapor emissions from crude oil storage nor vapor emissions from ship loading and unloading activities are regulated at this time, but an interim strategy to attain the National Ambient Air Quality Standard (NAAQS) for photochemical oxidants by controlling reactive hydrocarbon emissions has recently been proposed by EPA for the Texas State Implementation Plan (SIP)*. Controls have been proposed for previously exempt crude oil emissions from storage tanks. Regulation of crude oil emissions from vessel loading and unloading is not anticipated at this time.

Floating roof storage/surge tanks are specified for the Kleer Mine site, and are considered by EPA to be the best available control technology. The technology for vapor control and recovery systems for marine terminal crude oil transfer operations has been developed, but there has been relatively little application of it. Since the SIP does not require such systems to be employed, the feasibility design upon which this EIS is based does not include them. This was done so that the document would reflect a worst case analysis of the impacts. However, the working designs for the facilities are still being formulated, and inclusion of a vapor recovery system for marine terminal operations is being considered.

Another requirement for SIPs to meet the NAAQS is new source review. The most recent ruling from EPA regarding new source review has established the trade-off system**. Under this proposed provision, new source plus SIP-required reductions from existing sources equal a net decrease in emissions. That is, the new source should not delay progress toward achieving the NAAQS in nonattainment AQCRs. The effects, if any, of this ruling on the SPR program remain uncertain at this time.

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*"Proposed EPA Revision to the Texas State Implementation Plan," Environmental Reporter, Current Developments, Volume 7, Number 29, November 19, 1976, pp 1065-1083.

**"EPA Draft Preamble to Interpretive Ruling on New Source Review Requirements," Environmental Reporter, Current Developments, Volume 7, Number 29, November 10, 1976, pp 1091-1094.

### 4.3.4 Acoustical Levels

#### 4.3.4.1 Operation Sound Sources

The major sound sources during the operation of the oil storage facility will be material handling equipment such as pumps for filling and emptying the storage facility. These pumps will be mounted on the surface and driven by electric motors. Continuous filling and withdrawal will occur for periods of 20 and 5 months, respectively, for each oil supply interruption.

Operation sound levels from facilities described above are estimated from measurements at a similar facility in New York State. This facility is a liquefied propane gas storage facility with similar material handling and processing equipment, the major differences being the use of dehydrators and use of trucks for transportation. The equivalent sound level contribution from the operation of the proposed facility is estimated to be 55 dB at 500 feet from the center of activity.

Oil will be transported by pipeline to and from the Winnsboro Terminal. It is anticipated that there will not be any noise generating activity along the route of the proposed pipeline. At the Winnsboro Terminal, where the proposed pipeline connects with the Texoma pipeline, the only noise generating operation will be from a pumping facility. It is estimated that the equivalent sound level, $L_{eq}$, contribution from the operation of the pumping station will be less than 55 dB at 500 feet.

#### 4.3.4.2 Ambient Sound Levels During Operation

Major activities during the operation of the proposed project will be during the filling and emptying of the storage facility. Continuous filling and emptying will occur for periods of 20 and 5 months, respectively (for the minimum fill rate of 50,000 barrels per day and design withdrawal rate of 200,000 barrels per day). The facility is expected to be used for emergency oil distribution an average of once every 5 years. (Shelf life of oil at Kleer Mine is expected to be unlimited by physical or chemical changes in the oil properties.) Thus, noise associated with oil transfer and handling will be generated for a maximum of 25 months every 5 years.

Operation noise levels are estimated from measurements at a liquified propane gas storage plant in New York State with similar equipment. It is estimated that the equivalent sound level contribution from the operation of the proposed facility to the ambient sound level is 55 dB at 500 feet. This contribution is at least 11 dB lower than the existing background ambient sound level on the site and will therefore not increase ambient sound levels.

No noise-generating activity is anticipated along the route of the proposed pipeline. At Winnsboro Terminal, where the proposed pipeline connects with the Texoma pipeline, the only noise-generating equipment will be a pumping facility. It is estimated that the equivalent sound level ($L_{eq}$) contribution from the operation of the pumping station will be less than 55 dB at 500 feet; this is expected to be no higher than present noise levels at the terminal.

Along the oil transportation route between the Gulf of Mexico and Winnsboro Terminal, no new noise-producing activities will be initiated; however, there will be a greater frequency of these activities as the volume rate of oil movement is increased. The most obvious increase will be tanker movements through Sabine Lake and the lower Neches River. A total of 143 tanker round trips between the Gulf of Mexico and Nederland, Texas will be required within a period of about 600 days to provide oil to fill Kleer Mine. This is a moderate increase in traffic level and represents a minor effect on noise level along the river. Some additional activity would be required at the Neches River tanker docks and at the Nederland tank farm connecting to the Texoma Pipeline system. However, noise levels associated with these activities would be no greater than for normal operations and would not be a significant alteration to the existing industrial environment.

#### 4.3.4.3 Acoustical Impact During Operation

As discussed in the previous section, the proposed facility operation will not increase the existing ambient sound levels at Kleer Mine or at Winnsboro Terminal. Thus, it is anticipated that there will be no noise impact as a result of the proposed activity.

### 4.3.5 Ecological Impacts of Operation

Because of the nature of the proposed facilities and the minimal surface operations involved, project operations will have no significant effect on local or regional ecosystems, except as a result of any possible oil spill releases and maintenance clearing of woody vegetative growth from the 300-acre permanent pipeline corridor (approximately 60 feet wide). Impacts associated with possible oil spills are described in Section 4.3.8.

Clearing of pipeline corridor vegetation will be by mechanical removal of woody growth, including shrubs. No herbicide or other chemical treatment is anticipated. Soil disturbance will be minimal. The corridor vegetation will thus be periodically harvested and wildlife habitat stressed. Debris will be piled to one side as in initial construction. As herbaceous growth will be left in place, there should be only a minimal increase in erosion and stream sedimentation as a result of this activity. Particular care will be taken on side slopes and in flood plains to leave the ground cover and soil layer intact.

In addition, it should be noted that approximately half of the pipeline corridor follows the existing Mobil 20-inch pipeline route, which is already undergoing continual clearing of woody growth. Thus, only about 150 acres of additional maintenance clearing will be caused by the proposed project.

### 4.3.6 Historical/Archaeological Resources

There will be no impact on historical or archaeological resources as a result of project operations.

### 4.3.7 Impacts on Socioeconomic Environment

The operational phase of the facility will include filling and withdrawal of crude oil, as necessary, and maintenance of operational readiness during storage. During most of the operational life of the project, the oil storage facility will be relatively inactive. Only two or three permanent employees will be needed to monitor equipment and provide general security at the site. Mining operations will continue unaffected.

At approximate 5-year intervals, the oil in the caverns is assumed to be withdrawn under emergency conditions. As soon thereafter as is feasible, the cavern will be refilled with oil. Withdrawal will take approximately 5 months and a total work force of 8 to 10 people. Refill operations will take approximately 20 months (at 50,000 barrels per day) and will also employ 8 to 10 people. Most of the transfer personnel can be drawn from the local work force. Perhaps three supervisory-level personnel will be required from outside the local area. (Dallas-Ft. Worth is a likely source for these people.)

4.3.7.1 Land Use

The only impact on land use due to project operation will be the restriction on industrial and residential development along the pipeline route in order to maintain an easement. Access to the site will be controlled by FEA, and salt production from the storage caverns will be prevented for the length of the project.

4.3.7.2 Transportation

Transportation for the few project employees will be insignificant. Oil withdrawal and refilling will be accomplished through a dedicated pipeline and the Texoma pipeline. The stored oil will only be used when foreign oil is unavailable, so it will not interfere with the transport of other oil.

Movement of crude oil between the Gulf of Mexico and Winnsboro Terminal will utilize existing capacity in the nation's oil transportation systems. There is some uncertainty, however, whether sufficient numbers of tankers will be available to move the oil, given possible simultaneous demands to fill other oil storage systems as well as service existing markets. There is a possibility that tanker rates, including world-scale VLCC rates, could be affected by a significant short-term increase in demand (other factors may be of greater significance, however). Utilization of deepwater port facilities (LOOP and Seadock) and VLCC lightering in the Gulf of Mexico may alleviate some of the problem (see Section 8.3.4).

Distribution of oil to refinery and market centers during a period of oil supply interruption should not be a problem. The Texoma Pipeline system carries predominantly foreign crude oil and should have the capacity to withdraw the oil at necessary rates.

4.3.7.3 Population, Employment, and Housing

Due to the small size of the operational work force, the project should have no significant effect on population size, occupational makeup, disposable income, or housing availability in the local area.

4.3.7.4 Economics

Since a replacement mine is planned at Kleer Mine, the economic effects of project operations on the area will be minimal.

At a maximum, the oil storage facility will generate only $100,000 income per year. The facility will not require extensive servicing by private or public operations. Electrical requirements will increase during pumping phases. These requirements, however, will be relatively small. Impacts on the economic base in Van Zandt County will be minimal, and a very small amount of new local secondary employment will result. This new employment is a beneficial, but not significant, impact to the local area.

The increased demand for oil tankers and pipeline transportation of oil during the periods of cavern fill and withdrawal will have a positive effect on certain sectors of the economy. Most of the benefits would accrue to owners of oil tankers and pipeline systems and to shipyard workers and material suppliers.

4.3.7.5 Government Sector

Project operation will not require any additional public services and will not generate any indirect demand for those services. During operation, however, the counties affected (Van Zandt and Wood) may accrue ad valorem taxes from the project (depending on facility ownership status). Of the total estimated ad valorem taxes ($174,000 annually), Van Zandt County could receive approximately $122,000 annually, and Wood County (through which the pipeline runs) could receive approximately $52,000 annually. This would be a minor benefit to the counties because tax revenues are considerably larger (Van Zandt County revenue from principal taxpayers alone was more than $44 million in 1974).

Since mining will continue during operation of the oil storage facility, no loss of tax revenues to the county/city or state will occur. Very minor additional federal income tax would accrue as a result of project operation.

### 4.3.7.6 Aesthetic and Cultural Impacts

The additional site facilities, the underground pipeline and corridor, and the terminal facilities will have only a minor degrading effect on the scenic features of the area since they are being added to a much larger mine facility, an existing pipeline network, and an existing terminal facility. Much of them may be screened by vegetation. The pump station and above-ground piping will be relatively low-profile, although the site will probably be surrounded by a high fence for security reasons. Flaring may be visible in the immediate area, including nearby residences, especially at night. Storage tanks at Winnsboro Terminal will be located adjacent to an existing tank.

Normal operation of the oil storage facility will have no adverse impact upon aesthetic features in the area. If an oil spill should occur, local areas of up to a few acres could be affected. Cleanup and recovery of the oil would remove most of the obvious effects (Appendix G); full recovery could take several months or even a few years, depending on the type of land affected.

### 4.3.8 Oil Spills and Related Risks

The major risks from oil spills that may be attributed to the storage of oil in Kleer Mine are due to the possibility of accidental oil discharge into the surrounding land areas and watersheds (particularly coastal marshes, any of several river-reservoir systems, and the Grand Saline salt marsh). This risk begins with the transport of oil from the Gulf of Mexico 95 miles up the Neches River by tanker to Nederland, Texas. From Nederland, oil would be carried through the 26-inch diameter Texoma pipeline 225 miles north to Winnsboro, Texas (Figure 2.3-8). From Winnsboro, a 42-mile long pipeline is proposed to connect with Kleer Mine.

Oil spill risk can be attributed to several operational modes, including pipeline transport, terminal operations, and cavern storage. Oil would be transported between the Gulf and Winnsboro only during fill operations. Transport operation between Winnsboro and Kleer Mine is considered for both fill and withdrawal. Allocation of oil from Winnsboro during an oil supply interruption has not been determined as yet, and, consequently, no oil spill analysis is presented.

The following sections describe in detail these potential sources, together with locations, expected volumes, and frequencies of oil release into the environment associated with the Kleer Mine oil storage project. Further details concerning the methodology of projecting oil spills from the pipeline and the transfer points at Grand Saline and Winnsboro are provided in Appendix G. The elements of an Oil Spill Prevention, Control and Countermeasure Plan (SPCC) are outlined in Appendix H.

4.3.8.1 Pipeline Transport

The data base for projecting pipeline oil spills is the 1968-73 record of the Office of Pipeline Safety, U.S. Department of Transportation. The projection of risk is based upon exposures of time and pipeline length. The applicable spill parameter appropriate for new U.S. lines has been estimated at $50 \times 10^{-5}$ events per mile per year, or 0.5 events per year per 1000 miles (Appendix G).

The 42-mile pipeline route between Grand Saline and the Winnsboro Terminal crosses open, very gently rolling country (Figure 3.2-2). The route deviates from a straight line path to avoid crossing existing and planned reservoirs that provide flood control and irrigation water for the region. About half the proposed route follows the right-of-way of an existing 20-inch Mobil pipeline.

During standby operation of the oil storage facility, the pipeline could be operated in 2 modes: 1) it could be left completely full of oil; or 2) it could be purged with an innocuous fluid. If the Kleer pipeline were kept full of oil during the standby or storage period, the line would always have a potential for accidental oil release during this time. The frequency of a spill in this continuous mode is projected to be 0.46 events, or 1 chance in 2 of having a spill over the 22-year (1978 to 2000) life of the project. Based on the average U.S. pipeline spill size of 1083 barrels, the total spill expectation for Kleer Mine in this mode would be 498 barrels over the life of the project. The following probabilities of spills would apply:

None in 22 years: 62.7 percent
One in 22 years: 29.6 percent
Two or more: 1.7 percent

Alternatively, the pipeline could be flushed with an innocuous fluid during standby periods. In this mode the pipeline is full of oil only during operation. Assuming a 50,000 BPD fill rate for the cavern (probably minimum rate for most of the fill cycles), a withdrawal period of 150 days, and 5 full cycles of use (10.3 years total pipeline use), the number of spills in the life of the project would be 0.22 (1 chance in 4.5), and the total spill volume expectation would be 238 barrels. The spill probabilities for this mode are:

None in 22 years: 80.4 percent
One in 22 years: 17.8 percent
Two or more: 1.8 percent

Although the risk of oil release is somewhat greater if oil is left in the pipeline during standby storage, there are other important factors to examine when considering use of an innocuous fluid. Approximately 120,000 barrels of water would be required to fill the line with water during each standby period. Biodegradable rust inhibitors would have to be added to the water to prevent pipeline corrosion. Oily residues in the lines would have to be flushed into the environment prior to system operation, requiring oily water separators, holding ponds, and other equipment. Because of the inherent simplicity of a pipeline system which is left full of oil during standby operation, standard industry practice is to flush a pipeline of oil only when an unusually high risk exists (such as hurricane flood exposure to aboveground lines).

Because of the relatively small risk of total oil spillage under either option, the pipeline will be designed to remain full of oil throughout the life of the storage facility. The maximum credible spill for a closely supervised spur pipeline connecting Kleer Mine with Winnsboro Terminal is estimated to be about 5000 barrels, based on various combined static and pumping losses (see Appendix G).

The Texoma Pipeline will be subject to additional spill risk exposure as a result of pumping crude oil to Kleer Mine. The approximate distance between Nederland and Winnsboro, through the Texoma Pipeline, is 225 miles. Pumping 30 million barrels of oil to Kleer Mine represents approximately 75 days of capacity for Texoma. At 50 X $10^{-5}$ spills per mile per year and a 1083-barrel spill average, the expected pipeline spill risk per fill is 25 barrels with an expectation of 0.023 spills. Total expected spillage for 5 fill operations is 125 barrels (Table 4.3-2), with a frequency of 0.115 events (1 chance in 9 of a spill occurring).

Because of the greater line size and pumping rates, the maximum credible spill from the Texoma Pipeline is estimated to be 10,000 barrels. The expected probability distribution of spill sizes is given in Table 4.3-3. Thus, only 10.2 percent of all spills from Texoma (a total of 0.0117 during the lifetime of the project) are expected to exceed 2,000 barrels.

4.3.8.2 Oil Spill Risk from Gulf of Mexico and Neches River Transport Operations

Movement of oil to the Texoma Terminal at Nederland, Texas might occur by several possible modes. The source and origin of crude oil to be stored at Kleer Mine is not known with certainty at this time. The transportation mode assumed for this analysis consists of offloading from VLCCs (very large crude carriers) to small (e.g., 30,000 DWT) tankers in the Gulf and a second transfer to surface tanks at Nederland for injection into Texoma. However, the oil could also be shipped directly from the point of origin to the Nederland Terminal in small tankers, or it could be offloaded from VLCCs to deep water port terminal facilities at various locations in the Caribbean and then transported to Nederland via small tankers. Each of these methods would require 143 trips up the Neches River to Nederland to achieve one fill cycle if 30,000 DWT tankers were used. Oil spill risks calculated are summarized in Tables 4.3-2 and 4.3-3.

VLCC Transfer in Gulf

Each fill cycle would require 143 transfer operations. Spills occur approximately once in each 18 transfers; average spill volume is estimated at 11.3 barrels. Thus, 8 spills, totaling 90 barrels, are projected to occur during each fill operation.

Given the occurrence of a spill, the chance of a particular size range for tanker transfers is given in Table 4.3-3. Large spills (more than 200 barrels) have less than a 6.5 percent chance of occurring from this mode during the life of the project (given 40 expected spills as in Table 4.3-2 and a 0.16 chance that a spill is above 200 barrels as in Table 4.3-3).

The maximum credible spill size associated with this accident mode is estimated to be 1000 barrels. This is twice the size considered for transfer operations at Nederland because pumping rates are greater and seastate conditions are more hazardous.

Transport Between VLCC and Nederland

Transport of oil between Nederland and the VLCC involves approximately 95 miles of travel in the Gulf of Mexico, Sabine Lake and Neches River. For transport by 30,000-DWT tankers, the accident rate is considered to be .0758 per vessel/year. The vessel transport time is estimated at 2 days round trip. Also, a port call spill rate of $2.6 \times 10^{-4}$ may be projected for the tanker movements at Nederland. Average spill size is taken to be 770 barrels, intermediate between the average U.S. port size of 428 barrels (U.S. Coast Guard, 1973) and the 1111-barrel size recorded for world tanker data for all less-than-total spills (J. J. Henry Company, 1973). During each fill operation, the total number of expected spills is therefore 0.097 (1 chance in 10) and total expected spillage is 75 barrels. During the life of the project, the total number of tanker spills is 0.485 (1 chance in 2), and total expected spillage is 375 barrels. The maximum credible tanker spill is considered to be 60,000 barrels (see Table 4.3-2).

Given the occurrence of a spill, the chance of a particular size range is given in Table 4.3-3. Large spills (more than 2000 barrels) have less than a 2.5 percent chance of occurring with tankers.

Transfer in the Neches River

Transfer from 30 MDWT tankers to the tank farm at Nederland will take place while these vessels are secured at existing dock facilities. Total spillage volume is estimated at $1 \times 10^{-6}$ units per unit transferred, or 30 barrels per fill (150 barrels over the life of the project). Spill frequency is estimated to be once in 90 offloadings. This yields an estimated 8.0 accidents averaging 19 barrels each during the life of the project (see Table 4.3-2).

Given the occurrence of a spill, the chance of a specific size range is given in Table 4.3-3 for tanker-to-terminal transfers. Spills greater than 200 barrels have less than a 2 percent chance of occurring.

Maximum credible spill size for oil transfer operations at Nederland is considered to be 500 barrels.

Summary of Oil Spill Risk from Marine Oil Transport Operations

From Table 4.3-2, it may be seen that the maximum credible spill size and the largest expected average spill are associated with tanker transport up the Neches River (60,000 barrels maximum; 770 barrels average). The largest expected total spill volume and most frequent spill incidents are associated with the transfer of oil between vessels in the Gulf (450 barrels total; 40 spills). The total oil spillage expected during five complete fill operations is 975 barrels.

As indicated in Table 4.3-3, very large spills are extremely unlikely. The percent chance of a spill over 2000 barrels during the life of the project may be calculated by multiplying the expected number of spill incidents during the life of the project from Table 4.3-2 and the percent probability of spills greater than 2000 barrels, given a spill occurs, from Table 4.3-3. The percent chance associated with tanker transport is 2.5 percent. There is no reasonable chance of such a spill occurring during transfer operations as the maximum credible spill size for these operations is 1000 barrels.

4.3.8.3 Oil Spill Risk from Terminal Operations

The equipment used in surface oil transfer operations at the site (meters, meter provers, remote-controlled valves, pressure regulators, and so forth) constitute a portion of an average U.S. oil terminal. Only the aboveground storage tanks would provide an element of risk significantly different from the underground Kleer storage. Estimated terminal spill probabilities (U.S. historical base) require some correlation of the spill exposure with those of the entire national petroleum industry. The data base is a part of the pipeline spill record. From this base it is estimated that $5 \times 10^{-10}$ spills per barrel will occur for oil moving through the controls, valves, pumps, and other equipment at both the Kleer Mine storage site and Winnsboro Terminal (see Appendix G). Five emptying and filling cycles during the life of the project (300 million barrels total movement) indicate an expectation of 0.15 events, or 1 chance in 7 of a spill over the project life at each terminal. For an estimated average event size of 300 barrels (based upon the maximum amount of oil that would be in the surface system at any one time), the expected spill volume at each terminal would be about 45 barrels.

Normal maximum credible spill size for the Kleer Mine and Winnsboro Terminal facilities would be 1000 barrels; to be conservative, however, the facilities are considered to be an extension of the pipeline and to have the same 5000-barrel maximum spill size.

Design modifications at Winnsboro Terminal include two 90,000-barrel batch holding tanks planned for use in both withdrawal from and injection into the Texoma line; thus, terminal operations closely approach those of an average U.S. terminal. Therefore, higher frequency and larger maximum size spills might be expected compared to the Kleer Mine site. However, the hazards to the environment associated with these spills will be minimized by the diking system to be constructed around the tanks (Figure 2.3-6). The pumping station, which is outside the dikes, will present the same risk as the Kleer Mine operation. Thus, the total spill expectation from each terminal is 45 barrels, with a frequency expectation of 0.15 events during the project life.

The tank farm at Nederland is an existing facility. Spills from storage tanks due to incremental throughput of oil for Kleer Mine storage will be negligible and will be contained within perimeter dikes. Spills associated with connecting pipeline systems are included in the estimates of Section 4.3.8.1. Therefore, no additional spill risk exposure to the environment is incurred at Nederland as a result of the project.

A summary of oil spill accident potential for pipeline transportation and terminal transfer operations is provided in Table 4.3-2. The total expected volume of oil spillage is 713 barrels during 5 full cycles of oil storage. This is an extremely small volume of expected oil spillage.

The probabilities that a particular spill will fall within various size ranges are given in Table 4.3-3. This table indicates that very large spills are statistically improbable from the proposed Kleer Mine system. Combining the spill rate statistics in Tables 4.3-2 and 4.3-3, for pipelines and terminals, the chance of a spill greater than 2000 barrels during the lifetime of the project is less than 4.1 percent (1 chance in 24 or a recurrence interval of 540 years). During the life of the project, spills greater than 2000 barrels have a probability of 0.0393 (1 chance in 25) of occurring from the pipeline, and less than .00075 (1 chance in 1330) at each terminal.

Fume and Vent Control

There is a slight risk of toxic gas ($H_2S$) escaping during cavern filling. The residual of hydrogen sulfide gas remaining after shipment of a sour crude should be negligible. However, it must be considered that a batch of fresh sour crude might unaccountably arrive for storage, in which case some hazard could be present. Combustion of the gas vented from the cavern through a piloted flare, as planned, eliminates the potential hazard.

Diking

Petroleum facilities frequently use a peripheral berm or dike around the facility to contain spills. Because of the potentially unique salt marsh in the vicinity of the mine site, berms may be needed around the surface facilities and along the pipeline route near the marsh. The use of berms involves some additional problems because they collect rainwater as well as spills. The rainwater must be released unless evaporation at the site is sufficient to dry the area without drainage. Should an oil spill occur, subsequent rainwater may tend to be surcharged with a residue of oil; treatment may be needed to prevent deterioration of water runoff quality into the marsh. Alternatively, provision could be made to remove oil-contaminated soil from within the berm (see Section 5.0).

Winnsboro Terminal is presently diked with clay material. If the expanded terminal and the Kleer Mine facility are adequately diked, terminal spills will not lead to adverse environmental effects.

Pipeline routes generally are not diked because such extensive diking systems could be more disruptive to the drainage pattern and water quality than infrequent small oil spills. For the pipeline leading to the Kleer site, it would probably be sufficient to use diversionary berms wherever a pipeline rupture could result in oil draining directly into the marsh. Water impoundment would not occur with a diversionary berm, but the berm should be designed such that diversion of runoff would not divert necessary runoff from the marsh.

Fire Losses

The incremental increase in risk of major fire due to the storage of oil at the Kleer Mine site would result almost entirely from the pipeline terminal at Winnsboro because that is the only point of oil accumulation in the system other than the cavern. In the cavern, the oil in storage can be readily sealed to prevent a major loss by fire. At the Kleer Mine site, a pump failure fire would not be expected to consume more than the 300 barrels in the site piping system at any one time.

The loss of storage tanks due to fire is rare (especially for crude oil), but not unknown. The additional exposure at Winnsboro (180,000 barrels in two tanks) constitutes less than 1 percent of the storage capacity for the Kleer Mine. Furthermore, Winnsboro would not be in use 60 percent of the time during the program, further reducing the exposure relative to the historical risk for most U.S. storage tanks (as discussed in Section 4.3.8.1). Also, oil released as a result of the fire would be contained within the dike system. Smoke from a fire would constitute a short-term adverse impact to air quality in the vicinity. Possible impacts are not considered to be significant.

Storage of crude oil in the Kleer Mine will increase the necessary oil-handling steps for the oil involved before it is eventually consumed, as compared to direct import from a Gulf coast terminal to a refinery. To that extent, there will be a small, unquantifiable increment in risk of injury to the facility personnel. However, the types of transfer station operations required involve those with the least risk, typical to the petroleum industry.

#### 4.3.8.4 Oil Spill Risk from Cavern Storage

Oil storage in an ordinary petroleum tank depends upon the walls, roof, and floor of the tank to form an impermeable barrier to migration of the oil. Should the barrier be broken, gravity or pressure forces would provide a mechanism for migration of the oil onto or into the surrounding soil. In cone roof tanks, the roof forms an imperfect barrier, and evaporation provides a mechanism for migration into the environment. In floating roof tanks, losses are minimized by eliminating the formation of hydrocarbon vapor above the liquid surface; losses are limited to leakage past the annular seal since no direct venting occurs during fill or withdrawal.

The risk of loss of oil to the environment from underground storage involves the same two factors, both of which must be present: loss of impermeability in the confining walls, and a mechanism for oil migration. In salt dome storage, the massive salt structure is generally impermeable, except for the shafts which have been cut for access. Gravity as a mechanism for oil migration is replaced by another concern: upward displacement of the oil by a heavier fluid, such as ground or surface water.

Review of Features of the Kleer Mine Affecting Oil Spill Risk

The Kleer Mine salt deposit is a piercement dome rising from deep evaporitic salt beds. The top of the dome is at elevation 170 feet MSL, 220 feet below ground level at the site. The mine has been excavated at a single level between about -200 and -307 feet MSL, or about 400 feet into the salt. The lateral extent of the salt dome at the mine level is at least 9000 feet, and much greater at lower depths. Gas exploration may be planned around the flanks of the dome, but shafts would not be expected to be placed close to the envelope of the present mine or its proposed replacement. Solution brine mining has been carried out in the vicinity, but the leached caverns have been determined by sonar sounding to be at least 2500 feet from the mine cavity.

The mine is stable and impermeable, with negligible sign of closure due to plastic creep of the salt. Some debris (mine equipment and unusable salt fines) may be in the mine and will have to be secured before oil can be placed in storage. The deepest excavations of the cavity are not accessible by drainage to the planned sump location, necessitating construction of channels for oil storage. Small isolated depressions in the cavern floor may be filled with water to prevent accumulation of inaccessible oil.

The mine is free from inflows of water or gas, consistent with its impermeability, though some moisture condensation from ventilating air may cause local puddling near the shafts. Consequently, no disposal of liquid effluent from the mine during storage periods is expected. The mine wall temperatures are expected to be around 85°F, compared to temperatures of over 100°F in surface storage tank vessels in Texas during summer periods.

The shafts penetrate clayey soils near the ground surface but reach an unstable zone of limestone and voids near the surface of the salt. Some water inflow from this unstable zone is possible in the event of shaft collapse. There is ponded water at the surface, but there have been no indications of seepage into the soils surrounding the shaft. There are existing mine structures at the site, and ready vehicle access by road exists.

Risk of Catastrophic Spills from Storage Cavern

The level of storage is below both surface and ground water. To escape the reservoir, oil must be displaced to the surface or to ground water levels, thence along a pressure gradient to produce lateral migration. If oil reaches the surface, it can migrate by running downhill and/or floating on water. If it reaches ground water levels, it may not have a sufficient pressure gradient for significant lateral migration, other than local diffusion into aquifer sands.

The primary defenses of the reservoir against water entry and cavern collapse are the shaft seal, which would be constructed at about elevation -100 feet MSL, about 300 feet into the salt (Figure 2.3-3), and the room-and-pillar geometry of the caverns.

Surface Water - Catastrophic spills from flooding are extremely improbable because the shaft collar will be 25 feet above the maximum probable flood stage, as indicated in section 3.3. A concrete seal at the surface will prevent entry of water into the pump shaft from any possible source.

Ground Water Inflow - Shaft construction methods and the impermeability of the salt mass will prevent entry of ground water into the cavern except through failure of the shaft lining, shaft seal, or through an exchange with an unsuspected cavity of brine. As all brine cavities are at least 2500 feet from the storage cavern, possible ground water inflow is limited to shaft failure.

Shaft Failure - As described in Section 4.3.2.2, the chance of shaft failure, along with possible rupture of the pipes above the shaft seal, has to be considered a potential risk for salt dome oil storage. However, there is little chance of any oil migration from the site following such a failure, so long as the shaft seal over the cavern remains intact. Water could enter the cavern through a broken pipe above the shaft seal, flow down the pipe into the sump, and displace an equal volume of oil up the pipe. When the sump has filled with water to the bottom of the pipe, no more oil can enter it -- a water seal is created. The total amount of oil that could be displaced from the cavern is around 50 to 100 barrels, and this would be contained in the shaft. The water seal is an important passive safety factor.

If the shaft plug should fail along with a shaft collapse, substantial amounts of oil could escape into the shaft. Because of the hydrostatic head of the ground water and the low density of the oil, the oil could then migrate into the overlying sediment and to the surface. However, this possibility is very remote. As shown on Figure 2.2-3, the shaft plug will be situated in the massive competent salt deep within the dome, secure from the solutionary and potentially unstable materials that threaten higher portions of the shaft. Given the shaft plug emplacement environment, coupled with its vital importance, final design of the plug will incorporate necessary assurances against failure. The level of dependability that is achievable by standard engineering practice is best illustrated by the numerous successes of such plugs in containing shaft- and tunnel-emplaced nuclear detonations.

Lateral Cavern Failure - Exploration for natural gas from the deep flank zones of the Grand Saline dome is being carried out in the area. Because of the large size of the dome, these wells are generally at some distance from the mine cavity. There is a remote possibility that a well could penetrate close to the storage cavity at some future time, resulting in a high-pressure breakout into the cavern area, either directly from the well, or from possible pressurization of the brine well cavities about 1/2 mile from the mine.

High-pressure gas breaking into the cavern could conceivably pressurize the fluid and tend to force it up the pump shaft fill and vent lines. If the pressure were high enough to blow out the valves, oil would rise from the storage cavern to the surface, driven by the gas pressure. If the pressure blew out the shaft seal, only the gas would escape up the mine shaft.

This situation is not considered possible with any existing drilling activities. If new deep drilling were contemplated while oil is stored in the caverns, then the location would have to be examined carefully.

The possibility of any other lateral penetration into the cavern would not be expected to present any escape route for oil into the environment. If one should hypothesize a breakthrough of some unknown connection between the brine wells and the storage cavity, the brine and oil could exchange places, but both would remain within the dome.

Explosions - The explosive range of the air-vapor mixture over crude oil is narrow, but it must be considered reasonable that an explosive mixture could exist in the cavern at some point during a filling and/or emptying cycle. There are no flame ignition sources in the mine, but possible sources can be hypothesized: static electricity (salt being a dielectric), sparks induced by the electromagnetic field of lightning strokes, metallic sparks, spontaneous ignition by temperature or dieseling, some chemical reaction with an unknown piece of debris left in the mine, and so forth. Since these sources cannot be ruled out as impossible, the alternatives for safety are either to inert the atmosphere before filling (infeasible because of the size of the caverns and irregularity of the roof geometry), or to design the mine to withstand the effects of a gas explosion without harm.

A gas explosion is characterized by passage of a flame front through the gas volume. As an explosion, the action is very slow, in contrast to the decomposition of an explosive device located at some particular point. The pressure rise through the gas occurs more uniformly, without generation of high-energy shock waves. Consequently, the explosion overpressures tend to be low. The devastating effects of other gas explosions arise from the enormous total forces generated over large areas, in contrast to an explosive device that suddenly creates a high overpressure over a localized area.

It has been estimated that maximum overpressure from petroleum vapor explosions may be as high as 150 psi (personal communication, Macreagh, 1976). European practice is to design shaft plugs and seals to withstand 10 atmospheres. Rock structures in the cavern would be virtually unaffected by a pressure surge of 10 atmospheres because of the slow rise of the pulse (i.e., fractions of a second, as opposed to microseconds in a dynamite type of explosion).

<u>Transport and Storage of Mining Explosives</u> - There is potential for some risk to aboveground workers and facilities at the Kleer Mine storage terminal as a result of the transport of explosives used in mining salt. Up to 80 tons of ammonium nitrate explosives (Amphroprill) are consumed annually. The explosives are delivered to the site in 20 ton lots by truck. The amphoprill is stored within the mine under regulations established by MESA. Similar storage would be provided at the new mine. The 300-foot separation distance between the new mine and the oil storage caverns would eliminate any risk to the oil facilities in the event of an explosion while in storage.

Ammonium nitrate has an explosive power rated at 60 percent of TNT. The peak overpressure 1/2 mile from the point of detonation of 20 tons of amphoprill would be about 1/2 psi; the maximum velocity of primary fragments generated by the blast would be about 0.3 feet per second (U.S. Dept. of the Army, 1969). Personnel and equipment located at the surface within 1/2 mile of the detonation of a truck can be assumed to be subject to damage or injury.

Based on historical data, the accident rate for truck shipments of hazardous cargo is about 1.7 incidents per million vehicle-miles (Brobst, 1972). Because of relatively low traffic levels in the vicinity of the site, this rate is probably high, but can be taken as a conservative measure of the risk. Futhermore, ammonium nitrate is difficult to detonate accidentally; at most, no more than 2 percent of the transport accidents at Kleer Mine are projected to result in a detonation (1.5 percent of all accidents in the data base resulted in cargo fire damage). Thus, assuming that each delivery involves 1/2 mile of travel exposure to the site and that there are 4 deliveries per year, the probability of a detonation of a truck within damage range can be estimated at $7 \times 10^{-8}$ per year, or a recurrence frequency of once every 15 million years (i.e., 1 chance in 682,000 during the life of the project).

The incremental risk to personnel and facilities (above that calculated elsewhere in Section 4.3.8) is negligibly small. A detonation at the terminal could destroy the surface facilities, but presents no hazard to oil in the storage caverns.

Personnel exposure to explosives-related risk (other than the present risk to mine personnel) is limited to the few workers present during project operation (8 to 10 during pumping, 2 or 3 during standby) and the construction work force (as many as 350) during project construction. Should the decision be made to shut down the mine for a 40-week period during project construction, the personnel hazard would be reduced significantly. Another option would be to clear the area of construction personnel during delivery of the explosives.

4.3.8.5 Noncatastrophic Loss of Oil from Storage

The previous description of catastrophic or sudden oil losses applies as well to small or gradual leaks from storage. For the salt dome, the mechanisms are equivalent, differing only in time frame. However, oil in storage can deteriorate under adverse conditions.

A common problem with stored petroleum is growth of bacteria, which is most likely where the oil is in contact with water. Crude oil contains a small fraction of water, most of which is bound in emulsion. In time, some of this water, typically of the order of 0.1 percent, but under some conditions up to 0.5 percent, may pool at the bottom of the oil. The water tends to be briny, but may solution some salt until saturation is reached. The volume of solutioning would be very slight because so little water is involved.

A small amount of sludge may build up at the cavern floor-oil interface. This sludge will tend to be drawn into the sump during oil withdrawal. A low lip will be constructed at the sump to reduce sludge intake. Loss of stored oil due to the salt-sludge buildup can be considered a very minor hazard to the stored oil.

The shelf life of the stored oil, even with sludge buildup, can thus be considered to exceed the expected lifetime of the project.

4.3.8.6 Movement and Dispersion of Spilled Oil

Spills at the Kleer Mine Site

Spills at the site could result from rupture of the piping system between the pipeline manifold and pump shaft, such as in the metering units, or from the booster pump manifolds. The main lifting pumps will be submerged in the cavern; therefore, any failure in these units would be confined to the cavern. The oil transport system is composed of various size lines, up to the mainline diameter of 22 inches. The maximum oil volume in the site system would be 300 barrels. The maximum credible surface spill would therefore be estimated as a combination of these 300 barrels, plus about 10 minutes of full flow from the piping system, or a total of about 1700 barrels. Larger amounts of oil could be spilled through small chronic leaks; a routine inspection of the system and site will prevent these. Since the main 22-inch pipeline is also at the site, the maximum spill size has been estimated to be the same size as that associated with the mainline, or 5000 barrels.

Soil Absorption - A spill of 1700 barrels could be contained within an earth berm; however, a 5000-barrel maximum credible spill could breach the berm. (Note: The total expected spill volume during the lifetime of the project is 45 barrels at each terminal, averaging 300 barrels per incident, Table 4.3-1.) Clay and fine sand, typical of the surface soils at the site, would absorb perhaps 80 to 160 barrels per acre. If the berm were breached (by overflow or berm failure), two paths may be taken, including: 1) through the settling pond to the salt marsh, and 2) to Grand Saline Creek (Figures 2.2-1 and 3.2-4). Should significant quantities of oil reach the salt marsh, this unique habitat could be destroyed (see Appendix I).

When the soil is saturated with water, oil retention will be at worst a film of about 1 to 2 barrels per acre (BPA). See the discussion below on hydrological dispersion.

For purposes of attempting to quantify terrestrial ecological impacts in Section 4.3.8.7, dispersed spill densities are defined as follows:

1. Small - less than 2 BPA.
2. Moderate - about 25 BPA.
3. Large - more than 60 BPA.

Hydrological Dispersion - Except at flood stage, when stream velocities reach 3 to 4 feet per second, most streams in the project area have velocities averaging 0.70 to 1.0 feet per second (Table 4.2-1). At times, Grand Saline Creek has little or no flow past the mine site, although its "official" average velocity is 0.88 feet per second. Its length from the mine site to the juncture with the Sabine River is 6 miles; thus, an oil spill would "normally" reach the Sabine River in 10 hours.

The Sabine's "normal" stage velocity is 1.0 feet per second. Additional elapsed time (discounting the maximum molecular dispersion rate of about 0.3 feet per second) to reach the nearest reservoir (Toledo Bend, 200 miles downstream) would be about 294 hours or 12.2 days. At flood stage, this time would be cut to 75 to 94 hours.

If a 5000-barrel spill at the mine were hypothesized to occur at flood stage for both Grand Saline Creek and the Sabine River, the oil would reach Toledo Bend Reservoir within 92 hours. Pertinent calculations are:

1. Elapsed time at 3.3 feet per second = 92 hours.
2. Fate of oil: 1250 barrels evaporated (25 percent)
   1000 to 2000 barrels on river bank (20 to 40 percent)
   1750 to 2750 barrels dispersed on reservoir surface (35 to 65 percent).
3. Size of oil slick = 38 miles long at 92 hours, perhaps 400 to 800 feet wide or more in reservoir.

It is important to monitor stream stage and velocity to prepare a good response plan, as discussed in Appendix H.

Spills Along Pipeline and at Winnsboro Terminal

As noted in Section 4.3.8, the total expected spill volume for the life of the project, with 5 fill-withdrawal cycles, is 45 barrels at Winnsboro Terminal and 498 barrels along the pipeline route. The chance of a spill occurring in various watersheds is given in Table 4.3-3. Several watersheds crossed by the pipeline have reservoirs within 10 miles downstream (Grand Saline, Sabine, and Cottonwood Creek excepted). All, except Glade Branch and Brushy Creek which feed Quitman, have at least 0.5 mile of gently sloping ground as buffer between the pipeline and a creek leading to a nearby reservoir.

Soil Absorption - Where the buffer zone of soil and vegetation is, for example, 2500 feet by 100 feet, it provides about 5.7 acres. This area could easily absorb 450 to 900 barrels of oil unless saturated with water. It is possible that a larger spill event could occur and reach the streams, thus causing damage to drinking water supplies (Lake Cypress Springs or Lake Fork Reservoir) or to recreation waters.

It is anticipated that most spills will occur far enough from a stream and be small enough that the soil and vegetation will absorb the oil. Impacts to surface or ground waters would then be limited to oil in solution during runoff.

Hydrological Dispersion - Quitman Lake (1000 acres) is the only significant body of water with a high risk of receiving some impact from the pipeline. Not only is the length of pipeline in its watershed the longest (11 miles), but there are 3 feeder creeks with above-normal average velocities (1.4 feet per second as shown in Table 4.2-1). The lake is used for recreation and flood control, but not as a water supply.

The Glade Branch of Dry Creek is crossed less than 2 miles above Quitman Lake. A spill into the creek would take 2 hours to reach Quitman Lake at the average velocity; at flood stage it would take 45 minutes. Since a Mobil 20-inch pipeline parallels the planned 22-inch line across the watershed, chances of a spill are actually higher than calculated in the previous sections; however, oil spilled from the Mobil line is not attributable to the SPR project.

Lake Cypress Springs is the second most likely area to receive some oil spill. This lake is used for drinking water. Texoma, Mobil, and the planned 22-inch pipeline all cross Big or Little Cypress Spring Creeks; Winnsboro Terminal is located 6 miles up the Little Cypress drainage from the upper reaches of the lake. The new pipeline will cross 5.4 miles of Big Cypress Creek drainage. A spill would traverse the 10 miles of stream in 21 hours at average stage.

Other pipeline crossings are distant from important points of water use (reservoirs) and do not represent potentially serious impacts. To maintain proper perspective on the actual risks, note that the expected number of oil spills during the entire lifetime of the project is only 0.46 from the pipeline (Table 4.3-2).

Texoma Pipeline

The ultimate receiving waters for spills from the Texoma pipeline depends on the location of the spill. Major crossings include the Neches and Sabine Rivers. Also, the Angelina River is crossed just upstream of the Sam Rayburn Reservoir, a major recreation lake midway between Nederland and Longview. In most instances oil would be spread over the ground or dispersed in small streams or lakes without reaching these major water bodies as an identifiable spill. Areas exposed to oil spills would be the same as are currently exposed by oil pumping and handling operations.

Tanker Spills

Much of the lower Neches River has a pronounced spoil bank, which would contain the spilled oil. The spreading of a small spill may be such that ultimate recovery is rather low, but the areas affected would also be limited and would generally not be ecologically sensitive.

The movement of a major spill must also be considered. The tanker size projected to be used is about 30 MDWT capacity. Total loss from a tanker casualty is very unlikely, especially in the Neches River or Sabine Lake, because of cargo compartmentalization. To create a large tanker loss, rather energetic casualty conditions (strong currents, storms, rocks or collision speeds greater than those used on the river) are generally required. A spill of about 60,000 barrels may be considered as a maximum credible event for an accident involving two tankers.

The movement of oil from a 60,000-barrel spill will vary with the location of occurrence. On the Neches River, a slick up to about 10 miles in length would be formed. This could expand further, but rapid cleanup would tend to reduce the size after the first 12 hours. In Sabine Lake or the Gulf of Mexico, the spill would be carried by surface currents, winds and tides which are variable.

A spill of up to 60,000 barrels as a result of a tanker accident in the lower Neches River would be rather quickly carried into Sabine Lake or the Gulf of Mexico. From there, currents could carry the oil in almost any direction; much of the oil could impact the coastal marshes and shallow estuarine waters.

4.3.8.7 Hydrological and Water Quality Effects of Oil Spills

In addition to ecological impacts (Section 4.3.8.7), an oil spill in the tributaries of the Sabine or Red River would also affect the downstream water uses. A major short-term impact could occur to boating and fishing sports on Quitman Lake and to the domestic and municipal water systems supplied by Lake Cypress Springs. Municipal water systems would have to provide activated carbon polishing of the water to eliminate any residual oil taste in the polluted water. Little factual information is available to assess the overall significance of oil contamination on water resources. Most reports confirm that oil pollution has generally not presented a continuing problem. In some cases, spills have led to temporary inconveniences or abandonment of a water resource supply until measures were taken to contain and to treat or shut down the contaminated source. The degree of solubility of the oil and taste and odor problems may lead to difficulties in treatment or containment for small municipal or industrial streams. The stream intake may be boomed, treated with a "herder", simply shut down for a short period of time, or water from below the surface may be pumped for use.

Oil may also reach surface waters as a result of a spill from the Texoma Pipeline or from marine transport in the Gulf of Mexico or Neches River (Figure 2.3-8). The diversity of stream types and flow conditions prevent any detailea analysis of oil dispersal. In the major rivers, impacts are likely to be widespread though of moderate to low intensity.

Municipal water supplies may be the most significant impact. In smaller streams and creeks which are less completely flushed, ecological effects are likely to be most severe (Section 4.3.8.7), though any intensive human use will be disrupted at least temporarily. Ponds, reservoirs and lakes act as a point of concentration for spilled oil and make ideal sites for oil recovery operations. However, because of the relatively fixed relationship between water column, substrate and living organisms, oil spill effects are likely to be more severe and longer lasting than in most types of lotic (running-water) habitats.

An average crude oil has 30 percent paraffin hydrocarbons (alkanes), 50 percent napthene hydrocarbons (cycloalkanes), 15 percent aromatic hydrocarbons, and 5 percent nitrogen, sulfur, and oxygen-containing compounds. As soon as oil is released to the water environment, weathering begins. The major weathering processes are evaporation, dissolution, emulsification, sedimentation, biological degradation, and chemical oxidation.

Evaporation results in selective loss of low molecular-weight hydrocarbons and aromatics, thus tending to reduce concentrations of the most toxic portions of the crude oil. Evaporation causes a surface residue, which has a higher concentration of sulfur and organics and may develop a specific gravity greater than water, especially if silt, clay, or organic particles are suspended in the water and available for attachment.

Sedimentation of oil is encouraged by evaporation and dissolution of the lighter weight fractions and by contact with suspended sediments and organic material. Close to the stream banks, contact with suspended solids is likely during periods of high runoff or stormy weather, which disturbs bottom sediments. Sedimentation also can occur as a result of bacterial masses in the oil slick.

Bacterial degradation can occur to almost all crude oil fractions, but normal alkanes are attacked preferentially, and aromatics are least preferred. A supply of nitrogen, phosphorus, and oxygen is needed. In areas where oxygen concentrations are low, biodegradation is a slow, long-term process.

Ground water may occur at or near the surface or hundreds of feet deep. Ground water is usually in constant motion, but compared to surface water flow ground water movement is slow. Under the influence of gravity the water will flow to the lowest point in the reservoir unless influenced by drawdown of a water well or natural barriers. Flow of ground water can also be altered by variations in the types of soil present. The rate of movement in gravels or limestone can be up to several feet per day, but in denser soils the flow rate can be only a few feet per year. Flow rate depends greatly on the permeability of the aquifer and the gradient of the water table.

If an oil spill were to affect the ground water in the area, the direction of movement is relatively easy to determine (See also Section 5.2.4.1). By drilling three monitoring wells in a triangular pattern, the direction of flow is determined by measuring the elevation of the water in each well and analysis of the slope of the surface of the ground water. This procedure would be important in an oil recovery operation. Spilled oil would tend to follow the path of least resistance and in uniformly permeable soils the oil would travel vertically downward. In soil of variable permeability the oil could move somewhat laterally relative to the groundwater or impermeable soils. The oil also has a tendency to adhere to the soil particles and thus its flow rate can be naturally reduced; but, as the capability of the soil to immobilize the oil is exceeded, the oil will continue to migrate toward or through the water table. This migration will also depend greatly upon the size of the spill. Upon reaching the ground water table the oil would then move laterally in the direction of water flow.

4.3.8.8 Ecological Impacts of Oil Spills

An oil spill from the Kleer Mine oil storage and transportation system will affect the terrestrial and aquatic resources of the area by direct oiling of the soil, stream vegetation, and individual organisms. Terrestrial impacts are most likely to occur to vegetation, mammals, and to birds. Aquatic life may be considered in two general categories with regard to the effects of oil pollution: 1) organisms primarily utilizing the substrate such as emergent vegetation and benthic invertebrates, and 2) organisms of the water column, including plankton, invertebrates, and fish. In the immediate area surrounding the Kleer Mine storage system, the terrestrial environment (in particular, the salt marsh) is by far the most vulnerable and important ecosystem. However, because of the numerous streams crossed by the pipeline which are tributaries to major rivers, such as the Sabine and Neches, or which flow into lakes, reservoirs and estuaries, the potential impact of oil spills on the aquatic environment cannot be disregarded.

Oil Spill Impacts on the Grand Saline Salt Marsh

If a small spill occurred in the winter, it is unlikely that widespread vegetational damage would occur. Damage to shore and wading birds would also be minimal because winter is historically a dry season, and these birds would be less abundant than in seasons when the marsh is characterized by standing water. A thin oil coat on both vegetation and soil would affect the vigor of annual herbaceous vegetation because plants are most susceptible to damage from crude oil during early growth stages (Stebbings, 1968; Cowell, 1969; Baker, 1970). The young leaves and shoots would probably be "burned" by the oil. Thus, a drastic reduction in or total absence of photosynthetic capacity of annual marsh plants would probably result in the death of these plants.

As noted in earlier discussions, perennial vegetation should readily recover because the perennating structures are released from apical dormancy and provide for continuous plant growth. However, these conclusions are only a "best estimate" and more detailed vegetational studies are needed to accurately assess oil spill impacts on the salt marsh. Because saline soil conditions have long ago destroyed soil texture, it is unlikely that enough crude will penetrate the soil crust to contaminate subsurface horizons.

If a small spill occurred during the growing season, all vegetation would be harmed, but probably not past the point of recovery. Moderately large or large oil spills would have an effect on the soil proportional to a small spill, but vegetation damage would be much more severe.

A moderately large spill occurring during the early stages of the growing season might well damage marsh vegetation past the point of recovery. A winter season spill would not by as detrimental, especially if early spring rains helped to flush the oil from the marsh.

A maximum credible spill of 5000 barrels could permanently destroy large portions of the marsh. A literature review of marsh oil spills indicates that 25 barrels per acre can result in 100 percent destruction of plant life. Depending on spreading conditions, from 100 to 200 acres could be covered by oil from such a spill. As previously discussed, Distichlis and other halophytic species that characterize this marsh do not otherwise occur within 300 miles of the marsh. Therefore, natural plant migration is highly unlikely. With no food to attract waterfowl, they would not frequent the marsh and thus remove the most viable method of introduction for these species of vegetation.

Wading birds (sandpipers and plovers) would be most seriously affected by any summer oil spill. However, all waterfowl feeding on the marsh area would be indirectly affected by a spring or summer spill, since their marsh feeding area would be destroyed or contaminated.

Pipeline and Winnsboro Terminal

Virtually all research of effects of oil spills on plant communities has been conducted in coastal marshes. While these data may be extrapolated to project damage to the Grand Saline salt marsh, extrapolation to upland or riverbottom habitat types may not be valid. These habitats each have an ecology much different from that of a salt marsh.

Oil Spill Damage in Oak-Savannah Habitat Type - A small spill would damage the standing crop of vegetation, but complete recovery would probably occur in 1 to 2 years if soil damage is not excessive. Soil damage resulting from a small spill is directly proportional to the soil moisture saturation at the time of the spill. If the soil is at or near saturation, very little oil will penetrate surface horizons. Because the oil will be kept on the surface, sunlight and microbial action will combine to accelerate oil degradation. However, if the soil is very dry at the time of the spill, much more oil will enter the sandy surface horizons. This oil will coat plant roots and rhizomes and destroy soil microfauna. Because the oil is trapped in the soil, degradation and/or removal will be slow and the recovery period could well be measured in decades.

All burrowing animals such as the spadefoot toad and ground-dwellers such as the black racer would be destroyed by a small oil spill, as would all nesting birds coming in contact with the oil.

Moderately large and large oil spills would have catastrophic effects over the limited area they would encompass. Typical coverage may be 80 to 160 barrels per acre, depending on terrain and ground cover. Thus, a 5000-barrel spill might affect 30 to 60 acres. All herbaceous vegetation, ground-dwelling vertebrates and ground-nesting species would be destroyed. Moreover, if soil moisture were low and the surface horizons became saturated with oil, anaerobic conditions would be set up in the substrate, which would destroy most of the woody vegetation. Damage to the oak-savannah resulting from a moderately large or large oil spill would probably require more than 25 years for secondary succession to re-establish a herbaceous vegetation cover and another 25 years to restore the woody component.

Oil Spill Damage in the Sabine River Flood Plain Habitat Type - The damage resulting from oil spills in this flood plain habitat type is largely dependent upon moisture conditions. A small spill would be of only moderate consequence to vegetation because this area is characterized by a lack of herbaceous vegetation. Even if soil moisture is low, little soil damage should result from a small spill because most crude will be in contact with the soil surface and little runoff into vertical cracks will result.

Small spills would destroy ground-dwelling herpetofauna in the impacted area, but all other animals would be only indirectly impacted. Because the flood plain is frequently flooded, the crude should be flushed or diluted in a relatively short time. Consequently, recovery should be fast.

Moderately large or large spills would destroy all herbaceous vegetation in the impacted area (perhaps 30 to 200 acres, depending on terrain and moisture conditions for a 5000-barrel spill). If the soil is dry, extensive soil damage could result from crude flowing into the extensive system of surface cracks. Adams and Hanks (1964) have shown that water loss from these crack systems often exceeded loss by soil surface evaporation. However, if soil moisture were high at the time of the spill, little soil damage should result. All herpetofauna and mammals residing in the spill area will be either killed or displaced to compete in adjacent habitats. Floodwater will help flush the crude from this habitat type, but recovery will take up to 5 years if the spill occurs when the soil is wet and up to 50 years if the soil is extremely dry at the time of the spill.

An oil spill in the Sabine River could have significant impacts on birds utilizing the river as habitat. Records of oil pollution incidents show high correlation between the amount of time a bird spends in the water and the frequency and degree of contamination (Erickson, 1962). Most of the birds affected have been diving birds (Fox, 1961; McCaull, 1969; American Petroleum Institute and U.S. Department of the Interior, 1970; Zeldin, 1971). It should be noted that no diving ducks commonly frequent the Sabine River bottom. Instead, virtually all ducks found in the area are puddle ducks, which are somewhat less vulnerable to oil.

Diving ducks are most affected by oil-polluted water because they become immersed when diving through the oil layer, while other waterfowl make only limited contact with the contaminated water. It is estimated that about 75 percent of the surface area of a diving duck is contaminated when it enters contaminated waters. In contrast, contamination of geese can range from limited contamination of the head and feet to contamination of some or all of the underside of the body. This physical contamination would not cause high mortality rates, except during extremely cold periods when the crude oil reduces the insulating capacity of the birds' feathers. Physiological effects caused by oil ingested while preening could increase the toll of birds lost. Oil residuals from a water-spread spill would remain on the flood plain after the waters had receded and could destroy some nesting and feeding habitat.

Spill Impact on Tame Pasture Habitat Type - Spill impacts for the tame pasture will be approximately equivalent to those described for the herbaceous layer of the oak-savannah habitat type. Grazing activities would be precluded during the rapid (usually one season) recovery period, thereby reducing primary consumer activity.

Oil Spill Impact on Coastal Estuarine Habitat Type

Oil spilled from tanker activities in the Neches River, Sabine Lake, or nearshore Gulf of Mexico waters could pollute the water column, substrate, and marsh vegetation in the vicinity of Sabine Lake. Both aquatic and terrestrial organisms could be affected. Of particular significance are the salt and brackish marshes of the Sabine National Wildlife Refuge on the east bank of Sabine Lake. These marshes are important habitat for many species of birds, especially wading birds and waterfowl, and fur animals. They also provide important nursery ground for many species of commercial shell fish and fin fish.

Aquatic Impacts from Oil Spills

Crude oil constituents may be harmful to freshwater biota in the following basic ways (McKee and Wolf, 1963):

1. Free oils and emulsions may adhere to the gill membranes and interfere with respiration.

2. Oily substances may coat and destroy algae and other plankton thereby reducing a source of food for other aquatic organisms.

3. Settleable oils may coat the bottom and destroy benthic invertebrates, thereby reducing a major source of fish food. Fish spawning areas may also be impacted.

4. Oil substances, or organisms coated with oil, may impart an oily smell and taste to flesh if ingested by fish.

5. Organic materials may reduce available oxygen in the water sufficiently to kill fish.

6. Heavy coatings of oil on the surface of standing or slow-moving bodies of water may interfere with the natural processes of re-aeration and photosynthesis.

7. Water-soluble components may exert a direct, acute, or chronic toxic action on fish or fish food organisms. Crude oil in concentrations as small as 0.3 mg/l may be extremely toxic to freshwater fish.

Oil Spills at Kleer Mine - The site-specific effect of an oil spill at the storage facility will depend upon the volume of the spill, time of the year, and effectiveness of emergency procedures. If oil is allowed to reach either the salt marsh or Grand Saline Creek, adverse impacts to aquatic organisms will occur and could be significant. Extensive disruption of the salt marsh ecosystem would be significant due to its unique nature in the project region. Cleanup operations in the salt marsh would be difficult. Effects of an oil spill reaching Grand Saline Creek would depend primarily upon the volume of the spill. A small spill reaching the stream would, due to dispersion and dilution, probably not significantly affect the lower Grand Saline Creek area. This section of the stream is presently periodically subjected to toxic levels of chlorides entering the creek via the salt marsh, resulting in fish kills. A large spill, if reaching the Sabine River, would adversely affect at least plankton and fish. The ecological effects of a large oil spill reaching the Sabine River are discussed in the following section.

Spills Along the Oil Transportation Route - Under normal operating conditions, impacts resulting from operation of the pipeline are expected to be minimal. If disturbed areas (such as stream banks) are allowed to erode, increased sediment loads could be locally significant on a long-term basis. These are primarily effects of improper construction and soil stabilization techniques, however.

Impacts resulting from a rupture in the pipeline or other accidents that result in a release of oil into the aquatic ecosystems of the project area may be significant. The extent and severity of the impact on an oil spill depends upon: 1) the volume of the spilled materials; 2) location of the spill; 3) topography, including velocity of the water, sinuosity of the stream course, and substrate type; 4) time of year; and 5) effectiveness of emergency procedures. In general, the larger the spill and the larger the body of water it reaches, the more extensive the damage will be.

In the event of a pipeline rupture close to a river or stream crossing, the immediate impact would probably be the elimination of most aquatic species in the direct spill area. Impacts may become particularly far-ranging in turbid aquatic systems, such as streams in the project area during heavy runoff periods that usually occur at least several times each year. Oil and petrochemicals are quickly absorbed by suspended matter and may be transported over wide areas. Large heavy aggregates may be formed and deposited on the bottom far from their sources. Even on the bottom, oil may continue to yield water-soluble substances toxic to aquatic life (Committee on Water Quality Criteria, 1972). Sediments in which oil is incorporated become low in oxygen, possibly anaerobic. Under these conditions, degradation is very slow. It is also likely that the most toxic components of oil are the slowest to be broken down (Murphy, 1971).

Location of the spill may also be important. The proposed pipeline route crosses the Sabine River several miles upstream of a state public access area. As public access in this region of the river is limited, a large oil spill reaching this area would be detrimental recreationally and aesthetically as well as ecologically.

The probability exists that an oil spill will reach one of the larger lakes in the project area. As discussed in Section 3.6 and 4.3.8.6, these bodies of water are regionally important recreation areas. Impacts of a large spill reaching one of these lakes would be extensive and would probably affect the ecosystem to the extent that it could require several years to totally recover.

A maximum credible spill from the Texoma Pipeline is estimated to result in release of 10,000 barrels of oil. Using the assumption that 20 percent will evaporate, dissolve in the water column, or sink to the stream bottoms, the remaining 8000 barrels (discounting possible oil recovery before impact) could destroy as much as 320 acres of habitat for periods of 2 to 5 years. In most cases, typical acreage affected would likely be only 50 to 100 acres, however, depending on soil saturation, topography, and vegetative cover.

A maximum credible spill resulting from the sinking or heavy damage to a 30,000 -DWT tanker while in transit between the Neches River and the Gulf of Mexico is expected to be 60,000 barrels. Much of this oil could reach Sabine Lake or the Gulf of Mexico before effective spill control equipment could be deployed. Assuming that 20 percent evaporates and 10 percent dissolves or sinks, a potential 42,000 barrels of oil might remain at the surface within Sabine Lake or open Gulf waters. Because of the potential for wide dispersal of oil in this area, it will be assumed that a maximum of 50 percent of this oil could be recovered; under storm conditions, no oil might be recovered. Thus, at a density of 25 barrels per acre for complete vegetation mortality, from 840 to 1680 acres of marsh could potentially be lost. The brackish marshes bordering Sabine Lake and the Gulf are prime water fowl habitat, especially to the east in Sabine National Wildlife Refuge.

Spills of up to 500 barrels could occur during oil transfer operations at Nederland, and up to 1000 barrels in the open waters in the Gulf of Mexico. If the oil should reach the marshes along Sabine Lake, as much as 40 acres of vegetation could be destroyed.

TABLE 4.3-1 Estimated hydrocarbon emissions accompanying transport of oil from Gulf of Mexico to Kleer Mine during each cavern fill operation

| Location (see Figure 2.3-8) | Estimated Emission Rate (tons/day) | Duration of Emissions (days)[a] | Concentration Exceeding Standard (160 μg/m$^3$) Distance Downwind (miles) | Total Emissions (tons)[b] |
|---|---|---|---|---|
| Gulf of Mexico | 17.2 | 50 | 10.3 | 860 |
| Nederland, Texas | 12 | 50 | 7.8 | 600 |
| Tank Farm Terminals: | | | | |
| Nederland | 0.15 | 150 | 0.45 | 22.5 |
| Winnsboro, Texas | 0.04 | 600 | 0.25 | 25.5 |

(a) Duration of emissions depends on scheduling of tankers and batch operating modes of pipeline systems. Emission rates from tanker transfer and transport operations are throughput-dependent, i.e., total emissions would be little changed by different scheduling. Emission rates from tank farms are time-dependent.

(b) Expressed in terms of equivalent weight of oil. One ton equals 6.65 barrels.

TABLE 4.3-2 Summary of oil spill accident potential, Kleer Mine storage facilities

| | Accident Mode | Frequency Expectation per Single Filling Cycle | Expectation of Spills over Life of Project | Average Spill Volume (bbl) | Volume Expectation of Spillage Over Project Life | Maximum Credible Spill (bbl) |
|---|---|---|---|---|---|---|
| Transportation Between Kleer Mine and Winnsboro | Pipeline | 0.035 | 0.46 | 1083 | 498 | 5000 |
| | Terminal at Kleer Mine | 0.015 | 0.15 | 300 | 45 | 5000 |
| | Terminal at Winnsboro | 0.015 | 0.15 | 300 | 45 | 5000 |
| | Subtotal | 0.065 | 0.76 | 774 | 588 | - |
| Transportation Between Gulf of Mexico and Winnsboro | Pipeline | .023 | 0.115 | 1083 | 125 | 10,000 |
| | Tanker Transport | .097 | 0.485 | 770 | 375 | 60,000 |
| | Tanker Transfer: | | | | | |
| | Gulf | 8.0 | 40.0 | 11.3 | 450 | 1,000 |
| | Nederland | 1.6 | 8.0 | 18.8 | 150 | 500 |
| | Subtotal | 9.72 | 48.6 | 22.6 | 1100 | - |
| | Total | 9.79 | 49.4 | 34.2 | 1688 | - |

TABLE 4.3-3 Probable spill size distribution for pipeline, tanker, and terminal accidents, assuming the occurrence of an oil release

Pipeline Transport
Kleer Mine to Winnsboro
(Average Size 1083 bbl)

| Size Range (bbl) | %Probability |
|---|---|
| 0 - 1000 | 49 |
| 1000 - 2000 | 45 |
| 2000 - 5000 | 6 |

Pipeline Transport
Nederland to Winnsboro
(Average Size 1083 bbl)

| Size Range (bbl) | %Probability |
|---|---|
| 0 - 200 | 18.5 |
| 200 - 500 | 22.7 |
| 500 - 1000 | 24.5 |
| 1000 - 2000 | 24.1 |
| 2000 - 5000 | 8.6 |
| 5000 - 10,000 | 1.6 |

Terminal Facilities
(Average Size 300 bbl)

| Size Range (bbl) | %Probability |
|---|---|
| 0 - 200 | 45.5 |
| 200 - 500 | 41.5 |
| 500 - 1000 | 10.0 |
| 1000 - 2000 | 2.5 |
| 2000 - 5000 | 0.5 |

VLCC/30 MDWT Tanker Transfer in Gulf
(Average Size 11.2 bbl)

| Size Range (bbl) | %Probability |
|---|---|
| 0 - 10 | 71.0 |
| 10 - 20 | 17.5 |
| 20 - 50 | 8.3 |
| 50 - 100 | 2.46 |
| 100 - 200 | 0.58 |
| 200 - 500 | 0.13 |
| 500 - 1000 | 0.03 |

30 MDWT Tanker Transport
(Average Size 770 bbl)

| Size Range (bbl) | %Probability |
|---|---|
| 0 - 200 | 25.8 |
| 200 - 500 | 26.9 |
| 500 - 1000 | 30.1 |
| 1000 - 2000 | 11.9 |
| 2000 - 5000 | 3.99 |
| 5000 - 10,000 | 0.97 |
| 10,000 - 20,000 | 0.20 |
| 20,000 - 50,000 | 0.03 |
| 50,000 - 60,000 | 0.001 |

Tanker Transfer at Nederland
(Average Size 19 bbl)

| Size Range (bbl) | %Probability |
|---|---|
| 0 - 2 | 7.5 |
| 2 - 5 | 16.5 |
| 5 - 10 | 24.0 |
| 10 - 20 | 28.8 |
| 20 - 50 | 16.8 |
| 50 - 100 | 4.8 |
| 100 - 200 | 1.3 |
| 200 - 500 | 0.25 |

TABLE 4.3-4 Pipeline oil spill probabilities by watershed

| Watershed | Chance of Selected Number of Spills During Project Lifetime | | |
|---|---|---|---|
| | 0 | 1 | 2 or more |
| Grand Saline | 97.83% | 2.15% | 0.02% |
| Lake Fork Creek | 93.7 | 6.1 | 0.2 |
| Big Sandy Creek | 99.3 | 0.7 | - |
| Sabine River Basin | 98.13 | 1.86 | 0.01 |
| Big Cypress Creek | 98.3 | 1.7 | - |

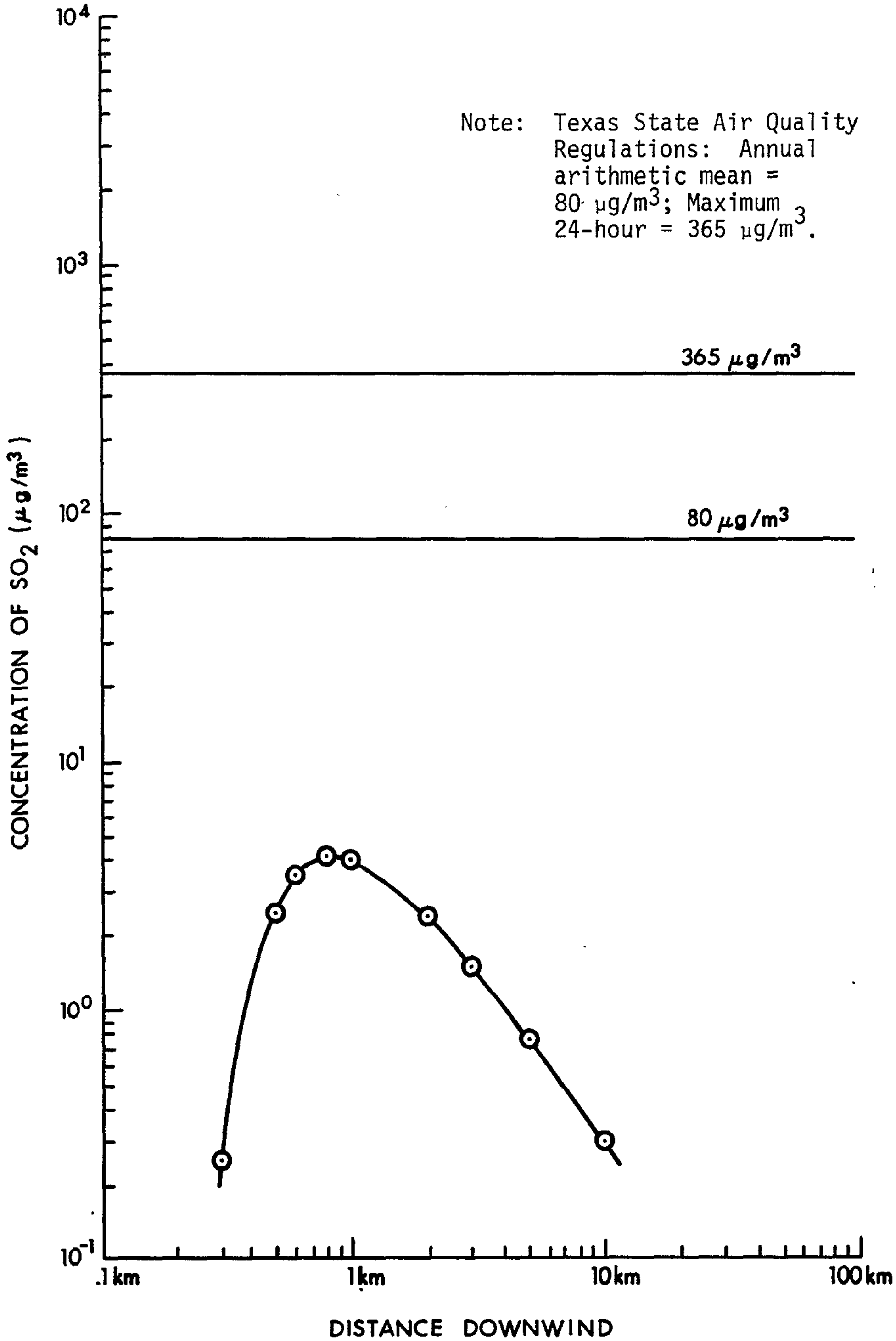


FIGURE 4.3-1 Downwind concentration of $SO_2$ ($\mu g/m^3$) resulting from flaring (assuming 0.27 gm/sec release $SO_2$ and 50,000 bbl/day pumping)

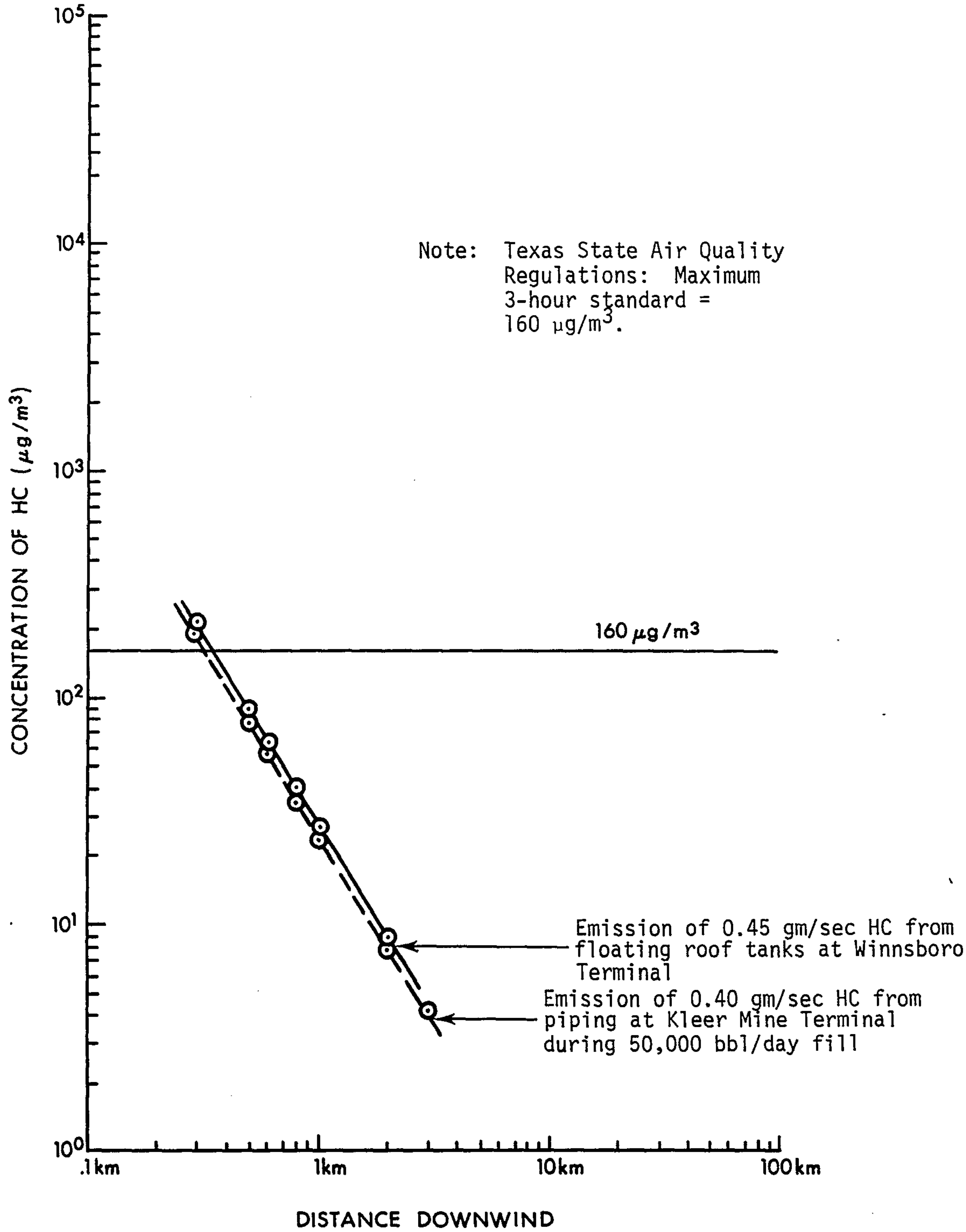


FIGURE 4.3-2 Downwind concentration of HC from leakage

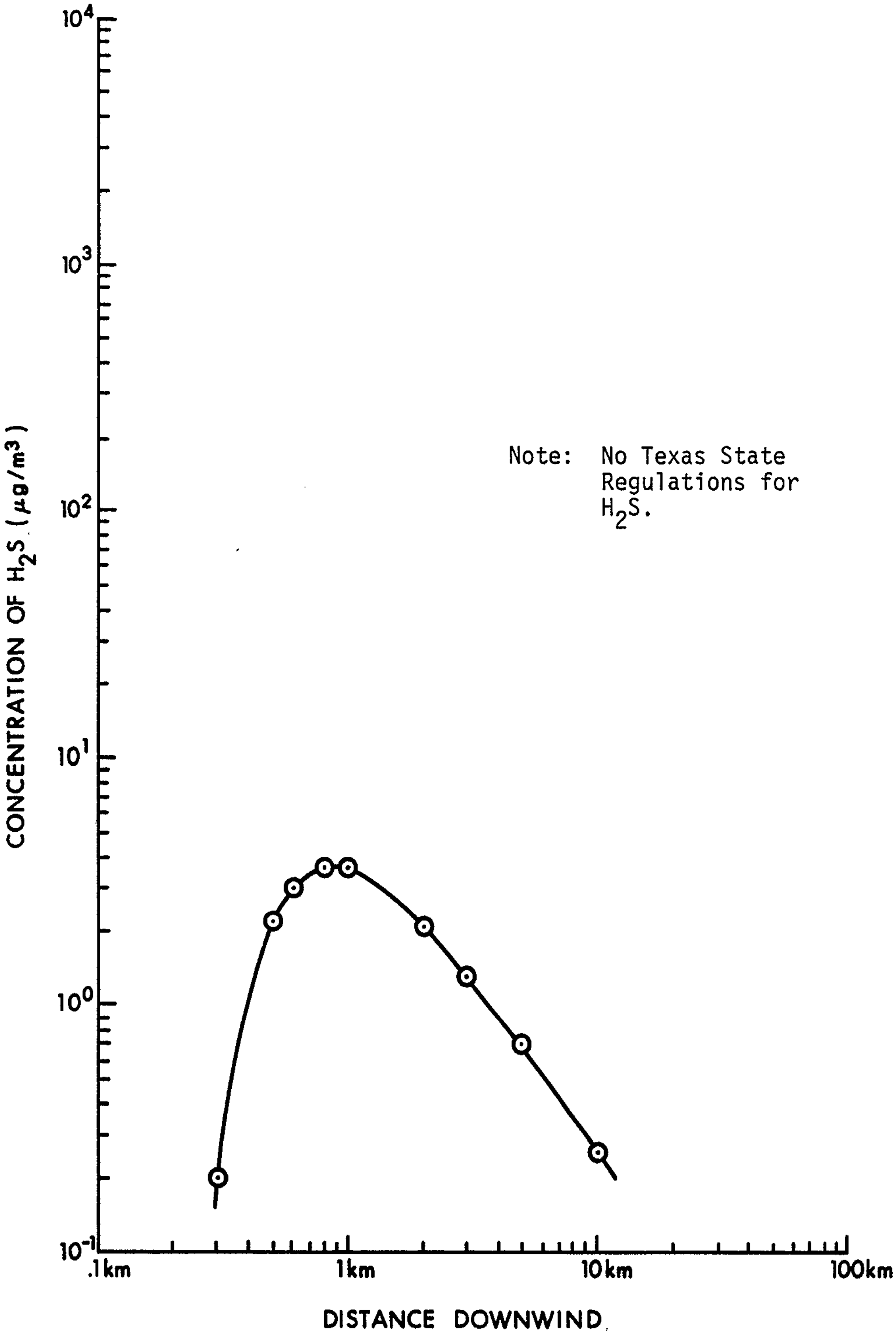


FIGURE 4.3-3 Downwind concentration of $H_2S$ (assuming no flaring) for 50,000 bbl/day fill rate and 0.135 gm/sec release of $H_2S$

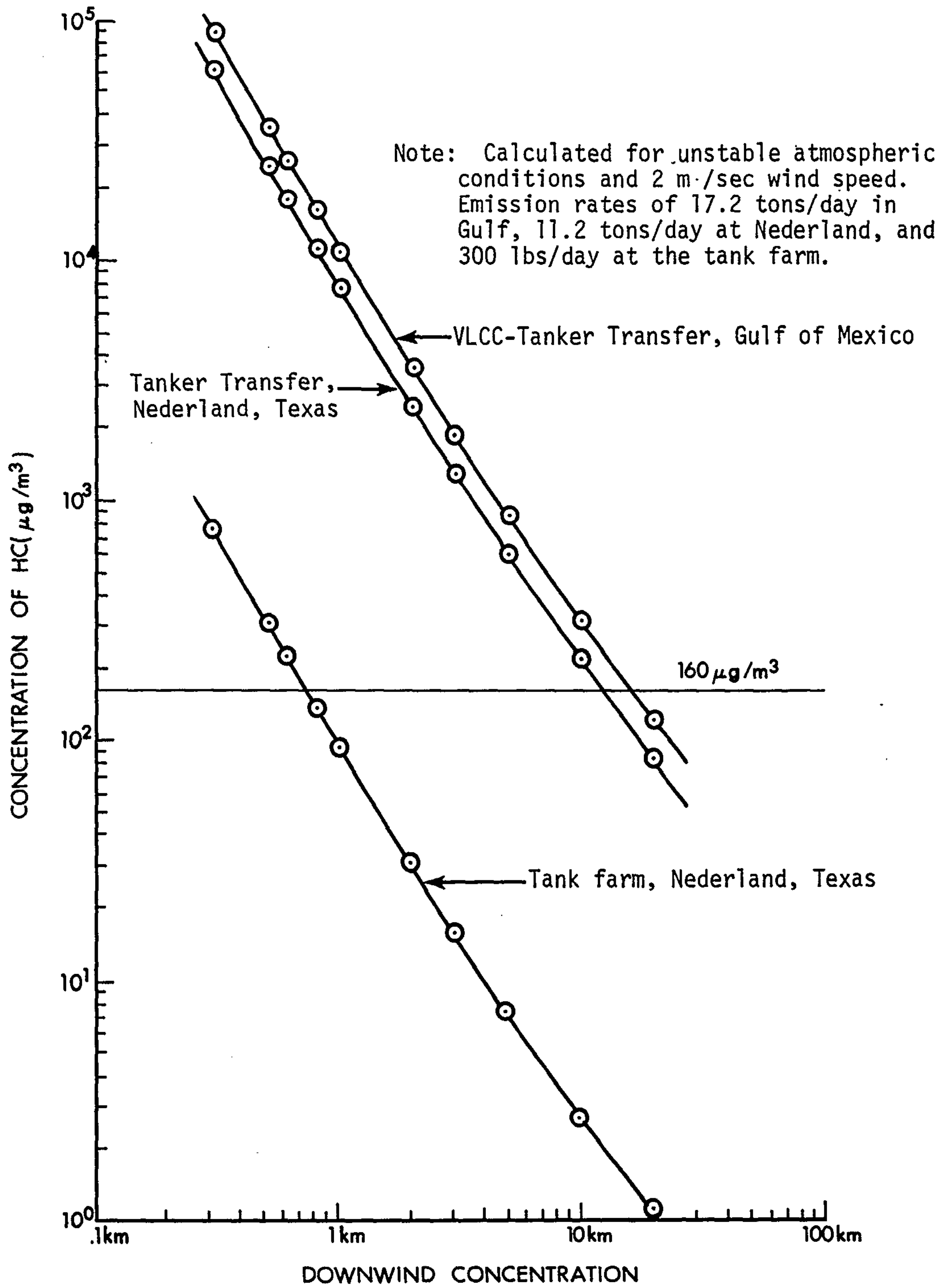


Figure 4.3-4 Downwind ground level concentration of HC (with no vapor control system) released during VLCC-tanker transfer operations in the Gulf of Mexico, tanker transfer at Nederland, and tank farm storage at Nederland

## 4.4 TERMINATION AND ABANDONMENT

No specific plan for termination and abandonment of the Kleer Mine oil storage site has been established. The FEA will develop such a plan in accordance with applicable regulations near the termination of the action. To date, no specific experience with the abandonment of an oil storage cavern facility has been developed in the United States. Conservative plans, in terms of environmental hazards, must account for surface subsidence and release of residual oils squeezed from the working by possible long-term plastic closure.

Present plans for the mine include putting it to some beneficial use after project termination, such as disposal of dredged spoil, slurried fly ash, or other polluted or toxic materials. The final selection of an abandonment plan and decision as to whether or not to seal the mine off will probably depend on the economic and environmental trade-offs and regulations that are in effect at the time of termination.

Continued use of the facility would assure continued surveillance of the cavern. The inherent integrity of the cavern would prevent any leakage of material into the environment. Activities associated with the specific use, such as waste transport, would impose some potential for environmental damage resulting from traffic, spillage, and noise.

If the facility is not put to beneficial use, the shafts could be sealed and the caverns left empty, as is the current practice with most abandoned underground mines. No adverse environmental effects are likely to result from such action.

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

There are presently no official plans, policies, or controls established by Federal agencies in Van Zandt County or elsewhere in the project region. Furthermore, lands under consideration for use in developing the Strategic Petroleum Reserve facility at Kleer Mine are presently devoted to industrial uses. This includes the 1 to 2 acres of land required for facilities at the Winnsboro Terminal. Half of the pipeline route to be used for transport of the oil between Kleer Mine and Winnsboro Terminal is presently accessible to the Mobil Pipeline Company; thus, about 21 miles, or 300 acres, of river flood plain, oak-savannah, and tame pasture must be temporarily disturbed by pipeline construction. Most present uses can be continued during the project lifetime.

The East Texas Council of Governments keeps historical records but to date has set no policy on land-use priorities (section 3.9). There are no zoning ordinances which apply to lands affected by the proposed action.

## 4.6 SUMMARY OF ADVERSE AND BENEFICIAL PROJECT IMPACTS

### 4.6.1 Summary Tabulation

Table 4.6-1 summarizes the findings of the various discipline analyses of project impacts. The data are in both qualitative and quantitative form, as appropriate, and represent the best professional judgment of potential impacts that could be made. A general appraisal of overall environmental impacts of the Kleer Mine project is presented in section 4.6.2.

A benefit that must be added to those tabulated is, of course, the intended goal of providing a substantial crude oil reserve for the country in case of a national emergency (see section 4.7). The 30 million barrels of oil to be stored at Kleer Mine represent about 6 percent of the total planned Strategic Petroleum Reserve, and 20 percent of the Early Storage Reserve.

### 4.6.2 Overall Project Appraisal

Conversion of the Kleer salt mine to an oil storage facility and development of a new mine nearby are not likely to generate significant environmental impacts except for possible short-term unemployment due to temporary mine shutdown, the remote possibility of a major oil spill, the release of relatively small amounts of hydrocarbon vapors from Winnsboro Terminal and the tank farm at Nederland and the release of locally significant quantities of hydrocarbons due to marine transport of oil from the Gulf of Mexico up the Neches River to Nederland. The fact that the mine site, Winnsboro Terminal and the entire transportation route from the Gulf to Winnsboro have long been used for industrial purposes and that the project locations are generally not a unique resource or habitat for significant flora or fauna minimizes the scope of impacts resulting from construction and operation activities. However, the mine is located adjacent to the Grand Saline salt marsh, a unique habitat in this part of Texas; special care will be required to avoid disrupting the marsh. Although the pipeline crosses some pasture land and river bottom-lands, these are not unique nor especially significant to the area, and the pipeline will be underground. Sedimentation may be a minor, local problem in watersheds crossed by the pipeline, but the impact is not considered significant. Construction noise may cause some annoyance to residents in the town of Grand Saline for a period of several months.

For the option of no mine shutdown, socioeconomic impacts of construction are not likely to be large or long-lasting since much of the work force is expected to be residents of the area. If the option of temporarily shutting down the existing mine is selected, there may be a significant, short-term (40 weeks) adverse social and economic impact to segments of the local population. Perhaps as many as 150 workers involved in salt mining and processing operations would be affected.

Operation of the Kleer Mine facility will have negligible socioeconomic impacts since its employment requirements (in addition to the Morton salt mining operation at the relocated mine) are very small. Continuation of mining activities is of great importance to the local economy, and the assessment that operation of the oil storage facility is of negligible local socioeconomic significance is contingent upon the continuation of salt production and processing after a new mine has been developed.

Environmental impacts of operation relate primarily to transportation of the oil by pipeline and tanker and to possible accidents involving oil spills. In case of a maximum credible oil spill accident, the environmental effects could be large, although probably of local significance. The probability of such a spill is very low, however. Property damage would probably not be great, although costs of recovering a large spill could be significant.

At Winnsboro Terminal, as much as 85 pounds of hydrocarbon vapors may leak from the proposed floating-roof storage tanks during each day of oil transfer operations. Vapor release from the tank farm at Nederland will total an estimated 300 pounds per day for approximately 150 days. Marine transport operations will release much greater quantities of hydrocarbon vapors to the atmosphere: an estimated 17.2 tons/day in the Gulf of Mexico and 12 tons/day at Nederland, during intermittent periods totaling 50 days during each cavern fill operation. Calculation of hydrocarbon concentrations downwind indicate that ground level concentration may exceed 160 $ug/m^3$ up to 1/4 mile from Winnsboro Terminal, up to 1/2 mile from the Texoma Terminal, up to 10.3 miles from the tanker transfer point in the Gulf of Mexico, and up to 7.8 miles from transfer operations on the Neches River. The effect on regional air quality should not be significant with the possible exception of emissions at Nederland.

TABLE 4.6-1 Summary tabulation of adverse and beneficial impacts*

| Subject Areas and Environmental Impact | Summary Characterization of Impacts | |
|---|---|---|
| | Adverse | Beneficial |
| **Geology** | | |
| 1. Land subsidence | No impact | None |
| 2. Seismic stability | No impact | None |
| 3. Engineering Stability | No impact | None |
| 4. Cavern integrity | No impact | None |
| 5. Disposal of mine water | No impact | None |
| 6. Loss of mineral resource | Negligible oil absorption; slight loss of recoverable salt | Expanded accessibility to salt deposits (with relocation of present mine). |
| **Hydrology** | | |
| 1. Surface water pollution | | |
| From mine: | Negligible. | None |
| From oil spill: | Small risk of large spill; temporary adverse impact. | |
| From pipeline construction: | Slight increase in erosion during construction periods, sedimentation in Lakes Quitman and Winnsboro. | |
| 2. Ground water pollution | No significant impact | None |
| 3. Water supply and recreation | Temporary adverse impact in the case of an oil release to Quitman Lake and Lake Cypress Springs. | None |

TABLE 4.6-1 (continued)

| Subject Areas and Environmental Impact | Summary Characterization of Impacts: Adverse | Beneficial |
|---|---|---|
| **Air Quality** | | |
| 1. Increase of hydrocarbons, $NO_x$, $SO_2$, particulates, and dust | Temporary localized increase in fugitive dust during construction operations; minor amounts of $NO_x$ and $SO_2$ from construction equipment and from flaring of volatile oil fractions vented during filling of cavern; negligible odor generation during filling and withdrawing operations; moderate amounts of HC vapors released during temporary storage of oil in floating roof tanks at Winnsboro Terminal and Nederland, Texas locally significant amounts of HC vapor released during transport of oil from VLCCs in the Gulf of Mexico to the tank farm at Nederland. | None |
| **Noise** | | |
| 1. Construction equipment | Moderate: increase in nighttime ambient sound levels at nearby undeveloped areas will be less than 6 dB during construction; increase at nearby Grand Saline will be 3 dB. Some potential for annoyance to residents within one-half mile of project. | None |
| 2. Pumping operations during filling and withdrawal | None: 55 dB at 500 feet (at least 11 dB lower than existing background ambient sound level on the site). | None |

TABLE 4.6-1 (continued)

| Subject Areas and Environmental Impact | Summary Characterization of Impacts | |
|---|---|---|
| | Adverse | Beneficial |
| **Terrestrial Ecology** | | |
| 1. Wildlife habitat | Temporary removal of approximately 640 acres for site preparation and pipeline structures; maintenance of 300-acre corridor during project life will prevent forest regrowth; bottomland permanently modified at Sabine River crossing. | Creation of new "edge" at perimeter of site might lead to increased diversity of wildlife in immediate area. |
| 2. Road kills of small mammals and birds | Some increase during construction but no long-term increase afterwards over current levels. | None |
| 3. Oil spill effects | Some risk to vegetation, pasture land, birds and wildlife | None |
| 4. Unique habitat | Potential for construction and oil spill effect on Grand Saline salt marsh. | Recognition of unique quality of marshes may prevent future development or drainage. |
| **Aquatic Ecology** | | |
| 1. Wildlife habitat | Potential degradation from bank erosion and turbidity resulting from site and pipeline excavation and grading. An oil spill could significantly affect habitat and populations, but risk of major spill judged to be minimal. Pipeline construction will temporarily displace local aquatic life in localized areas. | None |

TABLE 4.6-1 (continued)

| Subject Areas and Environmental Impact | Summary Characterization of Impacts: Adverse | Beneficial |
|---|---|---|
| Historical and Archaeological Assets | | |
| 1. Cultural resources | Survey indicates several sites could be affected by construction or operation; a detailed survey of potential sites within the proposed development area will be conducted when final route is selected; action will be taken to minimize adverse impacts. | Survey will add to archaeological knowledge of area. |
| Socioeconomic Characteristics | | |
| 1. Land use | | |
| a) Construction phase | Removal of approximately 640 acres of pasture and forest land for mine relocation and oil pipeline construction. | Increased economic utilization of land and expansion of local property tax base (if privately developed). |
| b) Operation phase | Other than maintenance to 300-acre pipeline corridor, no impact on existing land uses in area, except in case of oil spill. Probability of large oil spill occurring and affecting sparsely developed recreation area judged very small. | None |

TABLE 4.6-1 (continued)

| Subject Areas and Environmental Impact | Summary Characterization of Impacts: Adverse | Beneficial |
|---|---|---|
| **Socioeconomic Characteristics (cont'd)** | | |
| 2. Transportation | | |
| a) Construction phase | Negligible impact on State Highway 110; temporary increase in vehicular traffic at terminal and pipeline construction sites. | None |
| b) Operation phase | Moderate increase in tanker traffic in Neches River. | Fuller utilization of existing pipeline capacity. |
| 3. Population and Housing | | |
| a) Construction phase | Small temporary increase in daytime population for approximately 1 year; maximum of 140 nonlocal construction workers commuting daily from Dallas - Ft. Worth. | Slight net increase in income accruing to local residents. |
| b) Operation phase | Negligible (nonlocal personnel for storage facility estimated at fewer than 5). | Slight net increase in income accruing to local residents. |
| 4. Economic Changes | | |
| a) Construction phase | Temporary local scarcity of construction workers during period of peak employment for mine conversion and relocation. (No scarcity expected if mine is temporarily closed). Effect on salt production dependent on decision to close mine. Maximum of 40 weeks of output loss locally significant to region. | Estimated $7.3 million of regional construction labor income during mine conversion and other relocation activities (net of only $6.3 million if mine is shut down and 150 workers are put out of work). Increased demand for local supplies of construction services (materials, fuels, |

TABLE 4.6-1 (Continued)

| Subject Areas and Environmental Impact | Summary Characterization of Impacts: Adverse | Beneficial |
|---|---|---|
| 4. Economic Changes (cont'd) | | labor). Combined effect of construction payroll spending and procurements could stimulate some increase in secondary employment and income. |
| b) Operation phase | No significant adverse impact. | Slight long-term increase in income and employment in Grand Saline area. Slight temporary increase in tanker and pipeline construction employment and in shipyard employment. |
| 5. Government sector | | |
| a) Construction phase | Construction traffic near Grand Saline may necessitate controls. No increase in education and public welfare costs anticipated. Possible temporary decline in tax revenues on salt production if new mine output does not exactly offset decline in present mine production or if mine is temporarily shut down. | Increase in sales tax and federal income tax. |
| b) Operation phase | Costs of restoring public facilities in case of oil spill; possibly significant, but not highly probable. | Expanded tax base and increased revenues if owned and operated by a private company (estimated to exceed current mine property taxes by approximately $185,000 per year). |

TABLE 4.6-1 (continued)

| Subject areas and Environmental Impact | Summary Characterization of Impact: Adverse | Summary Characterization of Impact: Beneficial |
|---|---|---|
| 6. Aesthetic and Cultural Assets | Significant adverse social effect on dislocated miners and families if mine shutdown occurs. No significant adverse aesthetic or cultural effects. Mine not used for cultural purposes and is not pristine. An oil spill could significantly degrade aesthetic qualities relating to recreational uses of water, and costs of restoration could be significant; however, probability of a large spill is very low. | No direct impacts. Increased tax revenues could possibly lead to improvements in public cultural facilities. |

* For further details on project impacts, especially quantification of effects, see the appropriate subsections of 4.2 and 4.3.

## 4.7 CONSIDERATIONS OFFSETTING THE ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION

The basic need for a Strategic Petroleum Reserve Program is summarized briefly in section 1.0 and in more detail in the Programmatic EIS prepared by the FEA (DES 76-2). National dependence on foreign oil is approximately 40 percent of our present demand. Although present national policy is intended to achieve increasing energy self-sufficiency, that is not a goal that can be achieved in the near future, and the required capital and resource investment will be immense. During the interim, another interruption of foreign oil supplies similar to that in 1973 could severely affect economic and social conditions in the United States.

The intent of the oil storage program is to provide a measure of insurance against disruption of the national oil supply over the next 20 to 25 years while other, more reliable and environmentally acceptable energy supplies are being developed. The Strategic Petroleum Reserve Program is intended to reduce mid-term and long-term dependence on foreign oil supplies, recognizing our present national short-term oil dependence.

The Kleer Mine was selected during engineering feasibility studies as a candidate site, having superior technical and environmental characteristics, for inclusion in the Early Storage Reserve; that is, for supplying substantial reserves of oil by January 1979. Some adverse environmental effects will accompany development of the Kleer Mine for oil storage (sections 4.1 through 4.6). The importance of the site in providing a potential 20 percent of the established Early Storage Reserve capacity is a factor that subst ntially offsets the expected adverse environmental effects.

SECTION 5.0

UNAVOIDABLE ADVERSE IMPACTS AND AVAILABLE MITIGATIVE MEASURES

Some environmental impacts can be reduced or prevented by the use of sound planning methodologies, construction safeguards, and operational procedures. Other impacts are unavoidable because of technical or economic impracticality. It is the purpose of section 5.1 to identify the significant unavoidable adverse effects that will occur should the proposal be implemented as described in section 2.0; also, a brief discussion of available mitigating measures is presented in section 5.2.

5.1 UNAVOIDABLE ENVIRONMENTAL IMPACTS

This section drops the word "unavoidable," since it is understood that all impacts discussed fall in this category.

5.1.1 Construction Impacts

5.1.1.1 Soils

The principal adverse impact on the physical environment as a result of construction is erosion and subsequent sedimentation occurring as the result of runoff over disturbed land surfaces or along excavated trenches. Soil in most of the 651-acre construction area is clayey; topography of the region is flat to gently rolling and ground cover is usually good. These factors minimize erosion potential. Standard engineering practices, such as interceptor barriers in the trench, shallow drainage ditches, and temporary settling basins will serve to minimize erosion during the actual construction period. By proper backfilling of the trench, especially in areas susceptible to erosion, and careful revegetation procedures (including mulching where erosion potential is high), erosion will not be significant.

5.1.1.2 Hydrology

River and stream crossings will require the excavation or dredging of trenches where the pipeline will be located. Small streams may be either temporarily diverted or dammed, or passed across the pipeline trench by means of a flume or conduit. High flow stream crossings require that trenching, pipe laying, and backfilling operations be conducted while the water flow continues. In most cases, some disturbed soil and bottom sediments will be carried downstream. If additional backfill material is required, bankrun sand, gravel, or crushed stone will be used.

Temporary causeways required in soft-bottom streams for movement of construction equipment will cause some siltation and increased turbidity in the stream. Causeways will be constructed of nonpolluting material with properly sized pipe flumes installed to minimize erosion. The causeways will be removed after construction is completed.

During construction, some siltation of the small streams will occur despite efforts to prevent erosion. A reduction in water quality will temporarily occur due to increased turbidity and suspended solids during site excavation and grading. No toxic materials or heavy metals are expected to be resuspended into the water column.

A small number of stock ponds may have brief increases in turbidity. Lakes will be directly affected by construction of the facilities, as discussed in section 4.2. Both Quitman Lake and Lake Cypress Springs are likely to have increased sedimentation rates for a few weeks following construction.

The adverse impact of the storage site or pipeline route on the natural ground water regime will be minimal. Mine modification and new mine conversion should require less than 35 gallons of water per minute for mixing cement, sanitary, and other miscellaneous uses. No rock cuts or excavations for the pipeline will be carried below the ground water table.

5.1.1.3 Air Quality

Dust and noise typical of mining construction activities will be created, particularly during the site preparation activities and when explosive blasting and shaft sinking operations will be necessary. Small amounts of emissions will be produced from open burning, engine exhaust, and the new salt mine facilities. FEA is committed to minimize such effects and to comply with local and state regulations and standards.

5.1.1.4 Biota

Implementation of the proposed action is likely to result in the following unavoidable adverse impacts:

1. The loss of 10 acres of bottomland and 2 acres of oak-savannah habitat at the Kleer Mine site and Winnsboro Terminal areas.

2. The temporary loss of 636 acres of habitat during construction of the pipeline corridor, distributed among watersheds as shown in Table 4.2-2.

3. The disruption and possible loss of those wildlife species that inhabit the oak-savannah habitat and cannot relocate in adjacent habitats (i.e., rabbits, small rodents, and birds).

4. A disruption in the area food chain resulting from loss of food source for some primary consumer species (herbivores) with an escalating effect on higher level consumers.

5. A temporary reduction in carrying capacity for habitat affected by construction of the pipeline corridor.

6. Temporary reduction in grazing area and forage quality for domestic livestock as a result of construction of the pipeline corridor and terminal facility.

The loss of habitat at the mine site and terminal facility are long-term impacts and cannot readily be mitigated. During and subsequent to pipeline construction, 150 acres of land (habitat) will be permanently (or project-life) disrupted. A measure that can be employed to hasten the return of this land to useful production involves pipeline corridor revegetation. This revegetation could include plantings of grass and low shrub species selected for their rapid growth characteristics. The use of tree and woody shrub species for this revegetation is not encouraged because of resulting high maintenance costs for clearing and periodic brush removal.

Unavoidable environmental impacts to the aquatic ecosystems in the project area during the construction phase will occur primarily along the pipeline corridor. These impacts will entail the destruction of an unknown, but probably relatively small, number of aquatic organisms during dredging operations and pipelaying. Benthic invertebrates and algae will be most affected; fish will vacate the immediate area and, as adults, are quite resistant to short-term increases in sediment loads. However, fish in the immediate area may be affected through loss of food organisms. If pipeline construction occurs during spawning periods, eggs and larval fish in the immediate area will probably be destroyed as these are generally quite sensitive to sedimentation.

5.1.1.5 Socioeconomics

Construction of the pipeline and terminal could have an unavoidable adverse impact upon historical and archaeological resources located on the pipeline route. These impacts will be minimized by having an archaeological consultant available during construction.

Construction of the pump facilities and operation of the oil storage facility should not have unavoidable adverse impacts upon the historical or archaeological environment as these are located in industrial areas.

Construction of the pipeline will have only a short-term effect upon 640 acres of land use. Once construction is completed, only about 150 acres of land will not be returned to its former state, as it must be maintained clear of woody vegetation. The landowner may not build on the land but can otherwise determine its use (mostly pasture). Winnsboro Terminal facilities will require approximately 10 acres of land and the Kleer Mine facilities approximately 2 acres.

Trucking and other vehicular traffic will increase during construction of the project. The level of traffic will depend on provisions made to bus employees to the site. Local traffic levels are light enough to allow some increase in traffic without significant impact.

With careful planning, there is no reason that construction or operation of the oil storage facility would dislocate people. There would therefore be little to no unavoidable impact upon population resulting from construction and operation of the oil storage and new mine facilities. Should the salt mine operations be discontinued temporarily, some of the existing employees may find employment in the construction crews. The remainder could be unemployed for the period of shutdown (estimated at 40 weeks).

Construction of the oil storage facility will affect the construction labor force. The impact, however, would be relatively short term and insignificant. The project will not significantly affect the basic economy of Van Zandt County.

### 5.1.2 Operational Impacts

#### 5.1.2.1 Soils

Other than temporary damage that might occur to soil productivity from an oil spill, the operation of the storage site will have no significant adverse impacts on soils.

#### 5.1.2.2 Hydrology

Consumptive use of water by the oil storage facility during operation will be small. Consumptive use of water at the new salt mine will be the same as that currently being used for solution mining, mine personnel, and sanitary facilities.

No water or wastes are expected to be discharged from the oil storage caverns into the nearby streams.

Filling the cavern with oil will not have an impact on aquifer hydraulics or on ground water quality. The mine shafts and cavern will be hydraulically isolated from the Wilcox-Carizzo aquifers. Therefore, no impact on the ground water regime is expected to result from operation of the storage facility.

#### 5.1.2.3 Air Quality

During storage operation, there will be no atmospheric emissions at the site except for flaring of small volumes of vented gases from the oil cavern during filling and leakage of hydrocarbons from surface piping. Flaring will reduce odor and hydrocarbon emissions to nominal amounts. No increases in gaseous concentrations should be detectable beyond the immediate construction area.

Oil leakage during filling operations will release a total of approximately 42 lb/day of hydrocarbons into the local atmosphere at Kleer Mine, 85 lb/day at Winnsboro Terminal, 300 lb/day at the Texoma Terminal, 17.2 tons/day in the Gulf of Mexico, and 12 tons/day at Nederland dock facilities. Air quality standards for hydrocarbons are presently exceeded in the vicinity of Nederland.

#### 5.1.2.4 Biota

Woody vegetative growth along the pipeline route will be periodically harvested. As herbicides are not planned to be used, secondary effects will be limited to continued loss of habitat for certain species of birds and small mammals.

Oil spill effects are noted in section 4.3.8 as minor short-term impacts from small to moderate spills. A maximum credible spill could destroy biota on up to 200 acres of habitat and several miles of stream bed.

#### 5.1.2.5 Socioeconomics

There will be a temporary (50 days) increase in tanker traffic in Sabine Lake and the Neches River during each fill operation. The increase is equivalent to approximately three round trips per day.

## 5.2 MITIGATING MEASURES THAT COULD BE IMPLEMENTED DURING DESIGN, CONSTRUCTION AND OPERATION

### 5.2.1 Introduction

Many of the environmental impacts associated with the proposed facility can be considerably reduced by proper design and execution of the project. It is the objective of the FEA to provide a reasonably economical means of crude oil storage together with maximum environmental safeguards. This objective may be accomplished by application of the best available technology in design and construction of the facility, and implementation of sound operating practices and effective emergency action plans.

This section considers in summary fashion the most important mitigative measures that are available and could be taken to provide additional environmental safeguards according to the following categories: 1) preventive measures; 2) environmental enhancement and restoration; 3) monitoring programs; and 4) measures to reduce the probability of oil spills.

### 5.2.2 Preventive Measures

Preventive measures are those taken during planning and implementation of a strategy. Some examples of measures that have been or could be taken in this project are given below.

#### 5.2.2.1 Preventive Measures in the Planning Phase

Pipeline routing at the conceptual design phase is very flexible. The criteria established for site selection included:

1. Minimum total and effective length between Kleer Mine and Winnsboro Terminal.
2. Minimum number of major stream crossings.
3. No large pond or lake crossings and maximum buffer zone when watershed is crossed.
4. Follow an existing pipeline route over the maximum distance that satisfies above criteria.

After these guidelines were used to select the general route, 7.5-minute topographic maps and county soils maps were used to plot a tentative route that meets, as much as possible, the following criteria:

1. Minimum bottomland and river flood plain disturbance, following the crests of hills to generally maximize the mileage in "good" trenching material like the Woodtell-Freestone soil series.

2. Right-angle stream and road crossings.

3. Avoidance of residential or other land intensively used or known to have cultural significance.

4. Maintain a buffer zone at least 200 feet wide between the pipeline route (120-foot wide corridor) and stream courses or banks.

5. Avoidance of known stands of timber and heavy thickets.

#### 5.2.2.2 Preventive Measures in the Implementation Phase

Some examples of preventive measures that may be implemented to reduce impacts are briefly discussed.

##### Water Quality

In order to maintain the current water quality of the streams and aquifer in the construction areas, all water pumped from the area can be treated off site by a commercial disposal company. Another option would be consideration of an on-site treatment facility during the final design stage.

Erosion potential can be decreased by replanting of vegetation along the pipeline corridor after the line is buried and covered with top soil. This measure would result in a decreased level of suspended sediments in the streams during periods of high water runoff. In addition, because of the relatively flat or gently rolling hills of Van Zandt County, these solids could not be transported for significant distances. With proper pipeline design and placement, there should be no significant disruption to the natural drainages or the water resources.

##### Air Quality

Two main sources of contamination will affect local air quality in the immediate oil storage area. Heavy mobile equipment will exhaust diesel fumes to the atmosphere, and will produce fugitive dust. In order to reduce the volume of exhaust fumes, all internal combustion engines can be maintained with regard to high performance efficiency and operation.

Fugitive dust could enter the atmosphere from several other sources within the storage site. In order to reduce the atmospheric loading from the shaft drilling and sinking operations, small amounts of water can be added to the drill-air-stream to reduce the fine cuttings liberated during drilling operations. If the rock material to be loosened by blasting is too dry and may cause sufficient dust clouds during excavation, this rock can be sprayed with water to reduce these emissions. All mine site roads and pipeline access roads could also be sprayed with water periodically to reduce fugitive dust, especially during the dry summer months. A description of possible vapor control systems for use in reducing hydrocarbon emissions from oil handling systems is provided in Section 5.2.6.

Noise

Vehicles utilized at the construction site can be equipped with muffler systems to reduce their noise contribution to the existing ambient levels in the residential neighborhoods. This measure should be especially enforced during the nighttime hours. Blasting of the shafts can be limited to daytime periods so as not to interfere with sleep in the residential areas. Blast mats or deep burial of the explosives could be used to reduce the noise and annoyance to nearby residents. The U.S. Environmental Protection Agency is studying the regulation of all types of equipment noise. It is anticipated in the near future that construction equipment, trucks, and mining equipment noise levels will be reduced by regulation.

Ecology

Revegetation of the disturbed areas at the storage site and along the pipeline corridor can help to prevent erosion and provide habitat within several months for rodents and other small animals displaced during construction activities. This new habitat would attract birds such as doves and quail and predators; it would also provide food for herbivorous animals.

Impacts of construction of the new mine development area and access roads can be minimized by: 1) erosion control through rapid establishment of a vegetative cover on exposed and disturbed areas; 2) control of surface runoff through use of ditching, diking, and settling ponds if necessary; and 3) minimizing time period during which wastes are temporarily stored on the surface.

Pipeline construction impacts can be reduced by rapid revegetation of disturbed areas to reduce erosion. Pipeline crossings should be perpendicular to the stream course where feasible. The pipeline corridor, where parallel to the margin of aquatic habitats, could be located so as to leave at least 50 feet, and preferably 100 feet, of untouched natural vegetation adjacent to streams, lakes, or ponds to minimize turbidity. Pipeline bridges across waterways are an alternative to trenching and should be considered for the Sabine River and Lake Fork Creek crossings.

Special attention could be given to controlling runoff from construction areas in order to avoid a significant alteration in quantity or quality of water flowing into Grand Saline salt marsh. Berms and dikes could be designed to maintain normal drainage quantities without excessive sedimentation. These should also provide some degree of control should an oil spill occur in the vicinity of the marsh.

Preventive Measures - A Summary Listing

1. During all construction activities, movement of vehicles can be controlled to protect natural vegetation, seeded areas, and erosion control structures. Vehicles should cross drainageways only where culverts are provided.

2. Areas used by heavy equipment can be gravel surfaced and sprinkled when necessary to control dust. Main roadways can be paved and maintained.

3. Whenever practicable, other methods of disposal (shredding or mulching) can be used rather than burning of waste vegetation.

4. Internal combustion engines can be maintained in good mechanical condition to reduce gaseous emissions.

5. Dust emissions from the batch concrete plant can be controlled by techniques reflecting the best available engineering practices.

6. Chemical toilets can be provided and maintained by a contractor until the plant septic tank system is completed or in areas where septic tanks are not suitable.

7. Liquid wastes such as chemicals, lubricants, and bitumens can be contained or stored in tanks for removal to offsite locations.

8. Soil erosion during grading and excavation can be controlled by diverting surface runoff away from the construction and spoils areas.

9. Temporary cofferdams can be installed across main streams and across the pipeline trench to contain siltation during pipeline laying.

10. The stream banks can be protected against erosion by additional riprap.

11. In order to check the effectiveness of the erosion control measures, water quality can be monitored at appropriate locations as part of the construction program.

12. All mineral solid waste resulting from construction and shaft sinking can be placed in the storage cavern for stabilization prior to filling.

13. Special attention could be given to maintaining the quantity and quality of runoff into Grand Saline salt marsh.

### 5.2.3 Environmental Enhancement and Restoration

The effect of pipeline construction can be mitigated by the choice of suitable pipeline construction techniques and site restoration measures. Some general guidelines that will be used in these tasks are discussed in this section.

#### 5.2.3.1 Pipeline Construction

Dry-land construction methods should not be used in the Sabine River flood plain during very wet conditions because construction would be drastically slowed and result in excessive environmental damage. If standing water is present throughout much of this bottomland during pipeline construction, the push-ditch construction technique that is often used in freshwater swamps and in riverbottom areas could be employed.

Soils in these areas can support marsh buggy-mounted excavating and backfilling equipment but cannot support conventional dry-land pipeline construction equipment. In the push-ditch method, a right-of-way width of up to 150 feet is cleared. The in-place pipelines with protective coatings will require minimum cover of 3 feet, requiring a push ditch of up to 8 or 9 feet deep. Depending upon soil conditions, a push ditch might be approximately 10 to 30 feet wide at the surface to facilitate the above ditch depth. Excavating of the push ditch is normally done with backhoes mounted on marsh buggies that travel along the right-of-way.

Push sites are selected at convenient locations along the right-of-way. These sites are used to assemble the pipe joints into the completed pipeline and to push it into its final location. The push sites are located by considering the location of pipeline and road crossings used and construction difficulties encountered. They are also located so as to have convenient access for hauling in heavy joints of pipe and associated materials to supply the need of the push sites.

The fabrication and assembly of the pipeline consists of welding together joints of pipe (each approximately 40 feet long) at the push site. The site will have several work stations. A final station is required for application of corrosion protection coating of the field joints. Several different operations are carried out simultaneously on different joints of the pipeline along the length of the push site. The completed pipeline is pushed forward into the push ditch and the assembly procedures are repeated. A marsh buggy or similar equipment travels along the right-of-way with the front end of the pipeline to guide the pipeline down the push ditch and aid in starting and stopping the pipeline as assembly continues. The length of the pipeline section that will be pushed will vary with the location of the push sites and the existence of other pipelines and roads that must be crossed.

After the completed pipeline is assembled and in its desired location, it is filled with water causing the line to sink to its final position. After pressure checks, the drag lines mounted on the marsh buggies travel along the right-of-way filling the ditch with spoil that was stored along the right-of-way.

5.2.3.2 Site Restoration

To plan a successful stabilization and revegetation program, a detailed survey and representative soil samples must be collected and normal agronomic tests conducted. Recommended levels of lime and/or fertilizer should be available from the Soil Conservation Service (SCS). Areas to be sprigged or seeded in tame pasture grasses, or in rangeland grasses, must be determined for seed ordering. Forested areas and bottomlands requiring special treatment must be determined precisely. The appropriate native species should be sprigged or planted in tame pastures if the denuded area is over 30 feet wide. Planned pipeline right-of-way width is 60 to 120 feet.

Where slopes exceed 10 percent or soil moisture-holding capacity is low, some type of hydromulching or asphalt mulching could be considered to prevent erosion.

If seeding or sprigging operations occur during the late fall or winter, a cool-season annual could be planted along with the native or introduced species to insure an adequate ground cover until the perennials initiate growth.

5.2.3.3 Environmental Enhancement and Restoration - A Summary

1. Transportation could be provided from nearby communities (perhaps Tyler, Longview, or Dallas) to minimize the local traffic generated during peak construction periods.

2. In clearing the transportation and pipeline rights-of-way, only small trees and shrubs could be removed. Growth retardants, chemicals, or herbicides could be avoided.

3. After grading, all necessary measures can be taken to control soil erosion. These measures may include temporary vegetative cover, mulching, gravel cover, and riprapping.

4. Original topsoil removed could be separated and later replaced and reseeded with native grasses when appropriate.

5. After completion of construction, all areas disturbed by construction and not required for permanent facilities could be landscaped and seeded to be compatible with the original terrain and to provide wildlife habitat.

6. Buffer strips of natural vegetation can be preserved along the forests and stream banks wherever possible to provide wildlife habitat and minimize erosion.

7. During operation and storage of the oil, observation wells can be monitored regularly to detect changes in water table elevation or contamination of the aquifer.

8. An archaeologist can be retained during the excavation phase to inspect the site, report the uncovering of any archaeological artifacts or sites of historical interest, and to recommend appropriate means of preserving them.

9. Permanent fencing can be limited to that necessary to maintain security of storage facility structures, and so forth.

### 5.2.4 Monitoring Programs

A comprehensive monitoring program has not been designed for this project. Various considerations could be integrated into this program in order to assure meeting industry standards and regulations of the various federal and state agencies.

The monitoring program could be designed to assure the protection of both personnel and the environment. Monitoring could consider normal activities during project construction and operation and, in the event that an accident should occur, measure the impact of the accident and the effectiveness of cleanup procedures.

#### 5.2.4.1 Construction Monitoring

The construction monitoring program could consider air quality, geology, hydrology, water quality, and both terrestrial and aquatic ecology. Particularly critical parameters to be measured during the construction monitoring program include:

1. A complete geological survey of the mine cavern and pipeline route to define any possible fault systems or other hazards along the route.

2. The stream stages, velocities, and water quality along the pipeline route.

3. The reclamation success in preventing degradation of surface water quality near the project storage site, the oil distribution system, and Winnsboro Terminal.

The aquatic monitoring program could measure flow rate, water chemistry, sediment composition and depth, bottom contour, and aquatic biota of the streams. These measurements could be taken in conjunction with on-going studies by others, with particular emphasis on measurements taken near existing public water supply intake stations and at stream entries to reservoirs below the project.

The terrestrial monitoring program would place special emphasis on vegetation because the major impact of project construction and oil spill risk during operation will be on the floral community. The program should concentrate on measurements in the immediate vicinity of the project and include a 1-mile wide strip centered over the proposed pipeline right-of-way. In addition, particular emphasis would be placed on species dependent for their existence upon the major streams affected by the action.

5.2.4.2 System Operation

When the system mode is neither filling nor withdrawing, routine monitoring will be required. This monitoring could be conducted in conjunction with the normal operation and maintenance procedures appropriate for these periods. Visual monitoring of system components for excessive emissions and for leaks will be the main efforts. Also, ground water pressures behind the pump shaft could be monitored to detect possible solution problems. However, during crude withdrawal or refill operations, the program discussed next could be activated to reduce spill size and impacts. (See also Appendix H.)

5.2.4.3 Measures to Reduce the Probability of Oil Spills

The basic elements of an oil Spill Prevention Control and Countermeasure Plan (SPCC) are discussed in Appendix H. The following is a partial list of available measures to reduce operational risks.

1. A shut-off system could be installed in the oil fill pipes below the shaft seal.

2. A cover could be placed over the pump shaft to prevent entry of surface water.

3. The concrete shaft plug could be designed to withstand overpressures created by a potential explosion in the cavern and the weight of a full shaft of water. Shaft plug(s) could also be designed to withstand the impact of soil and rock resulting from a shaft failure.

4. Diversion dikes or channels could be constructed to divert runoff away from the storage and terminal areas and to divert any oil spillage to the containment area. Special emphasis could be placed on keeping oil out of the Grand Saline salt marsh.

5. Installation of a modern supervisory control system could allow dispatchers to observe the status of operations at the pump station, and delivery point, and to shut down the flow in the system should any potentially dangerous deviation in normal operating conditions occur.

6. Installation of check and manual valves at all major stream crossings.

7. Installation of automatic gate valves at the pump station.

8. Installation of a cathodic protection system to prevent corrosion. Cathodic protection is utilized to protect the pipeline metal from electrochemical corrosion by using it as a cathode of a cell together with sacrificial anodes. This measure is used to protect the line from galvanic action between the bare steel and certain soils in which the pipeline is laid. Protection is often achieved by causing a small direct current to flow in the opposite direction to the galvanic cell.

9. Regular surveillance of the pipeline by air and/or surface methods. In more congested areas or in potentially hazardous areas, surveillance could be conducted at least every week. The entire system could be surveyed every 2 weeks.

10. Availability of well-equipped "strike-force" crews at strategic locations along the route could ensure prompt corrective action in the event of the discovery of hazardous conditions, leaks, or ruptures.

11. Installation and maintenance of warning signs and markers along roads, property lines, and in other areas as required for safety reasons or by government regulations.

12. Since a large percentage of pipeline leaks result from third party construction accidents, the route could be clearly marked with appropriate signs; literature, phone numbers, maps, and so forth could be distributed that pertain to the line locations, risks of rupture, and the properties of crude oil and its products. The signs and literature would request notification of the FEA regarding planned construction in the

vicinity of the line so that the line may be precisely located and marked. In addition, the FEA could periodically contact city, county, state, and federal agencies to assure that the location of these facilities is known, and that the proper persons to call are on record in the event problems develop.

13. A contingency plan may be developed as part of the SPCC to ensure prompt, decisive action to lessen detrimental impacts in the event of a major crude oil spill. This contingency plan would include plans for coordination with governmental agencies and private industry to enable the FEA or contractor to utilize the nearest and best equipment and crews located in a given area should a potentially hazardous spill occur.

### 5.2.5 Oil Spill Mitigation

The impacts discussed in sections 5.2 and 4.3.8, in particular, are not all addressed in this section. A framework for an oil Spill Prevention, Control and Countermeasure Plan (SPCC) is given in Appendix H, but the following brief discussion will serve to indicate the information that is available. Practicable plans can be prepared for the Texas Railroad Commission's review at the appropriate time in the detailed design phase.

The most significant mitigating measure to protect the environment during pump station operation would be construction of a berm of sufficient size to contain a moderately large (maximum credible) oil spill (assumed 5000 barrels). This berm would also contain any chemicals used in building or vegetation maintenance. The outer margin of such a berm could be vegetated or riprapped to ensure slope stability and reduce erosion. If the inner margin were vegetated, it would probably create an unacceptable fire hazard.

Baker (1971d) reported that burning and cloaking areas with dry powder failed to aid recovery of marsh vegetation. The conclusion was that it was best to leave oiled salt marsh to recover naturally. Cowell (1970) and Baker (1971e) have indicated that crude oil has a stimulating effect on vegetative production as degradation of the crude progresses. The possible increase in activity of nitrogen-fixing bacteria in oil-treated soil was perhaps responsible for the increase since investigations have indicated macro- and micro-nutrients do not exist in crude oils in amounts sufficient to be stimulating.

Prevention of oil spills is the first and most effective step in assuring that the aquatic environment is not affected by the project. If a spill does occur, the next step is to contain the spread of the spill, and then to remove the oil from water surfaces as soon as possible.

A "strike-force" response time and procedure can be developed for the SPCC. Potential impacts to the aquatic ecosystems in the vicinity of the storage facility can be reduced considerably by the construction of a barrier to contain spills. If oil should enter a marsh, creek, stream, pond, or lake in the project area through pipeline rupture or other event, adverse impacts can be mitigated by appropriate emergency procedures.

Procedures for containment and cleanup of oil spills originating from inland pipelines have been discussed by Klipp (1973). Generally, containment measures applicable to the aquatic habitats of the project area employ the use of booms or barriers and nonsinking absorbents. Dispersants are not recommended, as these agents are generally more toxic to the aquatic biota than the oil (their use can markedly increase the toxicity of the oil; Rehwoldt and others, 1974).

In quiet water areas such as ponds, lakes, and swampy areas, oil can be removed from the surface using special oil spill pick-up equipment, improvised skimmers, and portable pumps, or by vacuum trucks if the impact area is accessible to vehicles. Shorelines of ponds and other quiet water areas can be cleaned up by mechanical means including raking, removal of soils or vegetation (as dictated by least environmental impacts), or by washing and subsequent recovery from the water surface. In running streams, oil can be diverted into quiet water areas by use of booms, and can be recovered by use of nonsinking absorbents and skimming equipment or pumps. Shorelines of running streams tend to be self-cleaning. However, they may be cleaned by physical shoreline disturbance, jet spray washing, or other appropriate techniques, if environmental consequences are not severe (Klipp, 1973).

Containment and cleanup in larger rivers such as the Sabine River, especially during runoff periods, would be quite difficult. Effectiveness of mitigating measures would depend much on the rapidity of detection of the spill and the responsiveness of the cleanup crews. In a large spill, immediate implementation of containment and cleanup measures is essential. Efforts could be directed towards concentration and removal of as much oil as quickly as possible. Operations would probably have to be conducted from one bank to another. Multiple boom placement for diversion and control of spreading oil would probably be necessary and could be employed to direct oil into natural eddy areas and side channels where recovery equipment can be used to remove oil (Klipp, 1973).

### 5.2.6 Vapor Control Systems

The release of hydrocarbon vapors to the atmosphere, either by flaring or venting, affects project impacts in two ways. First, the hydrocarbon vapor represents an irretrievable loss of petroleum resources from the SPR system. The loss is estimated to be 0.18 percent of the potential cavern storage capacity from an uncontrolled system -- a total of 266,400 barrels (equivalent) for five fill/withdrawal cycles (section 7.4). Second, vapors which are not flared contribute a significant amount of hydrocarbons to the atmosphere, particularly in southeast Texas where hydrocarbon concentrations are already high. The quantities of unflared hydrocarbon emissions contributed to the atmosphere from an uncontrolled system are estimated to be: 1) a maximum rate of 195 BPD; 2) a maximum annual emission of 9960 barrels; and 3) a total release of 50,400 barrels of oil during the project lifetime.

Technology exists to significantly reduce the amount of vapors lost from the storage and transportation system. For example, a vapor blowback system involves simply a return line for gas flow between two petroleum reservoirs exchanging fluid. The gas expelled from the receiving reservoir is returned to the originating reservoir so that, in theory, the entire system is closed. Allowing for system leaks, 95 percent recovery should be achievable. This system would be most easily implemented at the Nederland docks during cavern filling operations. A method of clamping the return lines onto the tanker vents would be required. The system would be relatively inexpensive to construct.

Another system of vapor recovery is a vapor condensation unit. A condensation unit compresses the gases to 3 or 4 atmospheres, liquefying most of the petroleum vapors which are then recovered and reinjected into the cavern under pressure. The compressed air must eventually be returned to the atmosphere, and some petroleum is flashed off. The system's efficiency may range from 60 to 85 percent petroleum recovery. This system could also be implemented at the Nederland transfer terminal. It is also possible that a condensation system would be utilized in place of venting through a flare during cavern fill at the storage site to eliminate loss of vapors and to provide a means of continuous control of cavern storage pressures. A vapor condensation system requires a considerable capital investment, depending on the size of the unit required.

A third possibility is to flare the vapors before release, at a safe distance from the oil. Flaring essentially eliminates air quality effects but does not allow hydrocarbon recovery. A fourth possibility is permanent ballasting of tankers. This would nearly eliminate hydrocarbon emissions associated with transfer activities at Nederland and would also eliminate ballast discharge problems at the lightering site in the Gulf. All of these technologies for vapor control and recovery described above are state-of-the-art.

At present, most crude oil facilities do not handle sufficient quantities of oil to justify extensive vapor control systems. Also, existing state air quality regulations in Louisiana and Texas (locations of major crude oil facilities) specifically exclude crude oil facilities from control. Adaptation of existing technology would be feasible for the Kleer Mine oil storage system and may be economically advantageous.

An estimate of the mitigative effects of vapor recovery may be made by assuming the following: 1) at the Kleer Mine storage site, install a vapor condensation system with 60 percent efficiency; 2) at the Nederland transfer terminal, install a vapor blowback system with 95 percent efficiency; 3) losses during transfer between VLCCs and tankers in Gulf of Mexico assumed unrecoverable and unsafe to flare.

The mitigative effects of such a system may be expressed in terms of the reduction in hydrocarbon release to the atmosphere and a reduction in total loss of hydrocarbons from the Kleer Mine system. The reduction in estimated hydrocarbon release to the atmosphere may be summarized as follows: 1) maximum system daily emission rate reduced by 39 percent to 120 BPD; 2) maximum annual release to the atmosphere reduced by 39 percent to 6170 barrels of oil (equivalent); and 3) total release of hydrocarbons to the atmosphere during the project lifetime reduced by 38 percent to 31,200 barrels of oil. The reduction in total hydrocarbon loss from the Kleer storage system would be approximately 56 percent to 117,600 barrels over the life of the project.

## 5.3 REQUISITE PERMITS: FEDERAL, STATE, AND LOCAL PERMITS REQUIRED

There are no specific federal, state, or local agencies that prescribe mitigating measures for the mine site facilities. However, the National Environmental Policy Act of 1969 specifically stipulates under Title I, Section 102(F) that all agencies of the Federal government shall

> "make available to states, counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality of the environment . . ."

Therefore, one of the goals of this statement is to facilitate a coordinated effort among the FEA, other cognizant government agencies, and the general public, which could lead to implementation of useful mitigative measures on and adjacent to the storage site facilities.

The applicability of state and local permits and regulatory procedures to the project has not been determined. The following sections describe some local and state regulatory methods.

### Texas Railroad Commission

The Texas Railroad Commission (TRC) has jurisdiction over underground storage of hydrocarbons. No permits are necessary for construction activities proposed in section 2.0, i.e., mine conversion, construction of oil pumping stations and pipelines, and new mine development. However, before a pipeline can be used, a pipeline permit, "T-4," is required. The permit form (available from the TRC) must include origin, terminus, and size of pipeline, plotted on a map (unspecified scale).

Written request for a hearing on proposed underground storage of hydrocarbons is necessary; a public hearing would be scheduled within 45 days. Information on extent of salt and assurances of no leakage from the salt mine into surrounding territory will be required before storage permission would be granted.

### Texas Water Quality Board

The Texas Water Quality Board will review and comment on the "T-4" application to the TRC. Any point sources of effluents, such as brines to receiving waters, require a Waste Control Order in Texas; none are anticipated for the proposed project.

## Sabine River Authority

The Sabine River Authority of Texas and Louisiana would review and comment on the application to the Texas Railroad Commission. This agency is one of the principal conservation agencies concerned with the project.

## Texas Air Control Board

Under Texas Air Control Board Regulation VI, construction or modification of a facility requires a construction permit (PI-1) from the Texas Air Control Board. Either an emission permit or an exemption letter would be necessary. A copy of this report would be submitted to determine if a permit is required, or if a letter with details and a sketch of surface facilities would be sufficient.

Under Texas Air Control Board Regulation V, 502.3, crude oil storage is exempt from air quality regulation.

## Other Agencies

Interested Texas agencies contacted that do not have regulatory authority are as follows:

1. East Texas Council of Governments.
2. Texas Energy Advisory Commission.
3. Texas Division of Planning Coordination, Office of the Governor.

SECTION 6.0

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

## 6.1 INTRODUCTION AND SCOPE

This section describes the relatively short-term uses of the local environment that are implicit in the construction and operation of the proposed oil storage facility at Kleer Mine and the expected effects on maintenance and enhancement of long-term productivity. Based on the analyses in the previous sections of this statement, it is concluded that the proposed uses of the site and its environs would not significantly affect the long-term productivity of the environment.

The principal short-term use of the Kleer Mine will be the underground storage of crude oil for use during a period of national emergency. This oil storage will contribute to the short-term availability of petroleum resources should the nation's foreign supplies be unexpectedly and suddenly reduced, thus providing an element of stability and security to our economy and to our national well-being. The use of a producing salt mine for oil storage will reduce the total recoverable supply of salt at Kleer Mine. The effect on national mineral resources is miniscule, however.

The use of Kleer Mine for underground oil storage will add a potential reserve of 30 million barrels of oil for immediate use in the future. This amount will account for approximately 6 percent of the total SPR storage requirements as detailed in the Energy Policy and Conservation Act of 1975.

There is no current experience in the United States to indicate that any stress to the environment would occur due to underground oil storage. Long-term studies and experience in European countries indicate that no harmful effects can be expected using current technology. The increased storage potential may enhance both the short- and long-term economic productivity of the nation by reducing the threat of an oil supply interruption, promoting international stability of oil supply, and freeing national resources for the development of alternative energy supplies. Provided that adequate environmental protection, monitoring, and safety measures are taken to mitigate impacts, to minimize the leakage of oil, and for fire protection, few localized harmful effects can be expected. For this discussion, "short-term" refers to less than 4 years. "Long-term" is greater than the project life by perhaps 50 years or more.

On the other hand, it is recognized that chronic or high-level pollution from possible accidental oil spills could have adverse impacts in certain areas. It is difficult to quantify these impacts or to estimate the short- or long-term effects of a major oil spill, since these effects would depend upon the location and fate of the spill. Data provided on expected average spill rates and on maximum credible spill impact indicate that no significant damage to regional resource values should result (section 4.3.8).

If the Kleer Mine is developed for storage, approximately 2 surface acres and all salt within 300 feet of the existing mine caverns would be eliminated from future salt mining activities, at least until the caverns are no longer used for oil storage (see section 7.5). This removal will result in a reduction in the long-term mineral resources available to the local miners and the mine owners. However, the salt mine will be relocated to an area adjacent to the oil storage cavern; available salt resources are sufficient to allow continued mining during the forseeable future.

Disturbance of 42 miles of corridor (640 acres) for construction of a pipeline between Kleer Mine and Winnsboro Terminal is a short-term use of these lands. Half the habitats to be affected are already disturbed by a Mobil Oil pipeline, and do not represent a unique or especially valuable resource. No significant long-term effect on biotic productivity is anticipated.

Under normal operating conditions, impacts to the aquatic ecosystems of the project area will be short-term in nature, and will entail the loss of some fish and benthic organisms. Provided that a significant oil spill that would reach aquatic habitats does not occur, long-term productivity of the aquatic ecosystems in the project area should not be affected.

The relatively small construction and operational work force for the project is a short-term use of manpower without an adverse long-term effect. See section 4.6 for a summary of other effects.

## 6.2 EFFECT ON NATIONAL ECONOMIC PRODUCTIVITY

The Kleer Mine oil storage facility will provide a potential reserve supply of about 30 million barrels of petroleum during the operating life of the facility. This oil will provide some measure of certainty in meeting the projected energy needs of government, industrial, commercial, residential and other users.

Construction and operation of the storage site will thus increase available standby energy; the beneficial effect on economic productivity will be large compared to the loss of mineral salt resources, agricultural, forestry, recreational, or other potential uses of the site. Substantially increased payrolls and, possibly, increased property taxes will have a beneficial economic impact on the surrounding counties in Texas.

Should temporary closing of the Morton Mine be selected as the development option, there would be a significant short-term loss of economic productivity for those workers not able to find suitable alternate employment.

## 6.3 ADVERSE IMPACTS ON PRODUCTIVITY

### 6.3.1 Impacts on Land Use

Construction and operation of the Kleer Mine storage area, new salt mine, and Winnsboro Terminal will remove about 14 acres of land and a relatively small volume of salt rock from other uses for the life of the storage project.

Short-term impacts on resources caused by construction will include the temporary loss of 640 acres of oak-savannah/tame pasture/bottomland habitat in the pipeline corridor and the resulting stress on terrestrial wildlife species utilizing the corridor. There will also be a reduction in the carrying capacity of the land, in grazing land, and in the quality of forage for certain wildlife species and domestic livestock along the pipeline route. The noise associated with construction at the mine and terminal sites, along the pipeline route, and from pumping during the 20-month fill period will also be a short-term impact. The effect of all of these impacts on the long-term productivity of the ecosystem is expected to be minimal. It should be noted, however, that variables such as specific route location, time of year for construction, the success of the revegetation program, and maintenance procedures determine the degree to which these short-term impacts affect the long-term productivity of the area's ecosystem.

The impact on 60 acres of river bottomland habitat along the pipeline route is the one significant effect the project will have on the long-term use of resources. The effect is likely to be severe for most species of flora and fauna on the site because conditions within the corridor may not be suitable for habitat recovery. However, considering the limited size of the areas to be affected, the common species of flora and fauna now present, and the low probability of severe damage to the environment occurring as a result of the proposed action, the overall effects on the productivity of the regional ecosystem will be minimal.

Most of the land area affected could be restored to its present use when the storage facility is terminated or abandoned. No unique, threatened, or endangered species of plants or animals should be affected by the project.

### 6.3.2 Impacts on Water Use

Construction and operation of the project is not expected to be detrimental to commercial, ecological, or recreational uses of water except in a minor way during construction, or in case of a major oil spill. The loss of aquatic life, even in the case of an accidental spill and during initial habitat displacement, would be small.

### 6.3.3 Impacts on Airshed Use

Operation of the project will result in release of hydrocarbon vapors from surface piping and oil storage at Kleer Mine (42 lbs/day), at Winnsboro (85 lbs/day), and at the Nederland tank farm (300 lbs/day). These increases are not likely to affect the air quality in the vicinity, though there will be a slight reduction in the assimilative capacity of the air sheds.

Marine transport operations will cause a release of 17.2 tons/day of hydrocarbons in the Gulf of Mexico, and 12 tons/day at Nederland. These releases will be of short duration (50 days) but will degrade air quality and reduce the assimilative capacity of the air shed in the vicinity.

SECTION 7.0

# IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

## 7.1 INTRODUCTION

Irreversible commitments of resources are defined as those environmental modifications induced by the proposed action that, at some later date, could not be altered to restore these resources to their pre-project condition. Irretrievable commitments are generally resources used or consumed that are neither renewable nor recoverable for later use.

This section discusses the commitment of natural resources (land, water, air, and biota) of the site during construction, operation, and upon abandonment. Human resources are also committed for construction and operation of the oil reserve. Finally, some irreversible and irretrievable uses of minerals, materials, and energy are quantified.

## 7.2 NATURAL RESOURCES COMMITTED

Most of the natural resources impacted by the project are renewable. Sections 4.2 and 4.3 discuss construction and operation impacts, respectively. Land disturbance for pipeline construction (636 acres total) will lead to an estimated loss of 28 acre-feet of soil by erosion, much of it contributing in a small way to sedimentation in the downstream lakes. However, since the average annual erosion rate is presently 1.0 to 1.5 acre-feet per square mile, there will be no measurable additional loss of reservoir capacity except perhaps in Quitman Lake (section 4.2.2).

Economical recovery of some terminal surface is improbable. Of the 12 acres at Kleer Mine and 2 acres at Winnsboro Terminal, perhaps 5 acres will be permanently dedicated to some industrial use because of grading and paving.

Water resource impacts are mostly temporary. Consumption of water for construction is estimated at 8.5 million gallons from wells over a 24-week period of construction. To put this in perspective, recoverable ground water resources are estimated to be in the millions of acre-feet (section 3.3). Effects of expected oil spills will disappear within weeks if a cleanup or dispersive measure is operative.

No irreversible or irretrievable air quality effects are anticipated.

Biotic losses are mostly retrievable when particular measures are taken to restore the soil and revegetate. There may be some permanent loss of bottomland hardwood habitat (60 acres or less) due to altered microhabitat conditions within the pipeline corridor. There is a possibility of unavoidable impact to the Grand Saline salt marsh if a maximum credible oil spill should occur in the near vicinity.

## 7.3 HUMAN RESOURCES

As part of the regional resource base, the commitment of local labor to the project is important. Table 2.3-1 quantifies the numbers of workers and earnings that are required during construction. A total of 21,100 man-weeks, representing $7.3 million in field labor, is committed during a 2-year period. Management and engineering skills approaching that sum are partially expended prior to final approvals.

Operational labor and management are expected to total about 1000 man-weeks each year. At $400 average, this would be $400,000 per year that would not be available to other projects.

## 7.4 MINERAL, MATERIAL, AND ENERGY RESOURCES

Mineral resources in the area, other than salt, will not be affected by the project. The Kleer Mine cavern itself should be considered a man-made resource that could be preserved for competing uses. Material commitments are less important than energy uses in the Kleer Mine project, with the possible exception of 42 miles of 22-inch steel pipe (16,000 tons).

Table 7.4-1 summarizes the estimated commitment of minerals and materials for the various phases of the project. Actual consumption is small; economic considerations preclude future recovery of most of the steel (pipe, bulkheads, wire mesh) that could technically be recovered and sold to a nearby steel mill. Upon abandonment (termination), economic reparation of salt-oil sludge accumulation in the mine, as opposed to burning or burying the mixture, is highly improbable. About 44,000 barrels of oil, worth about $0.5 million today, could plausibly be washed down and treated.

If salt mining were resumed, the storage cavern walls could be partially mined out by conventional room-and-pillar methods. Thus, 160 million tons of salt would be freed for use or a 6 million cubic yard cavity could be converted to other beneficial uses. Both options would be available sequentially after SPR project termination.

Table 7.4-2 presents an estimated use of energy by the project. Use for each phase, e.g., construction or operation, are shown in comparison to the crude oil stored and amount handled in the assumed 5 cycles of filling and withdrawal. These are order-of-magnitude approximations to put the project in perspective. The total equivalent usage of 1,762,800 barrels of oil (probably accurate to one significant figure or ± 25 percent) represents 1.2 percent of the total potential storage capacity during the life of the project (150 million barrels).

Energy consumption by phase of project is:

| Phase of Project | Percent of Total Use |
|---|---|
| Mine Conversion | 0.4 |
| Pipeline Construction | 7.4 |
| New Mine Development | 1.9 |
| Operation (5 cycles) | 87.8 |
| Abandonment | 2.5 |
| | 100.0 |

The dominant energy requirement is for project operation (88 percent of total). If only one cycle were required, total energy usage would be about 524,200 barrels or about 1.7 percent of effective storage volume (compared to 1.2 percent for 5 cycles).

The equivalent power required for handling oil per cycle of cavern fill is about 242,000 barrels of oil; energy required to move oil from the Gulf Coast to Winnsboro totals 176,000 barrels of oil or 50 percent of the total energy required. Oil would have to be moved to Winnsboro even without development of an oil storage facility at Kleer Mine. Oil losses due to flaring of vapors during cavern fill average 43,200 barrels per fill. It is apparent that use of the highest efficiency distribution system (pumps, motors, valves, minimum effective pipe length, and so forth) could save thousands of barrels of oil equivalents in electrical energy. An efficient vapor recovery system could also save thousands of barrels each fill (Section 5.2.6).

There is some merit to development of an economical oil film and sludge recovery scheme, since the process of post-project mine cleanup should be common to most storage sites. Successful demonstration could save perhaps 2 percent (net) of the total energy commitment.

TABLE 7.4-1 Summary of minerals and materials committed to the project

| Use | Retrievable | Irretrievable: Consumed or Converted | Irretrievable: Economically Improbable |
|---|---|---|---|
| **Mine Conversion** | | | |
| Steel pipe, plate, wire | | | 150 tons |
| Concrete | | 2000 tons | |
| Salt (150-foot envelope) | 160 million tons after project | | |
| Mine Void | 6 million $yd^3$ | | |
| **Pipeline** | | | |
| Steel pipe | | | 16,000 tons |
| **New Mine Development** | | | |
| Steel plate, wire | | | 150 tons |
| Concrete | | 8000 tons | |
| **Operation** | | | |
| Standby oil storage (each operating cycle) | 30 million barrels | | |
| Oil losses (5 cycles) | | see Table 7.4-2 | |
| **Abandonment** | | | |
| Salt (0.5 inch on surfaces) | | | 31,000 tons |
| Oil (0.1 inch film) | | | 14,000 barrels |
| Sludge, oil | | | 30,000 barrels |
| Sludge, salt (5% of oil by wt) | | | 220 tons |

TABLE 7.4-2 Summary of energy used for the project

| Use | Equivalent Amounts $10^9$ BTU | Equivalent Amounts Barrels Crude[a] | Percent of Cavern Capacity[b] | Percent of Oil Handled[c] |
|---|---|---|---|---|
| Total, as detailed below | 9,696 | 1,762,800 | 5.88 | 1.174 |
| **Mine Conversion** | | | | |
| Steel (150 tons) | 6 | 1,100 | | |
| Concrete, delivered (2000 tons) | 12 | 2,200 | | |
| Driven Machinery (negligible) | -- | -- | | |
| Labor Transportation | 13 | 2,300 | | |
| Equipment Depreciated | 4 | 800 | | |
| Total Conversion | 35 | 6,400 | 0.02 | 0.004 |
| **Pipeline** | | | | |
| Steel (16,000 tons) | 649 | 118,000 | | |
| Driven Machinery | 60 | 11,000 | | |
| Labor Transportation | 6 | 1,000 | | |
| Total Pipeline | 715 | 130,000 | 0.43 | 0.087 |

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a Assume $5.5 \times 10^6$ BTU per barrel crude.
b Capacity is 30 million barrels or $1.65 \times 10^{14}$ BTU.
c Assume 5 cycles during project life.

TABLE 7.4-2 Continued

| Use | Equivalent Amounts 10$^9$ BTU | Equivalent Amounts Barrels Crude[a] | Percent of Cavern Capacity[b] | Percent of Oil Handled[c] |
|---|---|---|---|---|
| **New Mine Development** | | | | |
| Steel (150 tons) | 6 | 1,100 | | |
| Concrete, delivered (8,000 tons) | 48 | 8,700 | | |
| Driven Machinery | 117 | 21,300 | | |
| Labor Transportation | 13 | 2,300 | | |
| Equipment Depreciated | 4 | 800 | | |
| Total New Mine | 188 | 34,200 | 0.11 | 0.023 |
| Total Construction | 938 | 170,600 | 0.57 | 0.114 |
| **Operation** | | | | |
| Tanker Pumping (5 cycles) | 800 | 145,500 | 0.49 | |
| Tanker Transport (5 cycles) | 400 | 72,700 | 0.24 | |
| Pipeline Transport (5 cycles) | 5,450 | 990,900 | 3.30 | |
| Operation & Maint. (22 yrs.) | 60 | 11,000 | 0.04 | |
| Leakage (5 cycles) | 277 | 50,400 | 0.168 | |
| Flaring Losses | 1,190 | 216,000 | 0.72 | |
| Spill Expectation | 9 | 1,690 | 0.00 | |
| Maximum Credible Spill | 330 | 60,000 | 0.20 | |
| Total Operation | 8,516 | 1,548,200 | 5.16 | 1.03 |
| **Abandonment** (perhaps recoverable) | | | | |
| Oil film on salt surface | 77 | 14,000 | 0.05 | 0.01 |
| Sludge, oil and salt | 165 | 30,000 | 0.10 | 0.02 |
| Total Abandonment | 242 | 44,000 | 0.15 | 0.03 |

SECTION 8.0

# ALTERNATIVES TO THE PROPOSED ACTION

## 8.1 INTRODUCTION

The purpose of this section is to consider the environmental impacts associated with alternatives available to the proposed storage facilities at Kleer Mine. Alternatives to the proposed FEA program can be characterized under two main categories: 1) nonstructural alternatives; and 2) structural alternatives. Nonstructural alternatives refer to those other Federal programs which can be considered as alternatives to the Strategic Petroleum Reserve (SPR). These alternatives have been treated at length in the FEA Environmental Impact Statement on the programmatic aspects of the Strategic Petroleum Reserve program (DES-76-2, 1976). These alternatives include programs such as: 1) accelerated development of presently unavailable domestic energy resources; 2) energy conservation; 3) substitution of available domestic energy sources for imported oil; and 4) no action. These programs are not actually alternatives to the Kleer Mine; they address the larger question of optimum program policy.

## 8.2 NONSTRUCTURAL ALTERNATIVES

### 8.2.1 No Action

A description of the no action alternative and its impacts, as it applies to the entire program is provided in the programmatic EIS (DES-76-2). Within the program, a decision not to develop the Kleer Mine facility would result in the development of one or more of the other candidate sites to take its place. In this case, the impacts described in section 4.0 would not occur and the existing environment of the Kleer Mine project (as described in section 3.0) would be maintained. However, the decision to develop another facility in lieu of Kleer Mine could result in similar impacts associated with the alternative facility. These impacts would be discussed in an EIS for that particular site.

### 8.2.2 Permanent Shutdown of Kleer Mine

The FEA intends to provide for development of a new salt mine at Grand Saline dome which is equivalent to the existing mine. Present surface and mineral rights owned by Morton at Grand Saline will support such a mine adjacent to the existing surface facilities. The only effect on salt production or mine employment would be a possible temporary shutdown for approximately 40 weeks if this development option is selected (Figure 2.3-2).

The FEA has no authority to actually build the new mine or require it to be built. In accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 CFR 4601 et seq.), the FEA will pay Morton the actual reasonable expenses associated with relocation. If market conditions should be unfavorable for mine development at Grand Saline, Morton could decide to invest the relocation payment elsewhere. Such a decision is strictly up to the mine owner.

In order to analyze the worst case for permanent shutdown, it has been assumed that the mine and related plant facilities would be closed. The combined employment for these operations is about 210. It is estimated that less than 60 of these employees would be able to find temporary employment on mine conversion construction. Differences in occupational skills and other factors might limit the ability of the other 150 workers to find substitute employment in the vicinity. Other local residents would probably obtain many of the unskilled jobs. After mine conversion was completed, the 60 temporary construction workers would then also be out of work.

In addition to unemployment of existing Kleer Mine workers, about 1/2 of the 300 to 350 construction workers required for the project are associated with development of the replacement salt mine. Of the 150 new jobs that would be unavailable if a new mine were not built, 90 to 100 would have been filled by local residents.

The loss of 210 Morton jobs would, if uncompensated, lead indirectly to the loss of more than 200 service jobs in the area, assuming that each Morton job supported a minimum of one non-basic (service) job. Because Grand Saline does not have a substantial and diverse economic base, this loss could affect the local economy significantly. Also, until suitable alternative jobs were found (perhaps outside the region), it would have serious economic and social effects on displaced workers and their families.

At an average annual wage of $9,000 for each Morton employee, the loss of 210 jobs would remove as much as $1.9 million in annual gross wages from the local economy. After-tax disposable income in the area (if not offset by unemployment compensation or alternative employment) would drop by an estimated $1.3 million per year. New construction earnings from mine conversion would total about $1.5 million annually--not enough to offset the $1.9 million in current wages that would be lost.

In summary, the socioeconomic impacts on the local economy from shutdown of the Kleer Mine would be severe. Many residents and the local economy are highly dependent on the mine for wages; there is not a variety of local employment opportunities that could avoid relocation of households. As many as 210 workers and their families would be directly affected by at least temporary unemployment.

Construction costs (excluding acquisition costs) for the project with permanent shutdown of the salt mine are estimated at $0.47 per barrel of stored oil, compared to $0.99 per barrel with relocation of the mine.

Environmental effects of the project without development of a new salt mine would be slightly reduced, but not significantly changed, by permanently closing the Kleer mining operations. New production and service shafts would not have to be sunk. This modification would reduce the use of energy and materials and the volume of overburden to be placed in landfill, and would eliminate construction at the western edge of Grand Saline salt marsh (Figure 2.2-1). Mine conversion construction would be little affected, however.

If a decision were made not to develop a new salt mine, the surface acres required for the new mine would be left unaltered. Habitat would be left undisturbed. Site excavation and grading would be reduced by at least 50 percent, with consequent reduction in noise levels, dust, and engine exhaust.

Permanent shutdown of the salt mining operation would allow approximately 23.5 million barrels of oil to be placed in storage by January 1979, the same total as for the temporary mine shutdown option.

## 8.3 STRUCTURAL ALTERNATIVES

Structural alternatives available to the FEA can be discussed in terms of alternate storage methods, alternate mine sites, and alternative oil distribution systems.

### 8.3.1 Alternative Storage Methods

The Strategic Petroleum Reserve EIS (DES-76-2, 1976) includes consideration of all feasible oil storage methods and their impacts, including relatively small volume product storage in aboveground tanks and high-volume crude storage in underground caverns. Alternative storage methods include use of: 1) existing and new solution-mined caverns; 2) existing and new conventional mines; 3) existing and new conventional storage tanks; and 4) surplus oil tankers.

### 8.3.2 Alternative Storage Sites

During any future oil import interruption, SPR crude oil will have to be distributed to refineries in each of three major markets: East Coast and Caribbean via tanker ship; inland via the Seaway, Texoma, and Capline Pipelines; and the Gulf Coast refinery complexes (Freeport, Port Neches, and St. James). The Kleer salt mine is one of eight sites being studied as ESR candidates. Of these eight candidate sites, five sites can service all three markets including each of the three pipelines (see Fig. 8.3-1). These five sites include the West Hackberry salt dome (Cameron Parish, Louisiana), the Bayou Choctaw salt dome (Iberville Parish, Louisiana), the Bryan Mound salt dome (Brazoria County, Texas), the Cote Blanche salt mine (St. Mary Parish, Louisiana), and the Weeks Island salt mine (Iberia Parish, Louisiana).

The remaining three sites, Kleer salt mine (Van Zandt County, Texas), Central Rock limestone mine (Fayette County, Kentucky), and Ironton limestone mine (Lawrence County, Ohio), are unique in that oil from them could be distributed only to the inland market area because they are "downstream" on major crude oil transmission pipelines. Kleer would supply the Texoma pipeline market area, while Central Rock and Ironton would supply that part of the inland market area served by the Capline pipeline.

The site selection process will involve two steps. The first decision in the process will be to choose two or three of the five Gulf Coast sites for the purpose of satisfying the ESR needs of the Gulf Coast, the East Coast and the Caribbean. These five candidate sites are thus alternatives for accomplishing this purpose. Site specific EISs have been prepared for all give alternative candidate sites and made available for public comment (DES 76-4 through DES 76-8, September 1976).

The second decision in the site selection process will involve choosing sites to satisfy the ESR requirement for the inland refineries. Those of the five candidate sites which are considered in the first step of site selection, but are not selected in that process, would be considered again as alternatives to the three inland market sites during the second step in the site selection process because of their ability to supply the inland market.

For supplying the Texoma market, Kleer and the five Gulf Coast sites will be considered as an alternative group. For supplying the Capline market area, Central Rock, Ironton, and the above five Gulf Coast candidate sites will be considered as a second alternative group. The impacts which would result from development of each of the five Gulf Coast candidate sites are summarized in Section 8.3.2.1-8.3.2.5. The individual statements should be considered for detailed assessment of these impacts. ESR sites will be chosen from each of the above alternative groups.

The future site selection for the longer-range portion of the SPR program will be very similar to the process described above for the ESR. Candidate sites will be grouped geographically according to market and distribution requirements. Each group will comprise a set of alternative sites, and EISs will be prepared which compare the impacts of developing each site. Those among the first eight which are not selected for the ESR will be considered as alternative storage sites for the longer-term phase of the SPR if they were rejected as ESR sites for reasons other than unsuitability for oil storage; e.g., if they were found to be unavailable for the ESR within the required time frame.

8.3.2.1 West Hackberry

Converting existing solution-mined cavities in the West Hackberry salt dome to a 60-million barrel oil storage facility would require drilling three new wells for oil injection and 11 brine disposal wells, and constructing a temporary barge dock on Alkali Ditch as well as a new tanker terminal on the Calcasieu River with connecting oil pipelines to the site. Displacement water for oil withdrawal would be pumped from Black Lake Bayou. The construction and operation of these facilities would cause several unavoidable disturbances, but no long term environmental effects. The most significant of these are displayed in Table 8.2-1 and discussed below for storage site construction, brine disposal, dock facilities and pipelines, displacement, marine operations, and facility operations.

Storage Site Construction

The storage site itself would require three new wells, two 10,000 barrel brine surge tanks, pump and office buildings, and access roadways. Since the land is now used for industrial purposes, no major land use changes are anticipated. However, the construction activity would temporarily disrupt soils around the storage site and cause an increase in erosion and runoff which would diminish local water quality. Over the course of construction, the level of suspended solids are expected to increase just over 2 percent.

Construction equipment would temporarily reduce on-site air quality with increased concentrations of carbon monoxide (CO), sulfur dioxide ($SO_2$), nitrogen oxides ($NO_x$), hydrocarbons (HC), and 0.3 tons of particulates per month. Only the HC might exceed primary air quality and standards.

Since the land is classified as already highly disturbed, the water, air, and noise impacts are not expected to affect vegetation, wildlife, or aquatic biota significantly.

Construction of the storage site facilities and brine disposal wells together would generate 700 man-months of labor in the Lake Charles area, which would result in approximately $1.2 million in wages. Although local traffic would increase somewhat during the construction period, no significant adverse impacts on community facilities or local housing are anticipated.

## Brine Disposal

To dispose of the brine now in the West Hackberry dome cavities would require drilling 11 brine disposal wells and installing two 10,000-barrel surge tanks as well as a 10,000-foot pipeline between the storage site and disposal area. The brine disposal area would include 25 acres of pasture and 10 acres of marsh; filling the marsh would reduce fish and shellfish production by as much as 1,650 pounds annually.

Brine injection would increase salinity in the disposal aquifer by one part per thousand (ppt). Fracture of the overlying rock is not likely at standard brine injection rates, but brine could seep into the Chicot Sands fresh water storage area if old wells around the disposal area were not adequately plugged.

An alternative to injection wells for brine disposal would involve a brine pipeline running 20 miles to the Gulf of Mexico and would protect the geology and water quality near the site but would increase salinity in the Gulf to a maximum of 3.5 ppt 16 feet downstream of the diffuser and 0.1 ppt over a 250-acre area. Construction would temporarily disturb soils and lower water quality along the pipeline route, crossing the Sabine National Wildlife Refuge.

## Dock Facilities and Pipelines

The proposal for storage at West Hackberry calls for the construction of a temporary barge dock on Alkali Ditch and construction of a new tanker terminal on the Calcasieu River, connected to the storage site by a four-mile pipeline. The temporary facilities at Alkali Ditch would include two 1,000-barrel surge tanks (one for oil and one for brine), while the facilities at the tanker terminal would include a total of six tanks - two 100,000-barrel oil surge tanks, two 100,000-barrel ballast holding tanks, and two 15,000-barrel tanks for emulsion treatment. Construction would require dredging 35,000 yards of material from Alkali Ditch and 1 million yards from the Calcasieu River Channel. This could increase levels of turbidity, toxic sulfides, heavy metals and arsenic, as well as pesticides and other toxic hydrocarbons in bottom material. Disposal of the dredge spoil would destroy 90 acres of marshland. Maintenance dredging would also be required at both sites.

Construction of the proposed dock and pipeline facilities would require about 700 man-months of labor over approximately one year. The payroll for this aspect of the project would be about $1.2 million.

Paint solvent emissions from the preparation of the facilities would exceed standards at 2 kilometers from the site.

As an alternative, the existing Lone Star Terminal could be expanded with a 12-mile pipeline to the storage site as an alternative to construction of a new tanker terminal on the Calcasieu River. Less dredging would be required, 660,000 cubic yards. The dredge spoil could be disposed of in a less sensitive area, an already disturbed abandoned industrial property. However, the longer pipeline would disrupt 180 acres of marsh and farm land, as opposed to 55 acres of farm land, would slightly decrease water quality in the marsh, and would eliminate an additional 312 tons of productive marsh materials.

Two additional alternatives that involve existing pipelines may be possible with minimal new construction. Connection to these pipelines would disrupt 70 acres of brackish marsh and 50 to 80 acres of rice farming, at an income loss of nearly $33,000 in the latter. A third alternative, a new pipeline to the Texoma terminal, would disturb more marsh and dry land than any other alternative. Associated dredging in the Sabine-Neches Waterway would temporarily eliminate bottom organisms and lower water quality in the vicinity.

Oil Displacement

Water to displace the stored oil would be taken from Black Lake Bayou at the rate of 10,650 gallons per minute for 150 days, which would increase salinity slightly and temporarily lower the surface of the lake. Intake structures would trap some small organisms, but water quality and ecology in the lake would be restored shortly after displacement was completed.

An alternative environmentally less desirable and more expensive than the use of Black Lake would involve groundwater from drilled wells. Drilling the wells would eliminate the use of coastal plain grasslands for one year, and pumping would depress the local water table and possibly contaminate groundwater temporarily with salt water.

Marine Operations

Over the life of the project, the risk of oil spillage from accidents is the same for the proposed facility at West Hackberry as for the alternative of expanding the Lone Star Terminal, estimated at approximately 273 barrels for the tankship option and 3,087 barrels with the temporary barge system. Oil spills would destroy non-mobile species in their path, and leave a residual oily taste in fish caught in the vicinity. Vegetation contaminated by an oil spill would die but the contaminated area would revegetate itself within a couple of years.

Tanker and barge unloading during fill and tanker loading during withdrawal would result in the release of substantial amounts of hydrocarbons. During fill, barges and tankers would release 781 pounds per day and 8,286 pounds per day, respectively. During withdrawal, tankers would release 20,953 pounds per day. This would cause the Federal standard of 160 $\mu gm/m^3$ to be exceeded as far as 6 miles downwind for the barge operations, and for the tankers 30 miles during fill and 45 miles during withdrawal. Emissions from crude oil transfers are not regulated in the State of Louisiana.

Facility Operations

The major impacts associated with facility operation would occur during fill and withdrawal. During these operations the oil storage tank at the barge dock and those at the tanker terminal would release hydrocarbons at rates of 588 and 500 pounds per day, respectively. This would cause the Federal standards of 160 $\mu gm/m^3$ to be exceeded as far as 3 kilometers downwind for the barge dock, and greater than 2 kilometers downwind for the tanker terminal. The storage phase of the program would cause no additional significant impacts.

Only ten people would be needed to operate the facility during the storage phase. During oil recovery operations, 20 to 30 people would be required.

8.3.2.2 Bayou Choctaw

Converting existing solution-mined cavities in the Bayou Choctaw salt dome into a 94-million barrel oil storage facility would require drilling 28 brine disposal wells, constructing related brine handling facilities, expanding an existing dock and storage tank facility on Bull Bay, constructing a new tanker terminal at Addis on the Mississippi River, and constructing an oil pipeline between the dock at Addis and the storage site. Water for displacement of oil during withdrawal operations would come from a small on-site lake. Although the oil storage reserve at the Bayou Choctaw salt dome would not likely cause long term adverse environmental impacts, it would alter the local environment in significant ways. These effects are displayed in Table 8.2-2 and discussed below for storage site construction, brine disposal, dock facilities and pipelines, oil displacement, marine operations, and facility operation.

Storage Site Construction

Construction of dikes, roadways, well-heads, and buildings at the storage site would require about 15 months and would disturb farm and swamp land and induce soil erosion, which will, in turn, increase turbidity and suspended solids in nearby waters. Resident wildlife will be forced to emigrate to a more tranquil setting until the construction activities cease.

Construction equipment would temporarily degrade on-site air quality with CO, $SO_2$, $NO_2$, HC, and particulates. However, resulting levels of these pollutants, with the possible exception of the hydrocarbon concentrations from drilling rigs within a downwind distance of 0.5 kilometers, would meet Federal and state primary standards. Point solvent emissions would be high, but do not exceed Federal three-hour standards and are not regulated in Louisiana.

Brine Disposal

The brine disposal system would consist of 28 disposal wells evenly spaced in a rectangular field of 1,150 acres. Brine would be collected in a 500,000-barrel holding pond for temporary storage and settling, and then piped 6,500 feet to the disposal area. Since the brine disposal area is located in a backwater swamp forest, 128 acres of which would be converted to industrial use, construction would result in a loss of wildlife habitat.

The major environmental risk in brine disposal is the danger of acquifer fracture, which could cause contamination of fresh water or interference with oil and gas production. During the filling process at the Bayou Choctaw site, 267 ppt brine would be injected at a maximum rate of 19,450 gallons per minute at depths of -5,000 to -7,000 feet. After 150 days of brine injection under average conditions, the bottom hole pressure would increase but remain well below the fracture pressure. Pressure throughout the well would tend to equalize when injection is stopped and thus cause the bottom hole pressure to decrease. After several fill and withdrawal cycles, the bottom hole pressure would steadily increase again but still remain below the fracturing point. However, in thin (50-foot) sand layers, where the average pressure build-up is greater, the bottom hole pressure would probably exceed the fracturing point during the fifth cycle. The likelihood of actual fracture varies with the potential for well clogging, which in turn depends on the chemical and biological compatibility of the injected brine and the saline water in the aquifer.

Some risk of fresh ground water contamination also exists where abandoned oil and gas wells provide passageways between a fresh water aquifer and the saline acquifer used for brine disposal. Two such wells, the conditions of which are unknown, lie within the brine disposal area. In the worst case, 15 million barrels of saline water could leak to the Plaquemine aquifer (a nearby fresh water supply) over 20 years. Relative to the capacity of the Plaquemine aquifer, such leakage is small, and careful inspection and replugging of the 2 abandoned on-site wells can avoid any negative impact.

As an alternative to deep-well injection, a 116-mile pipeline would carry the brine 20 miles into the Gulf of Mexico. Since it would follow an existing right-of-way, this pipeline would avoid many impacts associated with pipelines in general. Nevertheless, the pipeline would eliminate 182 acres of sugar cane (one harvest valued at $62,500) and a total of 350 acres of wetlands, an amount considerably more than that affected by the deep well injection of brine. Disposal of brine in the Gulf would increase salinity 0.1 parts per thousand over a 250 acre area and 2.5 ppt over one acre. Although bottom organisms would be destroyed in the diffuser area, they would repopulate shortly after disposal stopped.

Dock Facilities and Pipelines

Barges serving the Bayou Choctaw site would use an existing barge dock on Bull Bay for the initial fill of the first storage cavern. The existing dock facility would be expanded by a new barge mooring ship and a new dock. In addition, a new tanker facility with mooring for two tankers would be constructed on the Mississippi River, southeast of Addis and 5 miles east of Bayou Choctaw. Six surge tanks and two ballast tanks would also be constructed at the tanker terminal.

Exapansion of the Bull Bay dock would have little impact; however, construction of the new tanker dock would require a 250-acre tract of already disturbed land and 30 acres of property planted in sugar cane. Dredging 86,000 cubic uards of bottom material in the Mississippi would moderately increase turbidity, toxic sulfides, heavy metals, hydrocarbons, ammonia, TKN, and COD at both the dredging and disposal sites. The dredging operations would destroy bottom organisms, and sediment settling would suffocate local mollusks and shellfish.

Oil for storage or distribution would be carried by a 5-mile pipeline between the docks and the storage site. The pipeline would temporarily disturb 30 acres of sugar cane and 25 acres of backwater swamp and thus cause temporary increases in turbidity. Ecological impacts would also be temporary since the pipelines would be buried and vegetation expected to return. Although a pipeline accident is very unlikely, an expected spill would release 16 barrels of oil, which would destroy local soil organisms.

An alternative to constructing a new tanker dock at Addis is to install a pipeline to an existing tank farm at St. James and expand the tanker terminal there. Most effects would be the same, but because it would require less dredging, this alternative would have less impact on water quality and aquatic ecology. In addition, since the river sediment is less polluted at St. James, the effects of dredge disposal would be further reduced. The pipeline itself, along an existing right-of-way, would have little impact on the environment. However, this alternative could prevent 127 acres of sugar cane production, valued at $43,000 (one harvest, requiring three years' growth).

Oil Displacement

Water to displace the stored oil would be taken from a 12-acre on-site lake, connected by canal to the Choctaw Bayou and the Intracoastal Waterway, that could accommodate displacement (115 million barrels per cycle) because of connection with these two waterways. No adverse effects to water quality are expected in any of the waters. However, some aquatic species would become trapped during the pumping process, and more mobile species would emigrate from the area. Both types of species would return after displacement is completed.

An alternative to the lake as a water supply source is the Mississippi River. The ecological impacts of using this water source would be the same, and no adverse effects on river flow would occur.

A third alternative, to use ground water pumped from drilled wells, would have the greatest adverse impact. The water table would be lowered approximately 10 feet within a half mile of this well area, accompanied by loss of swamp productivity.

Marine Operations

The major potential impacts from the operations of tankers and barges is the risk of oil spillage from accidents and the hydrocarbons emissions from the various oil transfer operations. Marine operations include both the temporary arrangement of transporting the oil along the Mississippi River by tankship to Port Allen and by barge to Bull Bay, and the permanent use of only tankship docking at Addis.

Vessels loading and unloading would produce estimated total hydrocarbon emissions of about 2,000 tons occurring over about 2.8 years of initial fill operations or about 2,000 tons for each 150 day withdrawal operation. Although hydrocarbon emissions from vessel loading and unloading are not regulated in Louisiana, the downwind associated with these emissions would greatly exceed the three-hour Federal standard of 160 $\mu gm/m^3$ for considerable distance downwind (5-10 km) during worst case atmospheric conditions.

Statistical analysis of accidents and spillage indicates that expected spills from tankers alone would total 536 barrels, and the temporary combination of tankers and barges, 7,857 barrels in a single fill and withdrawal cycle.

The large difference between the two systems arises solely from the need for barges at the temporary Bull Bay dock; the risk from the tankship phase of the operation is the same for both the temporary and permanent phases.

Oil spilled from vessels in transit would temporarily contaminate sediment and might affect the taste of fish in the area. Vegetation contaminated by oil would die, but the area would revegetate within a couple of years.

The potential impact of oil spills would be essentially the same for permanent docks located at Addis or St. James. The shorter travel distance up the Mississippi to St. James is offset by the greater congestion at that terminal.

Facility Operations

Operations of the Bayou Choctaw storage site would have no significant impacts other than those associated with oil fill and withdrawal and related employment. Vapor losses from the oil storage tanks at the tanker and barge docks would exceed Federal three-hour standards up to 10 km downwind from the tanks. The Bayou Choctaw storage facility would employ 20 to 30 skilled workers during oil recovery operations (150 days) and 10 full-time employees for maintenance and site security during the storage phase.

### 8.3.2.3 Bryan Mound

Converting existing solution-mined cavities in the Bryan Mound salt dome into a 58-million barrel oil storage facility would require on-site construction; construction of pipelines between the site and the Seaway dock, the Seaway tank farm (both under construction), and the displacement water source (Brazoria and Harris Reservoirs). Although the oil storage facility at the Bryan Mound salt dome would not likely cause long term adverse impacts, it would alter the local environment in several significant ways. The most significant effects are discussed below and displayed in Table 8.2-3 for storage site construction, brine disposal, storage tanks, dock facilities, pipelines, displacement, marine operations, and facility operations.

#### Storage Site Construction

Construction of dikes, roadways, well-heads, and buildings at the storage site would affect some already disturbed land within the existing site. Turbidity and suspended solids would be increased, but since little resident wildlife is on the site, impact would be minimal.

Construction equipment would temporarily degrade on-site air quality with hydrocarbons, $SO_2$, CO and $NO_2$; approximately 0.5 tons per acre of dust per month would be generated from construction activity. Since the area surrounding Bryan Mound is industrially developed, air quality is often degraded and pollutant levels may exceed Primary Air Quality Standards by factors of 3-15.

#### Brine Disposal

The Dow Chemical Company would process the brine displaced during fill through two close-by chemical plants. If Dow could not take the brine, a 4-mile pipeline would carry it to the Gulf for disposal. The two miles of pipeline along a 100-ft. wide corridor would affect 24 acres of coastal prairie, beach, marsh and developed land. The installation of two miles of pipeline in the Gulf would destroy 24 acres of benthic habitat temporarily. Although the increased salinity from brine disposal in the Gulf would destroy bottom organisms in the diffusion area, they would repopulate shortly after disposal stopped.

A second alternative brine disposal method, deep well injection, would require ten wells spaced at 1000-foot intervals one mile outside the perimeter of the site and would require 20 acres of additional land. The adverse effects of this alternative include drilling noise for a 12-month period, a one percent chance of brine spill from pipeline or well-head failure, and the possibility that overpressurization would contaminate the freshwater aquifers.

Dock Facilities, Storage Tanks, and Pipelines

Oil supply and distribution would involve on-site storage tanks, a pipeline system, and dock facilities (including a 20,000 barrel surge tank). Thirty acres of land would be cleared. During construction, runoff would carry some petroleum, herebicides, pesticides, and sediment into adjacent waters. The painting of the four 400,000-barrel floating-roof storage tanks would cause a vapor plume one kilometer long and 200 meters wide on several days during a 90-day period, depending on winds.

The proposed method of crude oil supply and distribution is designed to utilize, under a common carrier contract, the Seaway dock facilities now being constructed east of Bryan Mound, and the Seaway tank farm facilities west of Bryan Mound. Initially, the facility would consist of three tanker docks, to moor tankers from 35,000 to 85,000 dead weight tons (DWT), and a 15,000,000-barrel tank farm, located 7 miles west-northwest of the harbor. Ultimately, the dock facility could be expanded to four docks and the tank farm to a 27,000,000-barrel capacity with pipelines for inland distribution to northwestern and mid-western United States markets. Constructing the 100,000-barrel ballast treatment facility at the dock would require the clearing of three acres of already disturbed land. The painting of the tanks would release solvent emissions downwind. Treated ballast water released to Freeport harbor would contain 7 ppm of oil (maximum monthly average). Oil recovered from the ballast treatment process would be injected into the cavities at Bryan Mound.

Construction of new barge docks in the ICW approximately one mile southeast of the storage site is an alternative to the proposed facilities. The most significant impacts would be those associated with dredging. Dredged materials would be deposited in a 184-acre disposal area 3 miles east of the dredging site.

Oil distribution would require two 30-inch pipelines, both along 100-foot rights-of-way. A 3.7-mile pipeline connecting the site with the Seaway dock at Freeport would be routed along the protected side of an existing levee and would cause minimal damage to the already disturbed land involved. A 4.5-mile pipeline would link the site to the Seaway Storage Tank Facility to the west. This pipeline would affect 18 acres of marsh and 26 acres of coastal prairie as well as 9 acres of disturbed land. In addition, the pipeline would cross the Brazos River and the necessary dredging would increase turbidity up to one mile downstream and increase levels of toxic heavy metals, hydrocarbons and pesticides. One-half acre of Benthic habitat would be eliminated, but re-population would occur after one to two months following completion of construction.

The pipeline spill expectation for the entire project is 106 barrels. Spills associated with pipelines would be discovered quickly as a result of constant monitoring. On land areas contamination of soil would occur to a 10-centimeter depth and cover 0.4 acres for a 1,000-barrel spill. If rupture occurred at the Brazos River crossing, that section of the pipeline could be quickly isolated by valves on both sides.

Oil Displacement

Water to displace the stored oil would be taken from Brazoria and Harris Reservoirs via Dow Plant B at a maximum rate of 14,000 gallons per minute. No significant impact on the reservoirs or the Brazos River replenishment sources is expected since the reservoir volume is ten times the projected volume of displacement water required for one cycle.

A 24-inch concrete pipeline, requiring 15 acres for a 25 foot right-of-way, would be constructed for carrying water to the site from the Dow Chemical plant located five miles away. Construction would have little effect on the use of nine acres of previously developed land. Six acres of coastal prairie, although destroyed temporarily, should return to its previous condition during the next growing season.

Water from an alternative source of supply for displacement, the Gulf of Mexico, would be transported by a two-mile pipeline. Construction of a pumping station would affect one to two acres permanently and would temporarily affect up to 14 acres of coastal prairie and marsh. Unattached organisms of low mobility would be entrained at the intake during the five-month withdrawal phase, although intake velocities are relatively low.

A second alternative source for displacement water is the Brazos River, adjacent to the site. Less than one mile of disturbed industrial land would be involved, and dredging for the intake would destroy a small area of benthic habitat. Entraining and entrapping organisms of low mobility at the intake would be a minor problem.

Marine Operations

One of the most significant impacts from the operation of tankers and barges is the risk of accidental spillage in and approaching Freeport Harbor. Tanker traffic would reach a maximum during an emergency withdrawal of stored oil, with a worst case condition of 1.5 tankers per day (32,000 DWT) unloading 58 million barrels in 150 days. The total spillage expected during the lifetime of the program is 1,655 barrels, including terminal spills and vessel accidents. Should a maximum credible vessel accident occur in a given cycle, a median spill size of 5,300 barrels is estimated, which could involve about 3,850 acres of water surface in 48 hours if the spill is uncontained by the harbor and entrance channel.

If the alternative of constructing barge docks on the ICW is implemented, a total spillage of 14,500 barrels (versus 1,655 for tankers) could be expected for the fill or withdrawal project cycles because the number of barge trips is higher than that for tankers.

During the life of the project, offshore spills, more than spills in the harbor, would affect a diverse and productive habitat, causing destruction of immobile species and residual oily taste in fish.

Vessel loading and unloading at the Seaway dock would result in significant hydrocarbon emissions. It is estimated that vapor losses would occur at rates of 46,100 pounds per day during unloading and 70,500 pounds per day during loading at the respective proposed fill and withdrawal rates of 254,000 and 385,000 barrels per day. Under worst case atmospheric conditions, these operations would cause hydrocarbon concentrations to greatly exceed the 3-hour Federal standard of 160 $\mu gm/m^3$ for a considerable distance (greater than 10 kilometers) downwind. The maximum concentration at .5 kilometers is estimated at 57,700 $\mu gm/m^3$ (total hydrocarbons). The State of Louisiana currently exempts from regulation emissions from crude oil transfers.

## Facility Operations

During fill and withdrawal, hydrocarbon vapors would be emitted from the surge tank and the four storage tanks at rates of 12.2 and 986 pounds per day, respectively. Under worst case atmospheric conditions, the vapors from the storage tanks would cause concentration to slightly exceed the 3-hour Federal standard of 160 $\mu gm/m^3$ for approximately .5 kilometer downwind.

The weight of the filled tanks may cause some minor subsidence due to compaction of aquifers, unconsolidated material, and caprock.

The crew of ten, present at the site during the storage phase primarily for security and monitoring purposes, would expand to 46 during the loading and withdrawal phases.

8.3.2.4 Cote Blanche

Converting the Cote Blanche salt mine into a 27-million barrel oil storage facility would require relocation of existing mining operations, construction of a new pump shaft at the existing mine, enlargement of a barge slip, and construction of four barge loading platforms and associated pipelines to the site. Although they are not likely to cause long term adverse impacts, construction and operation of this facility would alter the local environment in several significant ways. These effects are shown in Table 8.2-4 and discussed below for storage site acquisition and construction dock facilities and pipelines, marine operations, and facility operations.

Storage Site Acquisition and Construction

The major construction activity at the storage site itself, sinking a new 12-foot pump shaft and pump station, would require minimum surface grading over 1 acre and therefore create only small, localized increases in dust, and of vehicle exhaust from construction equipment. Ecological effects would be limited to minor accumulations of dust on foliage in the immediate vicinity of the construction. Proposed freezing of the area surrounding the pump shaft would prevent any construction disturbance to the groundwater.

Development of a replacement mine would require considerably more construction activity. Approximately 20 acres of land now in pasture and forest would be needed for new mine development. Grading at the new mine site would increase soil erosion and runoff and lower surface water quality in the local area. The use of drilling mud around the walls of the hole to prevent water inflow would protect groundwater.

Although government acquisition of the mine site would eliminate the annual property tax of $26,000, construction of the storage facilities, including docks and pipelines, would provide 20,000 man-weeks of labor for 83 weeks and total annual earnings of $6.3 million for two years. Economic gain resulting from an interruption in mining to accelerate the storage schedule woul be offset by unemployment or underemployment of 120 mine workers and a loss of $1.7 million in earnings. If Domtar decided not to construct a new mine, the 120 jobs permanently lost would eliminate annual earnings of $1.2 million. The multiplier effect of this decision would entail the loss of another 200 service jobs and associated incomes within the region.

Dock Facilities and Pipelines

Enlargement of the barge slip and construction of four barge loading platforms would require excavation and disposal of 250,000 cubic yards of soil materials to create 9 acres of open water from marshland and involve another 20 acres of marsh and forest. Construction of four half-mile pipelines between the docks and the storage site would also disturb soils on the island.

Surface water quality would decrease in the access canal near the excavation and disposal sites with increases in biological oxygen demand (BOD) and nutrients and decreases in dissolved oxygen (DO) and ph. Since the existing barge slip is now dredged bi-annually; the additional excavation associated with enlargement of the dock facility would be less significant than in an otherwise undisturbed area.

The dock construction would not affect any rate species but would remove a small quantity of vegetation (e.g., oyster grass), and bottom organisms (e.g., blue crab).

As an alternative to enlarging the dock, the construction of a pipeline from Cote Blanche to St. James, following a route along either Bayou Teche (80 miles) or the Atchafalaya River (60 miles), is more likely if both Cote Blanche and Weeks Island are developed for storage. The Bayou Teche route would affect a larger number of acres (1,201 as opposed to 923), of which a greater percentage is now undisturbed. Both routes would degrade the quality of surface water by lowering pH and DO and increasing nutrient concentrations and BOD from deposits of excavated soils. However, by supplanting the barges, the pipeline would cause less impact from oil spills. The pipeline would be more expensive to construct but less expensive to operate than the barge facilities.

Marine Operations

The use of barges for transporting oil to and from the storage facility would increase erosion along the banks of the Intracoastal Waterway (ICW) and would in turn increase turbidity. Over the lifetime of the project, it is expected that about 2,700 barrels of oil would be spilled and that the maximum credible spill (Gulf shore) would be 60,000 barrels from a 45,000 DWT tanker. Although slow water currents and minimal wave action would inhibit the oil from spreading, the oil reaching shore would destroy many sensitive marsh species, which would regenerate after two years.

Transporting the oil to and from the dock at the storage site would result in significant hydrocarbon emissions, both during transit and at the transfer points in the Mississippi River and in the Gulf of Mexico. System leakage ("breathing") losses from tankers and barges would occur at a maximum annual atmospheric loading rate of 244 tons/year during fill and withdrawal. These emissions would be dispersed along the Mississippi River - Intracoastal Waterway route from the Gulf to the storage site. VLCC-tanker transfers in the Gulf and tanker-barge transfers in the Mississippi River would cause emissions at maximum annual rates of 1,220 tons/year and 1,300 tons/year, respectively. Under worst case atmospheric conditions, transfers at the Mississippi River transfer point would cause hydrocarbon concentration in excess of the three-hour Federal standard of 160 $\mu gm/m^3$ as far as 6.8 miles downwind. The State of Louisiana currently exempts from regulation emissions from crude oil transfers.

As an alternative to small barges, large, seagoing barges might be used to transport part of the oil directly between the tankers in the Gulf and the site. This system would require larger dock facilities and a pipeline across the island creating a greater impact on the ecology of the island. However, their use could result in a 42 percent reduction in spilled oil and a 37 percent reduction in hydrocarbon emissions.

Facility Operations

Transferring the oil from the storage cavern to the barges at the dock would result in significant hydrocarbon emissions as the barge tanks are filled with oil and the vapors contained therein are vented to the atmosphere. These venting losses would occur at a maximum annual atmospheric loading rate of 731 tons/year. Under worst case atmospheric conditions, this operation would cause hydrocarbon concentrations in excess of the three-hour Federal standard of 160 $\mu gm/m^3$ as far as 4 miles downwind. Because of unavailable system leaks, minor amounts of hydrocarbons and hydrogen sulfide would be emitted during filling of the storage cavern as a result of flaring of the vapors that would be vented during that operation.

Fifteen employees would be needed during the 150-day withdrawal and the 300-day refill periods. Only two to three permanent employees would be needed to maintain security on the site during the storage phase of the program.

### 8.3.2.5 Weeks Island

Conversion of an existing salt mine to an 89-million barrel oil storage facility at Weeks Island would involve the construction of a new replacement salt mine, enlargement of an existing barge slip, and construction of abutment barge docks and six and one-half-mile pipelines between the barge slip and storage facility. Although the oil storage reserve at Weeks Island is not likely to cause long term adverse impacts, construction and operation of this facility would alter the local environment in several significant ways. These effects are discussed below and in Table 8.2-4 for the construction of the storage site as well as for a new replacement mine, dock facilities, pipelines, marine operations, and facility operations.

Storage Site Construction and Acquisition

Conversion of an existing salt mine to an 89 million-barrel oil storage site would entail only temporary, local increases in the levels of hydrocarbons, $NO_x$ and $SO_2$, as well as dust, which results from the grading needed for the above-ground pump station and small electric substation.

Construction of a new salt mine to replace that converted for oil storage would involve about 20 acres of land used currently as a landfill site. The socioeconomic impact of such construction would depend on whether (1) salt production was interrupted and (2) Cote Blanche followed a construction schedule similar to Weeks Island.

Development of the new mine at Weeks Island with no interruption in salt production would require 18,500 man-weeks of labor over 93 weeks and provide an estimated $6 million in salaries. If mining operations continue uninterrupted at Weeks Island as well as at Cote Blanche, production at both sites would yield a total of $13.9 million.

With a 64-week cessation in salt production at Weeks Island, designed to expedite the completion of the storage facility, 16,800 man-weeks over 73 weeks could be required, and the resulting loss in salt production would decrease state revenue, through severance taxes, by $92,000 and local revenues by $50,000. If construction interrupted salt production at both Weeks Island and Cote Blanche, only $11.7 million in salaries would be released, with $7 million to the local area. The resulting 3.5 million-ton decrease in salt production would proportionately reduce state revenues, through severance tax, by $210,000 and local revenues by $150,000.

A construction schedule for Weeks Island that does not require an interruption in salt mining would cause a shortage of laborers for the time that both mine relocation and storage conversion peak. One possible solution to this problem would entail a different coordination of activities between the two sites. If the Cote Blanche mine were closed during conversion at Weeks Island, the unoccupied work force could assist in mining operations at Weeks Island to expedite construction without drawing heavily from the outside labor market.

Dock Facilities and Pipelines

The proposed method of crude oil supply and distribution is designed for barge transport coordinated with a pipeline system. Six abutment docks would be constructed to accommodate 25,000-barrel barges, and the southern portion of an existing barge slip would be enlarged by 80 percent. An estimated 250,000 cubic yards, involving about 9 acres of marsh and spoil banks, would be excavated for the slip and transported to an approved Corps of Engineers site. Ancillary equipment (manifold, pumps, meters) would require ten acres adjacent to the slip. The excavation would temporarily displace local aquatic life, including benthic organisms like blue crabs. Increased runoff from the grading of the adjacent ten acres would cause temporary turbidity, BOD, DO and nutrient problems.

Barge transport would require the construction of six 0.5-mile pipelines between the barge slip and the storage facility. Although excavation and backfilling would, in displacing several thousand cubic yards of soil, temporarily cause sediment to run off into the barge slips and Waterway, overall impact would be small.

Despite the probability that a pipeline rupture would cause oil spill is low, a maximum spill of 500 barrels would most likely affect only three acres.

With both Weeks Island and Cote Blanche as storage facilities, the proximity of the two sites increases the possibility that a large diameter pipeline could replace the barge system as the means of supply and distribution for the sites. Two alternative pipeline routes to St. James are available, one running 80 miles along Bayou Teche and the other 60 miles along Atchafalaya. The first would more adversely affect virgin wetland forest. The pipeline would involve a lower operating expense and probability of oil spill than those of barge transport.

Marine Operations

Barge operations would involve a total distance of 225 miles. Oil would be offloaded from very large crude carriers to 45,000 DWT tankers in the Gulf of Mexico, transported up the Mississippi River to Venice, Louisiana, and transferred to 25,000-barrel barges for further transport up the Mississippi through Algiers Lock to the ICW and ultimately Weeks Island barge slip.

Daily barge traffic should increase 11 percent for the 28-month fill period and 36 percent for the shorter 9-month withdrawal period.

The maximum credible oil spill for the Gulf, possibly 60,000 barrels, could render 840 to 1,680 acres of marsh (1.5 percent of total marsh in the area) nonproductive for two years. Of the expected average spill of 1,827 barrels, 312 barrels may occur at the barge slip and 1,515 barrels anywhere in the ICW, Mississippi River, or the Gulf. The maximum credible spill from barges into the ICW, estimated at 20,000 barrels, could affect 10 miles of the channel. Transporting the oil from the dock at the storage site would result in significant hydrocarbon emissions, both during transit and at the transfer points in the Mississippi River and in the Gulf of Mexico. "Breathing" losses from tankers and barges would occur at a maximum annual atmospheric loading rate of 800 tons/year during fill and withdrawal. These emissions would be dispersed along the Mississippi River-Intracoastal Waterway route from the Gulf to the storage site. VLCC-tanker transfers in the Gulf and tanker-barge transfers in the Mississippi River would cause emissions at maximum annual rates of 4015 tons/year and 2140 tons/year, respectively. Under worst case atmospheric conditions, transfers at the Mississippi River transfer point would cause hydrocarbon concentrations in excess of the three-hour Federal standard of 160 $\mu gm/m^3$ as far as 7.5 miles downwind. The State of Louisiana currently exempts from regulation emissions from crude oil transfers.

As an alternative to small barges, large, seagoing barges might be used to transport part of the oil directly between the tankers in the Gulf and the site. This system would require larger dock facilities and a pipeline across the island creating a greater impact on the ecology of the island. However, their use could result in a 42 percent reduction in spilled oil and a 46 percent reduction in hydrocarbon emissions.

Transferring the oil from the storage cavern to the barges at the dock would result in significant hydrocarbon emissions as the barge tanks are filled with oil and the vapors contained therein are vented to the atmosphere. These venting losses would occur at a maximum annual atmospheric loading rate of 2,410 tons/year. Under worst case atmospheric conditions, this operation would cause hydrocarbon concentrations in excess of the 3-hour Federal standard of 160 $\mu gm/m^3$ as far as 5.7 miles downwind. Because of unavoidable system leaks, minor amounts of hydrocarbons and hydrogen sulfide would be emitted during pumping. Minor amounts of sulphur dioxide would be emitted during filling of the storage cavern as a result of flaring of the vapors that would be vented during that operation.

Fifteen workers would be required for transfer operations during fill or withdrawal periods. A crew of five or less would be required during the storage phase of the program, primarily for security purposes.

### 8.3.3 Alternative Transportation Systems Between Kleer Mine and Winnsboro Terminal

Some alternatives have been examined for siting of facilities necessary to convert the Kleer Mine to a storage cavern. Viable alternative terminals exist for tie-in to a crude oil import line. The Texoma-Longview Terminal has some surplus capacity, but is over 50 miles from Kleer by road and is probably 60 miles distant by an acceptable pipeline route (Figures 2.1-1 and 2.3-5). Impacts of construction and operation may be somewhat less adverse at Longview than at Winnsboro, but additional pipeline impacts would more than offset any slight terminal site advantages. Capital costs for a pipeline to Winnsboro are approximately $2.5 million less than for an equivalent pipeline to Longview. In addition, the Winnsboro site is connected to an east-west Mobil line, increasing oil movement flexibility.

Pipeline route alternatives between Kleer Mine and Winnsboro Terminal were assessed on the basis of 7.5-minute topographic maps, available soil surveys, and a low-level air reconnaissance, using criteria presented in section 5.2. Two probable pipeline routes to Longview were less thoroughly evaluated using topographic maps and industry experts. The exposure risk for oil spills would be greater for either of these routes than for the shorter one to Winnsboro because of greater length. Between 1980 and 2000, many watershed developments are expected in the area.

However, all are somewhat protected from a potential spill by being distant from the proposed route. Once the location of the terminal was settled, the detailed route selection was made by slow aircraft carrying a reclamation specialist and others. The pipeline route was relocated to avoid Lake Carl L. Estes (proposed) and Lake Ford Reservoir (under construction).

### 8.3.4 Alternative Transportation Systems Between Gulf of Mexico and Winnsboro

It is assumed in estimating impacts of transporting oil from the Gulf Coast to Winnsboro Terminal for storage in Kleer Mine that maximum use will be made of existing facilities of the petroleum transport industry. Consideration of a hypothetical route should not be construed as a commitment, since actual transport paths may vary with opportunity. The primary route selected for impact analysis includes the use of tankers to transport oil from the Gulf of Mexico to Nederland, Texas, then existing pipelines to deliver the oil to Winnsboro. However, another possibility would be to use the proposed Seadock facilities which would connect VLCCs in the Gulf directly to Nederland; this alternative is contingent on issuance of construction and operating licenses to Seadock, Inc. and the availability of sufficient throughput capacity for a particular fill operation. The facilities will not be available for the initial filling of ESR sites, but could be in operation by the early 1980's.

Analysis of impacts associated with using the Seadock facilities considers effects of transferring oil from VLCCs to a submarine pipeline at single point mooring buoys (SPM's) located in water depths of approximately 110 feet around a permanent platform complex and pumping the oil approximately 30 miles to shore and 120 miles to Nederland. Oil would be stored temporarily at the Seadock Terminal near Freeport in aboveground floating roof storage tanks. Impacts associated with VLCC transport of oil to the SPM buoy are not considered. Impacts associated with transport of oil from Nederland to Winnsboro are identical to those for the primary alternative and will not be repeated here.

One potentially significant impact is oil spills. Based on frequencies and spill volumes developed in the Seadock EIS (U.S. Department of Transportation, 1976), transfer of 30 million barrels of oil from

VLCCs to the Seadock pipeline would result in an estimated 0.24 spill incidents, totaling 44 barrels of oil (183 barrel average spill). Pipeline transport would require approximately 90 days of system use and an estimated 0.016 incidents, totaling 18 barrels of oil, per fill period. Thus, for 5 fill periods, there would be a total expectation of 1.28 spill incidents resulting in release of 310 barrels of oil into the environment; 70 percent of the oil would be released into the Gulf 25 miles from shore with negligible environmental impact. This is an 87 percent reduction in spill frequency and a 68 percent reduction in oil release compared to the primary alternative of using 30 MDWT tankers on the Neches River. Maximum credible spill size is estimated to be 2000 barrels for SPM operations and 10,000 barrels from the Seadock pipeline.

A second potentially significant impact is hydrocarbon emissions. Vapor emissions for this alternative would be limited to that caused by VLCC ballast uptake and tank farm emissions at Seadock and Nederland. Assuming that VLCC emissions on ballast uptake are similar to that from small tankers (possibly a very conservative assumption because of the lower surface-to-volume ratio), a maximum of 0.0056 percent of cargo volume will be released. This would amount to approximately 240 tons per fill or 16 tons/day for 15 days. Tank farm emissions would be 300 lbs/day at each, lasting 90 days at Seadock and 75 days at Nederland. Thus for 5 fill periods, there would be a total release of 1320 tons of hydrocarbon vapor, 91 percent of it 25 miles from the coast and primarily consisting of non-reactive methane and ethane fractions. This represents an 82 percent reduction from total vapor emissions associated with the primary alternative. Hydrocarbon concentrations may exceed 160 $\mu g/m^3$ for distances up to 9.5 miles downwind of the VLCC during the 15-day transfer period and up to .5 miles downwind of the tank farms.

A third potentially significant impact is energy use. Handling and pipeline pumping to transport oil to Nederland is estimated at approximately 720,000 MMBTU, or 131,000 barrels of oil equivalent, per fill. This is approximately 3 times as much energy as is required to transport the oil to Nederland by 30 MDWT tanker (primary alternative).

There are other, less tangible, advantages associated with using the Seadock facilities to transport oil to Nederland. All tanker traffic will be at least 25 miles from the coast rather than on the heavily travelled Sabine Lake and Neches River. Oil spills and hydrocarbon emissions will be further from coastal marshes and population centers. There is less liklihood of inducing tanker shortages or higher tanker transport rates. In summary, should the Seadock facilities be constructed and have sufficient capacity to transport oil for storage at Kleer Mine, associated environmental impacts should be smaller than for tanker transport up the Neches River. Impacts north of Nederland would be unchanged.

## West Hackberry

## ENVIRONMENTAL IMPACT SUMMARY

### Table 8.3-1

| ACTIVITY | IMPACTS DUE TO ACTIVITIES: GEOLOGY AND SOILS | LAND USE | WATER QUALITY AND SUPPLY | AIR QUALITY | NOISE | ECOLOGY | SOCIOECONOMIC |
|---|---|---|---|---|---|---|---|
| **STORAGE SITE CONSTRUCTION** | | | | | | | |
| Drilling of 3 new wells; construction of pump and office buildings and additional roadways | Temporary erosion and sedimentation; change in drainage patterns. | Enclosure of 240 acres now in industrial use; disposal of construction waste in existing land fill. | Increase of 2.35% in suspended solids from 5,028 cu yds of sediment; increase in turbidity. | Temporary degradation from construction equipment emissions; increase in fugitive dust of 0.3 tons per month; possible violation of 3-hr HC standards. | Noise impact zone (>55 dBA) up to 2,000 feet; nearest residence at 2,000 feet. | No significant impact; vegetation and wildlife at storage site already highly disturbed. | $1.2 million of construction labor from Lake Charles area; slightly increased local traffic. |
| **BRINE DISPOSAL** | | | | | | | |
| 11 brine wells<br>2 10,000 bbl surge tanks<br>10,000-ft pipeline to disposal area (P) | 10 acres of marsh filled around wellhead. | Conversion of 25 acres from pasture to brine disposal. | Salinity increase in disposal aquifer of 1 ppt; increase in salinity of Chicot Sands possible if old wells in area are unplugged. | Slight impact during drilling operations. | Noise impact zone up to 1,800 feet. | Reduction in fish and shellfish production by 1,650 lb/yr due to loss of 10 acres of marsh. | Same as site construction. |
| 20-mi pipeline to Gulf (A) | Temporary surface disruption. | Some alteration to Sabine-Neches dredging area. | Salinity increase of 3.5 ppt 16 feet downcurrent; increase of 0.1 ppt. over 250 acres; increases turbidity atop pipeline routes. | Temporary localized degradation from construction equipment emissions. | Noise impact zone up to 500 feet. | Temporary elimination of low mobility organisms near diffuser. | Greater impact than proposal. |
| **DOCK FACILITY CONSTRUCTION** | | | | | | | |
| Temporary barge dock on Alkali Ditch; new tanker terminal at Calcasieu River, required pumps and tanks (P) | 35,000 cu yds of dredging in Alkali Ditch and 1 million cu yds in Calcasieu River Channel; maintenance dredging at both sites; suspended sediment at both sites. | Alteration of 90 acres of marsh by dredging disposal. | Localized degradation from increased turbidity, toxic sulfides, heavy metals or arsenic, pesticides, and other toxic hydrocarbons in Alkali Ditch and Calcasieu dredging and spoil disposal. | Paint solvent emissions exceeding standards at 2 km. | Noise impact zone up to 2,000 feet; nearest residence beyond 2,000 feet. | Temporary elimination of bottom species and reduction of plankton productivity from dredging; temporary disruption of wildlife and vegetation from dredge disposal. | $1.2 million of construction labor from Lake Charles area. |
| Expansion of Lone Star Terminal (A) | Dredging of 660,000 cu yds. | Use of 30 acres of abandoned industrial property already disturbed; conversion of 100 acres of marsh to dry land with dredge disposal. | Turbidity downstream to lake; less impact than proposal due to less dredging and preferable disposal area. | Impact same as proposal. | Impact same as proposal. | Impact same as proposal. | Impact same as proposal. |
| **PIPELINES** | | | | | | | |
| 4-mi pipeline between site and terminal at Calcasieu (P) | Temporary surface disruption. | 1-year disruption of 55 acres of agricultural land. | No impact. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet. | Temporary disruption of wildlife. | Same as dock facility construction. |
| 12-mi pipeline between site and Lone Star Terminal (A) | Temporary surface disruption. | Disruption of 180 acres of marsh and agricultural land. | Slight increase in turbidity in marsh during construction. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet. | Loss of a small amount (312 tons) of marsh productivity during construction. | Greater impact than proposal due to longer pipeline. |
| Connect to existing pipelines (A) | Temporary surface disruption. | Disruption of 76 acres of brackish marsh and 50 to 80 acres of rice farming. | Slight increase in turbidity in marsh during construction. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet. | Temporary wildlife disruption. | Loss of $32,800 in rice farming income. |
| New pipeline to Texoma Terminal (A) | Temporary soil disruption. | 180 acres of brackish marsh, 106 acres of intermediate marsh, 48 acres of fresh marsh, 24 acres of dry land. | Slight increase in turbidity in marshes during construction. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet. | Temporary disruption of wildlife; disruption of benthic community in waterways where dredging required. | Greatest impact due to length of pipeline. |
| Pipeline accidents | Soil fouled in vicinity of pipelines. | Land unsuitable for farming until oil dispersed through soil. | Local degradation of water quality. | Slight hydrocarbon emissions. | Noise from cleanup operations. | Temporary destruction of local soil organisms and vegetation (on land) and non-mobile organisms in water. | Temporary loss of farm production over small area. |
| **OIL DISPLACEMENT WATER SOURCE** | | | | | | | |
| Black Lake Bayou (P) | No impact. | No impact. | Slight increase in salinity and temporary drop in surface level associated with withdrawal of 10,650 gpm for 150 days. | Slight hydrocarbon emissions. | Noise from pumps. | Entrapment of some organisms in intake structures; no effect on productivity: temporary loss of wildlife during construction. | Same as site construction. |
| Groundwater wells (A) | Surface disruption from drilling. | 1-year loss of small area of coastal prairie grassland. | 10,650 gpm for 150 days will result in local cone of depression and some temporary salt water intrusion. | Slight hydrocarbon emissions. | Noise impact zone up to 1,800 feet. | Temporary disuption of wildlife during drilling. | Greater impact than proposal. |
| **MARINE OPERATIONS** | Small amount of erosion on channel bottom. | No impact. | Expected oil spill of 273 bbls with tankers, 3,087 bbls with barges. | Barge hydrocarbon emissions of 781 lb/day during unloading; tanker emissions of 8,286 lb/day during unloading and 20,953 during loading; concentrations in excess of 160 $\mu gm/m^3$ would extend downwind for 6 miles and 30-45 miles during the barge and tanker operations respectively. | Very slight impact. | Destruction of non-mobile species and residual oily taste in fish from oil spills. | Reduced marketability of fish fouled by oil. |
| **FACILITY OPERATION** | No additional impact. | No additional impact. | Small quantities of sanitary waste; slight impact. | Evaporative hydrocarbon losses of 588 lb/day and 500 lb/day from the storage tanks at the barge dock and the tanker terminal respectively; concentrations would be 160 $\mu gm/m^3$ at 3 km (barge dock) and at >2km (tanker terminal). | Very slight impact, less than 70 dBa at 50 feet; no nearby residences. | No additional impact. | 10 people employed during operation; 20-30 employed during oil recovery; payroll during operation of $18,000 per month; payroll during recovery of $41,850 per month. |

(P) Proposed system design

(A) Alternative to the proposed system design

<u>Bayou Choctaw</u>

# E N V I R O N M E N T A L   I M P A C T   S U M M A R Y

## Table 8.3-2

## IMPACTS DUE TO ACTIVITIES

| ACTIVITY | GEOLOGY AND SOILS | LAND USE | WATER QUALITY AND SUPPLY | AIR QUALITY | NOISE | ECOLOGY | SOCIOECONOMIC |
|---|---|---|---|---|---|---|---|
| **STORAGE SITE CONSTRUCTION** | Short-term erosion from dikes, roads, and other earthmoving; 701 cubic yards of sediment. | 104 acres enclosed; industrial use unchanged; 3,000 to 10,000 cubic yards of construction waste in 1 of 9 landfill sites. | Small increase in turbidity from grease and oil; 7% increase in suspended solids in local waters. | Temporary degradation from construction equipment and paint solvents not in excess of standards; increase of 19.1 tons/yr of suspended particulates; 7% increase for parish overall. | Noise impact zone (greater than 55 dBA) within 2,000 feet; no residences within 1 mile. | Minor disturbance to wildlife; alteration of vegetation. | 386 man-months of construction employment on site; $675,500 in payroll; slightly increased traffic and resulting maintenance costs for public facilities. |
| **BRINE DISPOSAL** | | | | | | | |
| 28 Injection Wells 500,000-Barrel Holding Pond 6,500-Foot Pipeline (P) | No rock fracture under average pressure; possible rock fracture in 50-foot sand layers during fifth cycle. | 128 acres of swamp forest changed to industrial use. | Increase in salinity in saline aquifers; possible contamination of fresh aquifers if old wells unplugged. | Slight impact from drilling operations. | 95-100 dBA at 50 feet; noise impact zone at 1,800 feet; no residences within 1 mile. | Loss of wildlife habitat and production; <1% probability of brine spill that could destroy some marshland over 128 acres. | Included in storage site construction. |
| 116-Mile Pipeline to Gulf (A) | Temporary surface disruption. | 182 acres of sugar cane and 350 acres of wetlands lost. | 0.1-ppt salinity increase in Gulf waters over 450 acres; increase of 2.5 ppt over 1 acre; no increase more than 3.5 ppt. | Slight impact. | Noise impact zone within 500 feet; no residences within one quarter mile. | Temporary loss of benthic organisms and fish; <1% probability of brine spill that could destroy marsh. | Loss of $69,500 in sugar cane (one harvest; requires 3 yrs growth). |
| **DOCK FACILITY CONSTRUCTION** | | | | | | | |
| Expansion of Bull Bay; Tanker Dock at Addis; Storage and Ballast Tanks (P) | Suspension of sediment. | 250-acre tract, including 30 agricultural acres, disturbed. | Local increases in turbidity, toxic sulfides, heavy metals, hydrocarbons, ammonia, TKN, COD from dredging, and dredge disposal of 86,000 cubic yards and 1.5 million cubic yards for permanent dock. | Same as site construction. | 70 dBA at dock during construction. | No impact at Bull Bay; loss of aquatic species at new dock site. | 500 man-months of construction labor at dock sites; $875,500 in payroll. |
| Expansion of St. James Terminal Pipeline to St. James (A) | Suspension of sediment. | 30 acres disturbed; 127 acres of sugar cane production possibly precluded. | Same as proposal, but larger turbidity plumes that will dissipate more rapidly; river sediment less polluted; less dredging impact. | Same impact as proposal. | Same impact as proposal. | Less impact than proposal. | Possible loss of $41,000 in sugar cane (one harvest). |
| **PIPELINE** | | | | | | | |
| Oil Line 5 Miles from Addis to Site (P) | Temporary surface disruption. | 55 acres disturbed (30 in sugar cane, 25 in backwater swamps). | Temporarily increased turbidity in swamp. | Slight hydrocarbon emissions. | Noise impact zone at 500 feet; few residences within one quarter mile. | Minimal impact during construction only; vegetation will return. | 450 man-months of construction employment; loss of $7,503 in sugar cane production (one harvest). |
| Pipeline Accidents | Soil fouled in vicinity of pipeline. | Land unsuitable for farming until oil dispersion through soil complete. | Local degradation of water quality. | Slight hydrocarbon emissions. | Slight impact during cleanup operations. | 16 barrels spilled oil would destroy local soil organisms (if underground) and vegetation (if above ground). | Temporary loss of farm and swamp production over small area. |
| **OIL DISPLACEMENT WATER SOURCE** | | | | | | | |
| 12-Acre On-Site Lake (P) | No impact. | No impact. | No significant impact on lake or replenishing water sources; <1 ppt decrease in lake salinity. | Slight hydrocarbon emissions. | Slight impact; pumps and motors. | Temporary migration during displacement; entrapment of plankton, larval fishes, vertically migrating benthics, small aquatic plants. | No impact. |
| Mississippi River (A) | No impact. | No impact. | 32,000 gpm, representing 0.035% of river flow; no adverse impact. | Slight hydrocarbon emissions. | Slight impact; pumps and motors. | Impact same as on-site lake. | No impact. |
| Ground Wells (A) | Surface disruption due to drilling. | 5.7 acre-well area. | 10-foot reduction in water table level at 0.5 miles from pumping station. | Slight hydrocarbon emissions. | Slight impact; pumps and drilling rigs. | 4.2-ton loss of biological swamp production for 1 year plus impacts of on-site lake. | No impact. |
| **MARINE OPERATIONS** | Small amount of erosion on channel bottom. | No impact. | Expected spill of 536 barrels from tankers or 7,857 from barges per fill/withdrawal cycle. Disposal of 47,500 barrels of ballast water per tanker in brine well; no adverse impact to aquifer. | Worst case hydrocarbon emissions from storage tanks could exceed 160 $\mu g/m^3$ as far as 10 km downwind; maximum concentrations of 7500 $\mu g/m^3$ at 0.5 km. | Noise impact zone at 200 feet; no residences within ½ mile. | Destruction of non-mobile species and residual oily taste in fish if oil spills occur. | Reduced marketability of fish fouled if oil spills occur. |
| **FACILITY OPERATION** | No impact. | No additional impact. | Small quantities of solid and sanitary waste; no adverse impact. | Vessel loading and unloading could produce 2,000 tons hydrocarbon emissions for each fill or withdrawal; worst case emissions could exceed 160 $\mu g/m^3$ for considerable distance downwind (5-10 km); maximum concentration at 0.5 km of 6,125 $\mu g/m^3$. | Noise impact zone at 200 feet; no residences within ½ mile. | No additional impact. | 10 full-time personnel: 6 skilled, 3 laborers, 1 clerical; 20-30 skilled workers for oil recovery. |

(P) Proposed system design

(A) Alternative to the proposed system design

Bryan Mound

# ENVIRONMENTAL IMPACT SUMMARY

## Table 8.3-3

### IMPACTS DUE TO ACTIVITIES

| ACTIVITY | GEOLOGY AND SOILS | LAND USE | WATER QUALITY AND SUPPLY | AIR QUALITY | NOISE | ECOLOGY | SOCIOECONOMIC |
|---|---|---|---|---|---|---|---|
| **STORAGE SITE CONSTRUCTION** | | | | | | | |
| 58 million-barrel capacity involving 216 acres (P) | Short-term erosion from dikes, roads, and pipelines; 64,500 cubic yards of material involved. | 216 acres previously used for production of sulphur; 20 acres involved in new construction; one new 65x100-foot building. 3,000 to 12,000 cubic feet of surplus lumber, paper waste, concrete and formation water for entire project to landfill sites. | Small increase in turbidity and levels of petroleum products, herbicides and pesticides, metals, salt additives, and construction chemicals. | Temporary degradation by construction vehicles and drill rig equipment, resulting in hydrocarbons, $SO_2$, $NO_2$; about 0.5 tons/acre of dust given off per month of activity. | Noise impact zone (greater than 55 dBA) at 2,500 feet; no nearby residences. | Minor additional disruption of wildlife habitat. | 1,750 man-months of total construction employment on site; $250,000 per month payroll; 90 men involved in general site construction and drilling; slightly increased traffic and resulting maintenance costs for public facilities. |
| **BRINE DISPOSAL** | | | | | | | |
| Disposal of brine to chemical plants via existing pipeline (P). | No impact. | Brine disposed of in existing ponds at rate of 9,333 gallons per minute. | No impact. | No impact. | No additional impact. | No impact. | No impact. |
| Disposal of brine to Gulf via 4-mile pipeline (A) | Temporary surface disruption. | 24 acres (100-foot right-of-way through 8 acres of coastal prairie, 2 acres of beach, 4 acres of marsh, and 10 acres of cleared land). | Crossing of Gulf Intracoastal Waterway (ICWW) near Brazos River; destruction of nonproductive benthic habitat. | Slight hydrocarbon and dust emissions during construction. | Temporary annoyance to beach visitors from construction equipment. | 24 acres of benthic habitat destroyed temporarily along 100-foot corridor for 2 miles into Gulf; entrainment of low mobility unattached organisms near the intake. | No impact. |
| Deep well injection using 10 well spaced at 1,000 feet on the perimeter of the site (A) | Temporary surface disruption. | 20 additional acres required outside site boundaries. | Less than 1% chance of brine spill due to pipeline or wellhead failure; possibility that overpressurization could fracture aquiclude to cause freshwater contamination. | Slight hydrocarbon emissions during drilling. | Drilling noise for 12 months. | Minor additional disruption of wildlife habitat. | No impact. |
| **STORAGE TANK CONSTRUCTION** | | | | | | | |
| Four 400,000-barrel above-ground floating roof storage tanks on site (P) | Permanent surface disruption. | 30 acres of cleared land to be modified for tanks. | During construction, some petroleum products, herbicides, pesticides, and sediment. | Vapors from solvents during spray painting of tanks 1 km downwind for several of 90 days, depending on wind. | Noise impact zone up to 2,500 feet; no nearby residences. | Minor additional disruption of wildlife habitat. | 25 welders and pipefitters for all pipeline and tank construction. |
| **DOCK FACILITY CONSTRUCTION** | | | | | | | |
| Use of Seaway, Inc. dock facilities under construction; 100,000 barrel ballast treatment system and pump building (P) | Suspension of some sediment from channel. | 3 acres of cleared and already disturbed land for Ballast Treatment System. | Same as storage tanks. | Paint solvent emissions from spraying 1.18 gram per second during initial painting. | 70 dBA at dock facilities. | 3 acres of land for ballast treatment tanks; no critical wildlife habitat; no impact. | No impact. |
| New barge docks in ICWW (A) | Temporary surface disruption. | Precise location not determined but approximately 1 mile southeast of storage site. | Dredged materials to be placed on 184-acre disposal area 3 miles east; oil spills from associated barge traffic to be contained in the ICWW. | Slight hydrocarbon emissions. | Slight impact from construction. | Marshland, the waterway, a sand dune (disposal site) affected by dredged material; stagnant ICWW water; increased barge traffic. | Construction payroll less than that for storage site construction. |
| **PIPELINES** | | | | | | | |
| 30-inch pipeline from site to dock at Freeport, 3.7 miles east (P) | Temporary surface disruptions. | 45 acres, 100-foot right-of-way (ROW) through disturbed land. | Local and temporary increase in turbidity and levels of toxic heavy metals and hydrocarbons, and pesticides from dredging and dredge disposal for Brazos River, crossing. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet; no nearby residences. | Little effect except temporary displacement of transient species like waterfowl and small mammals. | 50-man labor force for all pipeline construction. |
| 30-inch pipeline from site to Seaway storage tank facility, 4.5 miles west (P) | Temporary surface disruptions. | 53 acres, 100-foot ROW through 18 acres of marsh, 9 acres of developed land, and 26 acres of coastal prairie. | | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet; no nearby residences. | Temporary disturbance of marsh and coastal prairie to displace wildlife until vegetation reestablished; dredging on Brazos River crossing to eliminate 0.5 acres of benthic habitat, but with repopulation after 1 to 2 months. | |
| Pipeline accidents | Soil fouled to 10 cm depth in buried pipeline for 1,000 barrel spill, covering 0.4 acres. | Local land unsuitable for current use until oil dispersion through soil complete. | Only local and minor degradation of water quality. | Slight hydrocarbon emissions. | Slight impact during cleanup. | 4.3 barrels; annual spill expected with mean spill size approximately 1,000 barrels; would destroy local soil organisms (if underground) and vegetation (if aboveground). | Small area involved not commercially productive; no impact. |
| **OIL DISPLACEMENT WATER SOURCE** | | | | | | | |
| Water supply from Brazoria and Harris reservoirs via Dow plant and 5-mile pipeline (P) | Temporary surface disruption. | 15 acres, 50-foot ROW through 6 acres of coastal prairie, 4 acres of developed land. | Displacement at maximum rate of 14,000 gallons per minute; no significant impact on reservoirs or Brazos River replenishment source; reservoir volume 10 times projected displacement water requirement during one cycle. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet; slight temporary impact on residences and businesses. Slight impact from pumps during operations. | Plankton affected primarily during withdrawal phase due to impingement and entrainment in intake structure. | 50-man labor force for all pipeline construction. |
| Gulf of Mexico water transported by 2-mile pipeline (A) | Temporary surface disruption. | 1 to 2 acres onshore for pumping station; 14 acres of coastal prairie and marsh. | Crossing of ICWW; disturbance of land areas with possible turbidity due to runoff during construction. | Slight hydrocarbon emissions. | Temporary annoyance to beach visitors due to construction. | Benthic habitat along corridor temporarily destroyed; entrainment of low mobility unattached organisms at the intake. | 50-man labor force as above for all pipeline construction. |
| Water from Brazos diversion channel adjacent to site (A) | Temporary surface disruption. | Less than 1 acre of disturbed industrial land involved. | Temporary increase in turbidity in diversion channel. | Slight hydrocarbon emissions. | Slight impact from construction and pumps. | Entrainment of low mobility, unattached organisms near intake; dredging for the intake would destroy small area of benthic habitat. | 50-man labor force for all pipeline construction. |
| **MARINE OPERATIONS** | Small amount of erosion on harbor bottom. | No impact. | Increased turbidity due to tanker traffic; possibility that median oil spill of 5,500 barrels could affect 3,850 acres of surface water if spill not contained to harbor and entrance channel; 331 barrels total expected spillage during complete withdrawal cycle for tankers; for barges, 2,900 barrels total expected spillage during one fill/withdrawal cycle (higher than tankers because of number of trips required). | Tanker hydrocarbon emissions of 70,500 lb/day during loading and 46,100 lb/day during unloading; concentrations in excess of 160 $\mu gm/m^3$ for considerable distances (>10 km) downwind; maximum concentration of 57,000 $\mu gm/m^3$ at 0.5 km. | Slight impact. | Destruction of non-mobile species and residual oily taste in fish from spill. | Reduced marketability of fish fouled by oil. |
| **FACILITY OPERATIONS** | Possible compaction of aquifers and unconsolidated material in immediate vicinity of tanks. | No impact. | 7 ppm oil from ballast water treatment to Freeport Harbor at onshore facility; small quantities of sanitary waste. | Evaporative hydrocarbon losses of ~1,000 lb/day for surge and storage tanks combined; storage tank emissions exceed 160 $\mu gm/m^3$ for ~0.5 km downwind; small quantities of emissions from pumps. | Slight impact. | No additional impact. | Crew of 10 during storage phase; 46 during loading and withdrawal phases. |

(P) Proposed system design

(A) Alternative to the proposed system design

## Cote Blanche

# ENVIRONMENTAL IMPACT SUMMARY

### Table 8.3-4

| ACTIVITY | IMPACTS DUE TO ACTIVITIES: GEOLOGY AND SOILS | LAND USE | WATER QUALITY AND SUPPLY | AIR QUALITY | NOISE | ECOLOGY | SOCIOECONOMIC |
|---|---|---|---|---|---|---|---|
| **STORAGE SITE CONSTRUCTION** | | | | | | | |
| 12 ft Pump Shaft and Associated Aboveground Equipment (P) | Surface grading of 1 acre; no impact on mine structure; excavation of 15,000 cu. yds. of material for landfill disposal; loss of salt resource due to absorption; fracture unlikely due to absence of faulting. | No impact. | Impermeability of salt offsets potential impacts on groundwater system; no impacts. | Small quantities of dust and $NO_x$, $SO_2$ from construction vehicle exhaust; no violation of standards. | Less than 6 dB increase in nighttime ambient sound levels in nearby undeveloped areas during construction, no increase in nearby towns. | No impact. | Loss of $26,000 property tax per year; no adverse impact to archaeological sites. |
| **NEW MINE DEVELOPMENT** | Expanded access to salt deposits; increased gradings and soil erosion. | 20 acres of pasture and forest for development of new mine. | Slight decrease from soil erosion and runoff. | Slightly increased dust and construction vehicle exhaust. | 37 to 70 dB at 500 feet for ground refrigeration on equipment and service shaft construction, explosives; no impact on nearby towns, however. | No impacts; site of new mine already highly disturbed. | 20,000 man-weeks of construction over 83 weeks with earnings of $2,300,000 per year for 2 years; if mining interrupted, unemployment or underemployment of 60 mine workers for 74 weeks and earnings loss of $1.7 million; if mining not interrupted, continuation of 25,000 man-weeks of labor over 103 weeks and earnings of $4,000,000 per year for 2 years. |
| Permanent Shutdown of Domtar Mine (A) | 50% reduction in site excavation and grading. | Surface acreage required for mine site would be unaltered. | Reduction erosion and siltation associated with grading. | Slight reduction in air emissions during construction from those of mine relocation option. | Noise levels reduced over mine relocation option. | No impact. | Elimination of $1.2 million annually in gross wages; local loss of 120 jobs; induced loss of 200 service jobs in region. |
| **DOCK FACILITIES** | | | | | | | |
| Barge Slip and 4 Barge Loading Platforms (P) | 250,000 cu. yds. soil dredged; slightly increased runoff (barge slip now dredged biannually). | Alteration of 9 acres from marsh to open water; 20 acres required for aboveground storage, of which 15 acres are marshland and upland forest. | Small decrease at site of excavation and dredge disposal; increase in BOD, decrease in DO, reduction in pH, increase in nutrients, possible increase in heavy metals, suspended solids in access canals. | Increased dust, $NO_x$, $SO_2$ from construction vehicle exhaust. | 71 dB 10 hours each day at 500 feet from pile drivers for barge dock construction; no impact to nearby towns due to distance. | Removal of 50 x 10 grams dry weight of oyster grass; adverse impact to 6 x 10 grams of organisms, mostly blue crab. | Included above. |
| **PIPELINES** | | | | | | | |
| Four 0.5-mi Pipelines Between Doc and Site (P) | Disturbance of sand, silt, and clay soils; increased runoff. | About 3 *acres affected by representative* 500-bbl spill; seepage and movement to barge slip where it would be contained. | *No significant impact on ground or* surface water. | *Slight hydrocarbon emissions.* | 68 dB at 500 feet. | Spills reaching marsh beyond barge slip probably would affect less than 5 acres and would be allowed to weather and degrade naturally. | Included above; protection of potential for archaeological finds by presence of state archaeologist. |
| Pipeline to St. James via Bayou Teche (80 mi) (A) | Temporary disruption of soils along right-of-way, resulting in runoff. | Alteration of 1201 acres, of which 60% are undisturbed swamp. | Possible lowering of pH and DO and increase in nutrient concentrations and BOD from deposit of excavated soils; no impact on ground water; oil spill impacts less than with barge system. | Slight hydrocarbon emissions. | As above. | More adverse impacts on ecology of of unmodified swamp forest than on Atchafalaya route and of dock construction. | Less operation expense than for barge transport; construction employment of 150 persons for one year. |
| Pipeline to St. James via Atchafalaya (60 mi) (A) | Temporary disruption of soils along right-of-way, resulting in runoff. | Disturbance of 923 acres, of which 42% are undisturbed swamp. | Same as first alternative. | Slight hydrocarbon emissions. | As above. | Less impact than Bayou Teche route. | Less operation expense than for barge transport; construction employment of 120 persons for one year. |
| ***MARINE OPERATIONS*** | | | | | | | |
| Barges (P) | Increased erosion on banks of ICW and access canal. | No impact. | Slightly increased turbidity in ICW and access canal from barge operations; minimal impact from spilled oil (2724 barrels expected; 60,000 maximum) due to limited potential for lateral spreading. | Hydrocarbon emissions during transit at an annual rate of 244 tons/yr, and during vessel-to-vessel transfers at an annual rate of 1200-1300 tons/yr. Tanker-barge transfers would cause hydrocarbon concentrations in excess of 160 μg/m³ as far as 6.8 mi. downwind. | 55 dB at 500 feet for one barge passby; frequency of occurrence to increase by less than one additional passby per hour over present rate for 28-month fill, 5-month withdrawal period. Noise levels occurring over 12 months if weeks also developed and barges used for transfer. | Small risk to all fauna and wildlife inhabiting coastal marshes from spilled oil, temporary disruption of vegetation where oil spilled. | Significant increased demand for barges, tug boats, crews with resultant expanded employment and income in region, need for priorities in equipment use during emergency; possible impact to recreational use of water nearby from oil spill; significant cleanup costs. |
| Seagoing Barges (A) | Greater disruption of soils due to need for larger barge facilities and pipeline across island. | More land required for dock facilities. | Fewer water impacts due to expected spillage of 42% less oil. | Hydrocarbon emissions 17% lower than from smaller barges. | Slightly less impact than smaller barges. | Less impact due to lower expected volume of spilled oil. | Slightly greater than dock operation. |
| **FACILITY OPERATIONS** | No impact. | No impact. | No impact. | Hydrocarbon emissions during barge loading at an annual rate of 151 tons/yr, causing concentrations in excess of 160 μg/m³ as far as 4 mi. downwind. Minor hydrocarbon and hydrogen sulfide emissions from system leakage during pumping and minor sulfur dioxide emissions from flaring of vapors during fill. | Loading and unloading barges result in 55 dB at 500 feet (at least 12 dB lower than existing background). | No additional impact. | 24 permanent employees to monitor equipment and provide security; 15 people for 5 months during withdrawal; 15 people for 10 months during refill. |

(P) Proposed system design

(A) Alternative to the proposed system design

<u>Weeks Island</u>

## E N V I R O N M E N T A L   I M P A C T   S U M M A R Y

### Table 8.3-5

| ACTIVITY | IMPACTS DUE TO ACTIVITIES | | | | | | |
|---|---|---|---|---|---|---|---|
| | GEOLOGY AND SOILS | LAND USE | WATER QUALITY AND SUPPLY | AIR QUALITY | NOISE | ECOLOGY | SOCIOECONOMIC |
| STORAGE SITE CONSTRUCTION | | | | | | | |
| Conversion of existing salt mine to 89 million barrels oil storage facility (P) | Minimal regrading of soil. | Only temporary increase in vehicular *traffic likely.* | Impermeability of salt offsets *potential impacts on groundwater* system; no impacts. | Temporary local increase in hydro- *carbons,* $NO_x$, $SO_2$, particulates, and dust from construction (not measurable beyond several hundred yards from site). | Less than 6 dB increase in nighttime ambient sound levels in nearby un- *developed areas during construction;* no increase in nearby towns. | Removal of total 45 acres for entire site of low-quality habitat but *creation* of new "edge" along site perimeter for possible increase in wildlife diversity. | Slight loss of recoverable salt due to minor oil absorption; minor temporary increase in construction-related transportation employment. |
| CONSTRUCTION OF REPLACEMENT MINE (P) | No impact. | Approximately 20 acres of land affected on site currently used for landfill. Waste overburden disposed of in 1 acre landfill on site. | No impacts to ground or surface water systems; no flooding risk because of high surface elevation of facilities. | Impacts as above. | 37 to 70 dB at 500 feet for ground refrigeration equipment and service shaft construction, explosives; no impact on nearby towns, however. | No impact; new mine on site of landfill. | Increased accessibility to salt deposits due to relocation of operation to new mine; 18,500 man-weeks labor, involving *110 non-local workers, over 93 weeks* to generate $6 million ($13.9 million combined with Cote Blanche); with interruption in mining, 16,800 man-weeks labor, *involving 80 non-local workers,* over 73 weeks to generate $2.9 million ($11.7 million combined with Cote Blanche); loss from interruption of 64 weeks' salt output, $92,000 in severence tax, $210,000 combined sites), $50,000 to local ($150,000 combined sites). |
| *DOCK FACILITIES* | | | | | | | |
| Enlargement of existing slip to 450 x 650 feet and construction *of* 6 abutment-type barge docks (P) | *Estimated 500,000 cubic yards* excavated to enlarge southerly portion of existing slip. | Total *of 20 acres affected;* 9 acres of marsh and spoil deposit to be altered to open water; 10 acres of land adjacent to slip to be used for ancillary equipment (manifold, pumps, meters); excavated material to be disposed of in an approved site. | Temporary impact to water quality before bank stabilization complete from increased runoff; small increases in turbidity, nutrient, BOD, DO, decreased pH, possible increase in heavy metals; major impact on Spartina. | Impacts as above. | 71 dB 10 hours each day at 500 feet from pile drivers for barge dock construction; no impact to nearby towns due to distance. | Temporary displacement of local aquatic life by enlargement of slip; approximate loss of 50 x $10^6$ grams dry weight marsh grass due to barge slip development and 8 x $10^6$ grams of benthic organisms (9 x $10^3$ of which would be blue crabs). | Included above. |
| PIPELINES | | | | | | | |
| 6 *0.5-mile pipelines* between barge slip and storage facility (P) | Several thousand cubic feet of soil disturbed by excavation and refilling of pipeline trenches. | About 3 acres affected by representative 500-bbl spill; seepage and movement to barge slip where it would be contained. | *Sediment runoff* to Waterway, *barge* slip and marsh to west of site. | *Slight hydrocarbon emissions.* | *68 dB at 500 feet.* | *Spills reaching* marsh beyond barge slip probably would affect less than 5 acres and would be allowed to weather and degrade naturally. | Included above. |
| 1 80-mile pipeline to St. James via Bayou Teche (A) | Temporary disruption of soils along right-of-way resulting in *runoff* and sedimentation. | Alteration of 1,201 acres, of which 60% are undisturbed wetlands. | Possible lowering of pH and DO increase in nutrient concentrations and BOD from deposition of excavated soils; no impact on *groundwater; oil spill impacts* less than with barge system. | Slight hydrocarbon emissions. | As above. | More adverse impact on ecology of unmodified wetland forest than Atchafalaya route or dock construction. | Less operating expense than for barge transport; construction employment 150 persons for 1 year. |
| 1 60-mile pipeline to St. James via Atchafalaya (A) | Temporary disruption of soils along right-of-way resulting in runoff and sedimentation. | Disturbance of 923 acres, of which 42% are undisturbed wetlands. | Same as first alternative. | Slight hydrocarbon emissions. | As above. | Less impact than Bayou Teche route. | Less operating expense than for barge transport; construction employment 120 *persons for 1 year.* |
| MARINE OPERATIONS | | | | | | | |
| Barges (P) | Some erosion of banks generated by tugs and barges moving along waterway. | Very small possibility of large oil spill reaching developed water recreation areas; increases in barge traffic 11% daily during filling period; increases in traffic 36% over shorter 5-month withdrawal period; all in addition to Cote Blanche. | Slight increase in bank erosion during 28-month fill, 5- to 9-month emptying periods from increased barge traffic; minimal *impact from spilled oil in ICW* (1827 barrels expected, 20,000 barrels maximum) or Gulf (60,000 barrels maximum). | Hydrocarbon emissions during transit at an annual rate of 800 tons/yr, and during vessel-to-vessel transfers at an annual rate *of 2140-4015 tons/yr. Tanker-barge* transfers would cause hydrocarbon concentrations in excess of 160ugm/m³ as far as 7.5 mi downwind. | 55 dB at 500 feet for one barge passby; frequency of occurrence to increase by less than one additional passby per hour over present rate for 28-month fill, 5- *month withdrawal period; noise levels* occurring over 12 months if Cote Blanche also developed and barges used for transfer; if both Weeks and Cote Blanche, probable use of pipelines. | *Oil spilled in Gulf could signifi-* cantly affect habitat and populations; from 840 to 1680 acres of marsh could be lost from productivity *for 2 years* (1.5% of total marsh in area) if tanker spill occurred inland from Gulf; maximum credible spill in ICW could contaminate up to 320 acres for 2 years if it reached wet marsh. | *Significant increased* demand for barges, tug boats, crews with resultant expanded employment and income in region; need for priorities in equipment use during *emergency; possible impact to recreational* use of water nearby from oil spill; significant clean-up costs. |
| Seagoing Barges (A) | Greater disruption of soils due to *need for larger barge facilities* and pipeline across island. | More land required for dock facilities. | Fewer water impacts due to expected spillage of 42% less oil. | Hydrocarbon emissions 46% lower than from smaller barges. | Same as dock facilities. | *Less impact* due to lower expected volume of spilled oil. | Slightly greater than dock operation. |
| FACILITIES OPERATIONS | | | | | | | |
| Filling (28 months); storage (unknown period); withdrawal (5 months) | No impact. | No impact. | No impact. | Hydrocarbon emissions during barge loading at an annual rate of 2410 tons/yr, causing concentrations in excess of 160ugm/m³ as far as 5.7 *mi downwind. Minor hydrocarbon* and hydrogen sulfide leakage during pumping and minor sulfur dioxide emissions from flaring of *vapors during fill.* | Loading and unloading barges result in 55 dB at 500 feet (at least 12 dB lower than existing background). | *No additional impact.* | *Negligible impact; non-local personnel* estimated at less than 5 for storage periods; 15 workers (3 skilled, 12 *unskilled) during transfer operations.* |

(P) Proposed system design

(A) Alternative to the proposed system design

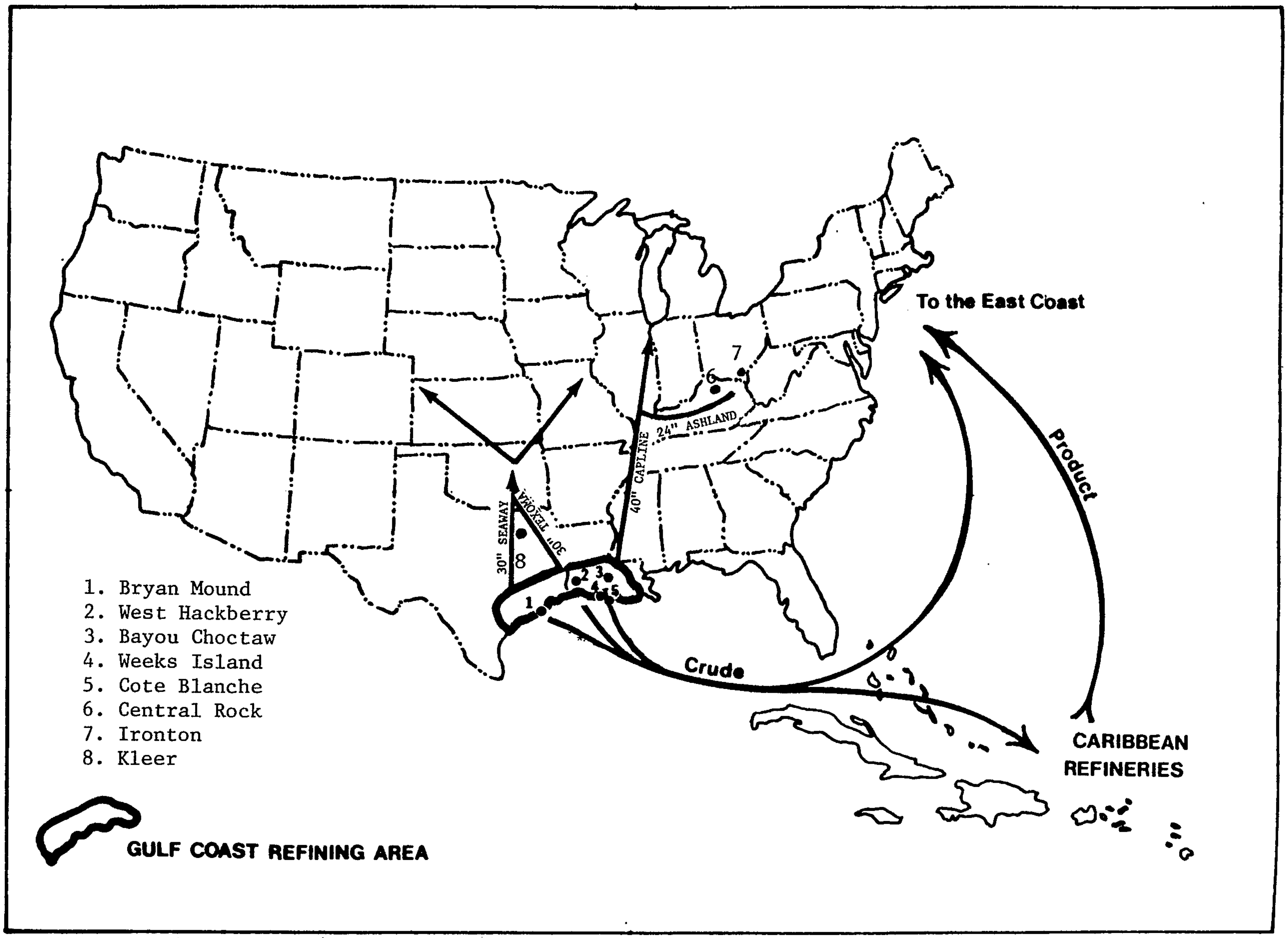


FIGURE 8.3-1 SPR Distribution Network

SECTION 9.0

## CONSULTATION AND COORDINATION WITH OTHERS

### 9.1 COORDINATION AND CONTACTS WITH OTHERS

In the course of developing this EIS, information and guidance was obtained from many different sources. The following tabulation lists those agencies and companies that were contacted.

| AGENCY - FEDERAL | LOCATION |
|---|---|
| Department of Agriculture, Soil Conservation Service | Dallas, Texas |
| Department of the Army, Corps of Engineers, Fort Worth District | Fort Worth, Texas |
| Department of the Interior, Fish & Wildlife Service | Fort Worth, Texas |
| Department of the Interior, Mining Enforcement & Safety Administration | Denver, Colorado |

| AGENCY - STATE | LOCATION |
|---|---|
| Texas - Office of the Governor | Austin, Texas |
| Texas Air Control Board | Austin, Texas |
| Texas Energy Advisory Commission | Austin, Texas |
| Texas Historical Commission | Austin, Texas |
| Texas Parks and Wildlife Department | Austin, Texas |
| Texas Railroad Commission | Austin, Texas |
| Texas Water Quality Board | Austin, Texas |

| AGENCY OR COMPANY - LOCAL | LOCATION |
|---|---|
| East Texas Council of Governments | Kilgore, Texas |
| Morton Salt Company | Grand Saline, Texas |
| North Texas State University | Denton, Texas |

| | |
|---|---|
| Sabine River Authority | Orange, Texas |
| Southern Methodist University | Dallas, Texas |
| Steve F. Austin State University | Nacogdoches, Texas |
| University of Texas | Austin, Texas |
| Van Zandt County Commissioners | Canton, Texas |

## 9.2 ENVIRONMENTALLY ORIENTED PERMITS AND LICENSES

Federal laws which have potential applicability to the Strategic Petroleum Reserve project include the Clean Air Act as amended in 1970, the Federal Water Pollution Control Act and amendments of 1972 (including the NPDES permit for mine water disposal), the Endangered Species Act of 1973, the Marine Protection, Research and Sanctuaries Act of 1972, the Ports and Waterways Safety Act of 1899, the National Environmental Policy Act of 1969, the Fish and Wildlife Coordination Act, the Coastal Zone Management Act of 1972, and the Protection of Cultural Resources Act (P.L. 89-665 and P.L. 93-291). These laws and the regulations adopted pursuant to them have been reviewed to determine the types of permits, licenses, certifications, and approvals needed for the various construction and operational phases of the project. Environmentally oriented permits and licenses are listed in Table 9.2-1. No final determination has been made as to what state and local regulations or permits are specifically applicable to the project. Regulations not applicable may be complied with by the FEA voluntarily, and it is hoped that a coordinated effort between the FEA and other cognizant government agencies will lead to implementation of useful mitigative measures at the mine site and along the delivery route.

Among the state permits and approvals listed in Table 9.2-1 are construction permits, use permits, and informal approvals. An example of a construction permit that may be required is the PI-1 from the Texas Air Control Board. Permission to use the mine for oil storage, and to operate the new pipeline, may be granted by the Texas Railroad Commission (TRC) after a public hearing of comments on a "T-4" permit application. Informal approval of construction plans by the TRC may be sought. The TRC may consult with interested state and local agencies such as the following:

1. Sabine River Authority of Texas and Louisiana
2. Texas Water Quality Board
3. Texas Air Control Board
4. East Texas Council of Governments
5. Texas Energy Advisory Commission
6. Texas Division of Planning Coordination, Office of the Governor
7. Texas State Department of Health
8. Van Zandt County Commissioners
9. Grand Saline City Judge

TABLE 9.2-1 Environmentally oriented permits and licenses

| Agency | Permit Type | References |
|---|---|---|
| U.S. Corps of Engineers, District Engineer (Fort Worth) | (a) Discharge of dredged material into navigable waters<br>(b) Structures or activities affecting the navigability of navigable waters; includes structures <u>under</u> a navigable waterway. | 33 CFR 209, 120 (b) (3), (b)(7) (e) (i), (g)(5)(ii), (g) (17) (iii);<br>33 CFR 209, 130 |
| U.S. Environmental Protection Agency, Region 6 | NPDES (National Pollutant Discharge Elimination System) permit required for any industrial discharges into navigable waters. In addition, should the NPDES permit system requirements not apply to a particular operation, certification is still required from the EPA administrator (or from appropriate designated State or Interstate agencies) whenever a Federal license or permit is being sought for activities which may result in discharge into the navigable waters. | 40 CFR 125; Water Pollution Control Act, Section 401 |
| U.S. Department of Commerce, Interstate Commerce Commission | Transportation of petroleum across state lines. | |
| U.S. Department of Transportation, Highway Department | Excavation permit for pipeline trenching on interstate highways. | |
| Texas Air Control Board | Construction Permit PI-1<br>Outdoor burning, visible emissions, particulate matter, and other specified emissions. | Texas Clean Air Act, Sec.3.27 and 3.28:<br>Regulation I through VI, effective 27 April 1975 |
| | Exemption letter | Regulation VI, Rule 607. |

TABLE 9.2-1 Continued

| Agency | Permit Type | References |
|---|---|---|
| Texas Water Rights Commission | Appropriation and use of state water<br>Water diversions and impoundments, and related facilities | |
| Texas Water Quality | Waste Control Dredge<br>Disposal of any waste into or adjacent to any body of water<br>Industrial Solid Waste Disposal<br>Permit or registration | Texas Water Quality Act as amended; Rules of the Texas Water Quality Board; and Texas Water Quality Standards. |
| Texas Railroad Commission | Use Permit T-4<br>Underground storage of oil and operation of new pipeline. Permit application will be sent to Texas Water Quality Board and distributed from there to other interested agencies. TRC action follows receipt of comments and public hearing. Approval of plans prior to construction is recommended. | Mr. Bob Harris, Oil and Gas Division, TRC |

## 9.3 REQUEST FOR COMMENTS

Comments on the Draft EIS for Kleer Mine were requested from the following agencies, companies, and organizations. Copies of the document were also made available to the Council on Environmental Quality and to the public on 21 January 1977.

Federal:

- Federal Energy Administration Regional Offices (I-X)
- Advisory Council on Historic Preservation
- Council on Environmental Quality
- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Health, Education, and Welfare
- Department of Housing and Urban Development
- Department of Interior
- Department of Labor
- Department of State
- Department of Transportation
- Department of the Treasury
- Energy Research and Development Administration
- Environmental Protection Agency
- Federal Power Commission
- Interstate Commerce Comission
- National Science Foundation
- Nuclear Regulatory Commission
- U.S. Army Corps of Engineers
- Water Resources Council

States:

- Louisiana
- Texas
  - Texas Railroad Commission
  - Texas Water Quality Board
  - Texas Air Control Board
  - Texas Energy Advisory Commission
  - Texas Parks and Wildlife Department
  - Office of the Governor

Local:

- Cameron Parish
- East Texas Council of Governments
- Franklin County
- Hopkins County
- Jefferson County
- Orange County
- Smith County
- Van Zandt County
- Wood County

Others:

American Petroleum Institute
Center for Law and Social Policy
Environmental Defense Fund
Environmental Policy Center
Friends of the Earth
Funds for Animals, Inc.
Izzak Walton League of America
Morton Salt Company
National Audubon Society
National Parks and Conservation Association
Natural Resources Defense Council
National Wildlife Federation
Nature Conservancy
Rice University
Sabine River Authority
Seadock, Inc.
Sierra Club
Southern Methodist University
Southwestern Electric Power Company
University of Texas

## 9.4 DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

The list of agencies and groups included with the Summary in the front of this statement indicates those who furnished written comments on the Draft Environmental Impact Statement to the Federal Energy Administration within the allotted comment period. Copies of the comment letters are included in Appendix J.

All of the review comments received by FEA have been considered in the preparation of this Final Environmental Impact Statement. The EIS has been expanded and modified where appropriate as a result of comments received. In other cases, either no substantive issues were raised or no change to the EIS was considered appropriate. The following listing presents a summary of the disposition of substantive issues raised in the comments.

### 9.4.1 Comments Received From Federal Agencies

#### A. Advisory Council on Historic Preservation, February 16, 1977

Comment 1: The Council must have evidence that the most recent listing of the National Register of Historic Places has been consulted and that either of the following conditions is satisfied: (a) if no property included in or eligible for inclusion in the National Register is affected by the project, this should be indicated; (b) if a property included in or eligible for inclusion in the National Register is affected by the project, the statement must contain an account of steps taken in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, and a comprehensive discussion of the contemplated effects on the property.

Response: As indicated on page 3.7-1 and in Appendix F (page F-2) of the draft environmental statement for Kleer Mine, two sites of historic significance are located in proximity to storage facilities and pipeline; no other historic sites within the pipeline right-of-way were included on, or were in the process of being nominated to, the State or Federal Registers of Historic Places at the time this draft was being prepared. A recent reexamination of the National Register of Historic Places, dated February 1, 1977, confirms this original analysis. A statement to this effect has been added to Section 3.7 of the final environmental statement.

Comment 2: The procedures for compliance with Section 106, as amended, of the National Historic Preservation Act of 1966 require the Federal agency to demonstrate consultation with the appropriate State Historic Preservation Officer.

Response: The FEA acknowledges the responsibility of the State Historic Preservation Officer with regard to regulations as required under the National Historic Preservation Act of 1966 as amended. The Texas Historical Commission Office was contacted early in the program as noted in Appendix F (page F-13) of the draft statement; this contact has been added to Section 9.1 of the final statement.

B. Department of the Army, March 17, 1977

Comment 1: Existing Lake of the Pines is located on Big Cypress Creek (Red River Basin) downstream from the Winnsboro Terminal and authorized Carl L. Estes Lake is located upstream and near the storage area. Big Sandy Lake, an authorized C-E project, is located just downstream from the pipeline crossing of Big Sandy Creek. Any significant spill or break in pipeline or storage would mean serious problems in the downstream reservoirs and stream reaches.

Response: As noted in Section 4.3.8.7 an oil spill in the tributaries of the Sabine or Red River would also affect downstream uses of these water bodies. The impact of a spill on a downstream reservoir or stream reach is discussed in Section 4.3.8.8 and would depend largely on the location (Section 4.3.8.8) and the amount (Section 4.3.8.1) of oil spilled. The 42-mile pipeline route between the storage site and the Winnsboro Terminal was chosen after contact with the U.S. Army Corps of Engineers to avoid crossing existing or planned reservoirs; also, approximately half of the proposed pipeline follows the right-of-way of an existing 20-inch pipeline. The expected spill risk of the pipeline is small (Section 4.3.8.1), but the impacts resulting from a rupture in the pipeline may be significant (page 4.3-44).

Comment 2: Based on present criteria, the permit under Section 404 of Public Law 92-500, the amendments of the Federal Water Pollution Control Act, will be required when the pipeline crosses Big Sandy Creek, Lake Fork Creek, Grand Saline Creek, and the Sabine River.

Response: The FEA acknowledges that the application for necessary permits should be made as soon as practicable, well in advance of the need to perform the work. In this regard, the FEA will make the necessary permit applications well in advance of the commencement of the work.

C. Department of Transportation, March 24, 1977

Comment 1: On page 3.2-10, collapses of surface ground in the vicinity of the proposed project are mentioned and a recent collapse is attributed to "abandoned shallow salt caverns." No details regarding such abandoned caverns, their numbers, locations, former uses, etc., are offered. A relevant question might be whether such caverns pose a hazard to surface or subsurface operations or structures, also whether there might be some historical significance associated with such caverns.

Response: The northern perimeter of the dome, particularly near the town of Grand Saline, has been extensively explored for oil, gas, salt, and salt impurities such as sulfur. The numbers and locations of drill holes are not known for the period prior to 1931 since it is only after this period that the Texas Railroad Commission assumed jurisdiction over and recording of drilling activities for the state. The exact locations of drilling activities have been treated as proprietary information. Early mining techniques and procedures were unsophisticated and most of the exploratory drilling and/or mining left only small drill holes or shallow caverns in the near-surface layers.

Four surface collapses have occurred within the past 60 years near the Kleer site. A recent collapse in April 1976 was located at the site of an abandoned leached brine well drilled in an area on the northwest flank of the salt dome. This area was mined by Morton Company's predecessor, B.W. Carrington 8 Company. This subsidence was the second collapse at this drill hole site. Other collapses in the area were limited to small areas of subsidence and were also located on the northern flank of the dome away from the present Morton Salt mine.

There have been no known or recorded occurrences of collapse on the southern flank of the salt dome which is the location of the present Morton mine. This condition suggests that the southern flank is an area of greater stability, as compared to the north flank of the dome. The northern flank is also characterized by an extensive drainage dissection pattern and has greater erosion of the caprock surface than that found on the southern flank. Before the Morton Company expanded the salt workings to their present location, they had the California Research Corporation perform a comprehensive seismic survey to assure that the new mine area would not be near the edge of the dome or near any of the old mine workings or solution holes. Kleer Mine's stability, dryness, and its excellent safety record are a testament to the careful choice of its location.

Comment 2: Referring to page 3.4-8, it may be useful to identify the Air Quality Control Regions (AQCR) for both the storage site and coastal area affected. In addition, there should be discussion of the coastal area AQCR present loadings and pollutant priority classifications.

Response: The AQCR for the Kleer Mine site is identified as the Shreveport-Texarkana-Tyler area on pages 3.4-8 and 3.4-9.

Additional data, from Texas AQCRs 7 and 10, on air quality in the southeast Texas coastal region has been incorporated in Tables 3.4-10 and 3.4-11.

Comment 3: On page 3.7-1, the Morton Salt Mine is identified as a site of "nationally registered historic significance." However, impact discussions on pages 4.2-15 (Section 4.2.6) and 4.3-15 (Section 4.3.6) do not mention possible effects on the Morton Salt Mine in this regard.

Response: The Morton Salt Company's first building was built at the site in 1930; the mine and the surrounding salt flats, were designated as a state historic landmark in 1936 and a state medallion was placed on the building.

In the event the FEA selects Kleer Mine for development, the FEA will coordinate with the Texas Historical Commission to mitigate possible impacts to the historic state landmark.

Comment 4: On page 3.9-10, in section 3.9.1.6, the question as to ownership of the proposed facility is raised. On page 4.3-17 (Section 4.3.7.5) the same question is raised again. However, on page 2.1-1 the statement is made that FEA would "purchase" the requisite site from Morton. Some explanation regarding ownership is in order.

Response: The FEA would either purchase or lease the site from Morton or would contract for storage with Morton. The statement on page 2.1-1 has been modified to this effect.

Comment 5: On page 4.3-20, oil spills with respect to two alternative modes of pipeline operation are discussed, viz. keeping oil within the pipeline or displacing the oil with water containing inhibitors. It is reasonable to infer that if crude oil is left for long periods of time in this 42-mile long pipeline, some measures will have to be taken to ensure the pipeline is not plugged by waxing or solidifying of portions of the crude. Will "pigs" be used in this pipeline? Also, the alternative of internal coating of the pipeline should be considered with respect to corrosion prevention and the issue of the use of inhibited water for displacement of the oil in the line.

Response: With the decision now to keep oil in the lines, it can be inferred that pigging will be required. Oil would be withdrawn from storage to drive the pig. The displaced oil would be pumped to a surge tank located at the terminal. After pig passage, the displaced oil would be returned to the pipeline and the oil from the surge tank would be returned to the storage system.

Pig traps would be required at the storage and terminal points and are shown in the plan drawings (Figure 2.3-3) as scraper launching traps.

Comment 6: On page 4.3-21 and in Appendix G (Oil Spill Risk Analysis Methodology), the discussions of oil spill risk from vessels do not make clear how the "FEA incremental" or "induced" traffic is viewed with respect to the oil spill data base used. The 30 million barrels required to fill the mine represents about sixteen 250M dwt VLCC's. The number of lightering tank vessels would be many more.

This represents additional tank vessel traffic which would not otherwise occur in that region of the Gulf and along the Sabine Lake-Neches River route.

Response: The VTS study of U.S. port casualty made a clear conclusion that casualty incidence in the ports was not density-dependent. Therefore, the increased spill risk due to new traffic within the 12-mile limit can be viewed as linearly increasing with incremental traffic. This is implicit in the FEA analysis.

This viewpoint is at variance with the Coast Guard Draft EIS for LOOP and Seadock - in which collisions only were considered density dependent (all other casualty modes were density independent). These collisions were considered as beyond the 12-mile limit. We believe that the incremental gain in oil spill risk due to vessels within the 12-mile limit is properly accounted for by the spill expectation projections. However, the risk from VLCC traffic mentioned outside the 12-mile line was not considered.

Comment 7: On page 10-9, the reference to the "1976 Draft Environmental Impact (4f) Statement, Seadock Deepwater Port License Application" is probably actually the LOOP Draft EI/4(f) Statement. (Note: Both LOOP and Seadock FEIS's were made available on 17 December 1976).

Response: The correction has been made.

Comment 8: The fact that oil handling by vessels is governed by the Coast Guard under the Oil Pollution Prevention Regulations should be considered by FEA in its EIS's for strategic storage projects.

Response: The FEA acknowledges the jurisdiction of the Coast Guard, under the Oil Pollution Prevention Regulations, governing oil handling by vessels.

D. Environmental Protection Agency, March 22, 1977

Comment 1: Potential construction impacts on water quality include sedimentation and infiltration and decreased water quality (page 4.2-3). Estimates of additional sediments to be received in area reservoirs are given on page 4.2-4. The increased sediment accumulation estimates are less than 0.1 percent of the total original storage capacity of each of the reservoirs; however, the final statement should discuss the possible effects the increased sediment accumulation could have on the expected project life of each reservoir. Quitman Reservoir appears to be the reservoir most affected, since it is expected to receive 83 percent of the present annual sediment accumulation due to the project. In addition, the final statement should also indicate if erosion control measures were included in estimating the sediment accumulation due to project construction.

Response: A discussion of the effects of increased sediment accumulation on the project life of impacted reservoirs has been included in the text on page 4.2-5. In all cases these effects are expected to be minimal. The estimates of additional sediments to be received by the area reservoirs, as discussed in the text, were calculated on a worst case basis; the implementation of mitigative measures, as discussed in Section 5.1.1, would therefore reduce the amounts of erosion and also their impacts markedly.

Comment 2: On page 4.2-14, it is stated that the proposed surface facilities "could alter freshwater flow to the marsh from the drainage area to the west." Since the marsh is considered to be unique, the final statement should describe the measures to be used to protect the marsh during construction and operation of the proposed facility.

Response: The impact of the project facilities and components, as discussed in the draft statement, was based on design details and locations of these facilities as described in the preliminary engineering feasibility studies. During the engineering design studies which would be conducted if Kleer Mine is selected as an ESR storage site, some of these facilities could be relocated because of engineering decisions or to reduce the potential impact on the environment. For example, if the Kleer Mine is selected to be developed as an oil storage site, measures could be taken to avoid alteration of the drainage area which extends from the site toward the salt marsh. All of the salt marsh (elevation 360 feet MSL) is located to the north and northeast of the storage site (390 feet MSL) (Figure 3.2.4). Construction of the pipeline to the Winnsboro Terminal could, therefore, be relocated to the south of the storage site in areas where elevations are about 400 feet MSL or less and where drainage from this new alignment would be in a more southerly direction, away from the marsh. The only creek which passes near the salt marsh is Grand Saline Creek; the pipeline crossing of this creek would be in an area which would have little if any impact on the marsh.

Comment 3: Liquid construction wastes (i.e., oily and briny water) from the project are proposed to be treated by a commercial disposal company (page 2.1-2). However, on page 5.2-2, it is stated that this waste water could be taken by tank truck to be treated in the municipal sewage system. If this alternative is chosen, the final statement should indicate that the municipal system is capable of treating this oily and briny waste water.

Response: The municipal sewage disposal system at Grand Saline does not have the capability to treat oily and briny waste water at this time; a new municipal facility is being developed for the city of Grand Saline; page 5.2-2 of the text has been modified to this effect. A new on-site treatment facility would be considered in the engineering design phases of the project if the Kleer site is selected as part of the ESR program.

Comment 4: Background noise levels were estimated for the project site and three other areas. It would strengthen the statement if an area land use map were included with the locations of the sites given. On page 3.5-1 it is stated that there are a number of residences within 1000 feet of the route and terminal locations. Noise levels and locations for these residences should be estimated and included in the final statement. This information would be helpful in assessing the potential effect of increased noise levels from the project on area residents.

Section 4.2.4 discusses the noise impacts of the proposed action. While it is indicated that there should be no increase in ambient noise levels in areas beyond one-half mile of the site, the final statement should discuss the noise levels to be experienced by residents less than 2000 feet away from construction sites, as well as the number that would be affected. It is indicated that construction activities at the site would be continuous (i.e., 24 hours a day). The final statement should indicate if the Ln and Ldn values given in Table 4.2-9 for construction activities include a 10dB penalty for night-time activities. Noise events become more intrusive at night, and a weighting factor is applied to night-time noise levels to increase the levels commensurate with their severity. If noise from the construction activities will annoy area residents, consideration should be given to limiting blasting to daylight hours. Other construction activities which could be annoying to area residents could be scheduled so the work at night would be less intruding and disturbing to sleep.

Response: An area land use map has been provided in the final environmental statement (see Figure 3.5-1) to indicate the site locations where background noise levels were estimated (page 3.5-1). Examination of the most recent information available within 1000 feet of the preliminary pipeline right-of-way and near the terminal locations indicated that about 81 houses would be located along the 42-mile pipeline corridor; this is approximately 1-house per each 0.5-mile of pipeline length. As noted in Section 3.5 (page 3.5-1) of the draft report, the proposed preliminary route traverses mostly sparsely populated pastureland and areas of oak trees and shrubs. Except for Grand Saline, the only populated areas within 2-3 miles of the proposed pipeline route are the villages of Alba and Golden, Texas. Because of the low population density in the area, the scattered locations of the 81 houses within the 2000-foot corridor along the 42-mile pipeline route, and the preliminary nature of the alignment, it was not deemed appropriate to measure sound levels at all of these scattered locations.

In the draft statement, a 10db penalty for nighttime activities was assigned to the $L_{dn}$ values but not to the $L_n$ values as given in Tables 3.5-1 and 4.2-9; this penalty has been noted in the table for the final statement. The penalty was not weighted to the $L_n$ values because according to standard practice it is not appropriate to add the 10dB correction factor to the equivalent sound level for the nighttime period.

As noted on page 5.2-3 of Section 5.2 of the draft statement on Mitigative measures, the "blasting of shafts can be limited to daytime periods so as not to interfere with sleep in residential areas". Other construction activities could be scheduled likewise to reduce noise impacts in residential areas where it is deemed necessary.

Comment 5: Assurances should be given in the final statement that possible mitigative measures discussed in Section 5.2 would be implemented, where feasible, if Kleer Mine is selected as a storage site.

Response: The FEA acknowledges and endorses the use of mitigative measures to minimize adverse environmental effects due to construction and operation of the storage site. Since the EIS is a document which is prepared prior to development of detailed engineering design specifications, the proposed project systems and components used in determining probable environmental effects are those established in the preliminary engineering feasibility studies. The FEA plans to implement reasonable alternatives and mitigative measures which have been considered for their effect on project impacts, as necessary to meet the appropriate regulations utilizing the best practical methods available.

Comment 6: We would like to point out that the EPA has issued guidelines for noise levels to protect public health and welfare, as stated in Appendix C, and the levels should not be interpreted as regulatory requirements. Therefore, the statement on page 4.2-12 that these guidelines were "promulgated" should be clarified.

Response: The statement on page 4.2-12 has been changed to read, "... (EPA) has issued guidelines ...".

Comment 7: On pages 4.3-8 and 4.3-9, class "F" stability air should be described as stable rather than unstable. On page 4.3-11, it is stated that at West Orange the high value recorded for ozone in the first six months of 1976 is 1.68 parts per million (ppm). Since the standard is 0.08 ppm, this value appears to be too high. The value should read 0.168 ppm.

Response: The correction has been made to reflect class "F" stability as stable air.

The correction has also been made to the high value recorded for ozone at West Orange. Recalculation indicates it should be 0.166 ppm.

Comment 8: It would strengthen the statement if additional air quality data for southeast Texas were included. EPA proposed hydrocarbon/photochemical oxidant strategy on November 11, 1976 (41 Federal Register 49840), using 1973 as the base line year for southeast Texas. The final statement should recognize that southeast Texas is a non-attainment area for photochemical oxidants because the national standard has not been achieved.

Response: Additional data on air quality has been incorporated in Tables 3.4-9 through 3.4-11. Also, a statement recognizing southeast Texas as a non-attainment area for photochemical oxidants has been added to page 4.3-11.

Comment 9: Assurances should be given in the final statement that the data given in the statement was obtained either by using accepted methodology or from an agency that used accepted methodology.

Response: All data have been obtained either from published literature or from agencies using "accepted methodologies". Most data are referenced directly as to their source, as for example, Table 3.4-6; where data were not available, a statement was made to that effect, as on page 4.2-13, Ecology.

### 9.4.2 Comments Received From State Agencies

A. Sabine River Authority of Texas, March 11, 1977

Comment 1: Our principal concern relative to this storage facility and the pipeline route is the probability of oil spills. Our concern is for oil spills in the drainages of the Sabine River and Lake Fork Creek and the effect on water uses in these streams.

The Sabine River Authority of Texas is at this time constructing Lake Fork Reservoir just upstream from the proposed pipeline route. This reservoir will be supplying water downstream to water intake facilities for Texas Utilities Services, Inc., and the city of Longview. It is this reach of the Sabine River and of Lake Fork Creek that could be most severely affected if, as calculated in the report, the maximum estimated credible spill of 5000 barrels were to occur.

Response: The Sabine River and Lake Fork Creek could only be affected by an oil spill due to a pipeline break in these watersheds and not due to spills at the storage site or at the Winnsboro Terminal. The preliminary pipeline route was selected to avoid crossing existing and planned reservoirs; the remainder of the route follows the right-of-way of an existing 20-inch Mobil pipeline (Section 2.3.3 and Section 4.3.8.1). Although it has been estimated that the maximum credible spill could amount to 5000 barrels (Appendix G) the chance of a spill of any size (Table 4.3.4) in Lake Fork Creek (6.1 percent) and Sabine River Basin (1.86 percent) is very small. Standard operating practices for pipeline operations and mitigative measures (such as suction or automatic valves at creek or river crossings) can be utilized to minimize oil losses and impacts. These measures will be fully considered in the design phase of the project. Also, historically, the watersheds and reservoirs in northeast Texas have been relatively free from oil spill impacts although the area is crossed by numerous pipelines and many oil fields are located in Van Zandt, Wood and Hopkins County. Furthermore, during the design and operation phases of the project an oil spill containment and recovery plan (Appendix H) would be implemented to meet the existing governmental regulations.

Comment 2: We are concerned as to the effects on water quality in Toledo Bend Reservoir. As noted on page 4.3-34 of the impact statement, the 5000 barrel maximum spill hypothesized to occur at flood stage could reach Toledo Bend Reservoir which is approximately 200 miles downstream within 92 hours, with an estimated 400 to 800 wide or more and 38 mile long slick in the reservoir. Such a possibility is certainly cause for concern and could be severely damaging to the aquatic habitat in the reservoir and to the water uses.

Response: It is acknowledged that if a maximum credible oil spill occurred under the "worst case" conditions as described in the text, the impact of this spill could be damaging to both the aquatic habitat and to the water uses of Toledo Bend Reservoir. However, as noted in Response to Comment 1 above, the probability of this maximum credible spill is very small. Furthermore, the chance of this maximum credible spill occurring during flood conditions in Grand Saline Creek is extremely small. In the approximately four days required for a spill to reach the reservoir, the water users in the area could be alerted to the potential impact that the spill could have and take precautionary measures to help reduce the effects that the oil may have on water use. In addition since most of the oil entering the reservoir would float and most intakes for water are usually located below the water surface, impacts would be further reduced. Should a spill occur, monitoring of these critical intake areas would determine whether the specific intake structure has been directly impacted.

Comment 3: We understand that the possibility of a 5000 barrel maximum spill is remote as based on the data for projecting pipeline oil spills. Further, we have noted the preventive measures and environmental safeguards that could be used to reduce the oil spill risks. However, we are familiar with and know the Sabine River as a stream that frequently flows at flood stage, as a stream that has long reaches that are inaccessible, and a stream on which it would be extremely difficult to lessen detrimental impacts in the event of a major crude oil spill.

Response: The FEA is also concerned with the potential impacts that a large oil spill could have on the inaccessible areas of the Sabine River and therefore, in preparing the SPCC plan, the areas of the River that are accessible would be defined and the plan of attack would be directed at these accessible areas. The clean-up team could base their operations in these pre-defined areas to recover oil as soon as possible and reduce oil spill impact. The need to minimize the affected area would be paramount to other considerations in a spill such as this. Both government agencies and private concerns should be as prepared as possible for a spill incident with the above-mentioned problems.

Comment 4: We would urge that, if the project is undertaken, every effort should be made to include safeguards against spills and that it should be explicitly spelled out ahead of time which governmental agencies and private industry would be responsible for the "strike-force" crews and the contingency plan to be used for corrective action in the event of a spill.

Response: The FEA acknowledges that safeguards against oil spills and recovery and cleanup activities after oil spills must be carefully planned in order to minimize environmental disturbance in the event of a spill. The Oil Spill Prevention Program of the Environmental Protection Agency (40 CFR 112) requires Spill Prevention Control and Countermeasure (SPCC) plans for facilities with oil storage capacity greater than 42,000 gallons that are in operation after January 11, 1974. The purpose of this regulation is to reduce to a minimum the likelihood of an oil spill reaching navigable waters and to reduce the extent of damage if a spill should occur. SPCC guidelines provide for preventive measures against spills, such as dikes and berms, where experience indicates reasonable potential for equipment failure. Monitoring and "strike-force" crews are also provided for in the SPCC.

In this regard, a SPCC plan, as generally described in Appendix H, would be required for the Kleer Mine if this mine is selected to be developed as part of the Strategic Petroleum Reserve. The regulations state that the SPCC plan should be prepared within six months and implemented not later than one year after the date that the facility begins operation. The EIS is a document which is prepared prior to detailed engineering design specifications. Further, the mine has not yet been selected as a SPR site. Therefore, since the law states that the SPCC plan is not required until operations begin, it is not appropriate to prepare the contingency plan at this time.

B. Texas Water Quality Board, February 25, 1977

Comment: We recommend that adequate erosion control measures be employed during pipeline construction and that pipeline routes be revegetated after construction in order to prevent excessive erosion.

Response: The FEA acknowledges and endorses the use of mitigative measures to minimize erosion during pipeline construction. These measures include stream bank stabilization and erosion control techniques such as cofferdams and the revegetation of disturbed areas as described in Section 5.2. Where proper mitigative measures are undertaken, erosion caused by construction can be minimized. The FEA would work with the Texas Parks and Wildlife to select environmentally acceptable plants for revegetation procedures.

9.4.3 Comments Received From Local Agencies

No substantive comments were received from local agencies.

9.4.4 Comments Received From Companies, Groups and the Public

A. Southern Methodist University, Archaeology Research Program, February 17, 1977

Comment 1: Section 3.7, "Archaeology and Historical Resources", is an accurate synthesis of our field reconnaissance and assessment. One factual error is that pottery was generally absent during the Archaic period.

Response: The reference to pottery sherds has been removed from the sentence summarizing the Archaic period findings.

Comment 2: Section 4.2.6, dealing with the impact upon the archaeological and historical resources needs clarification. We recommend that an intensive survey be undertaken to inventory the total scope of affected archaeological resources prior to commencement of construction but after the field location of the right-of-way is marked. Further, we recommend that testing be undertaken at potentially significant sites and that sites determined to be significant be nominated to the National Register of Historic Places. Any historic or prehistoric sites which are discovered and cannot be avoided by pipeline relocation will need to be thoroughly investigated to minimize adverse impact on the archaeological and historical resources affected by pipeline construction.

Response: The FEA acknowledges its responsibility with regard to the preservation of archaeological resources in the proposed construction area. An in-depth archaeological analysis of the proposed pipeline route, including a field reconnaissance, will be made in accordance with Federal regulations (Public Law 93-291) after the pipeline alignment is finalized. No adverse impacts to archaeological resources in the area are anticipated since one of the results of the planned investigation would be to determine if the proposed route would specifically affect any archaeological or historical sites. The second purpose of the investigation would be to help recommend an alternative pipeline route if necessary and to help minimize adverse impacts from pipeline construction.

B. Southern Methodist University, Herbarium, February 23, 1977

Comment 1: On pages 3.6-12 and 10-5, Robert Kral's name was misspelled (as Karl) and on page 316-13, last paragraph, the word drosera was also misspelled twice (as dorsera).

Response: The spelling corrections have been made.

Comment 2: In the section on "Rare and Endangered Species," pp. 3.6-18, 3.6-19, the latest list of Endangered and Threatened Wildlife and Plants (September 26, 1975, Federal Register) was said to have been used to identify endangered and threatened species in the project area. The latest Federal List was published in 1976, 6 mos. prior to the date of the statement (Jan. 1977). Rubus duplaris Shinners is in both of the Federal Lists and is known from Freestone and Henderson counties. This plant species is in the same vegetation zone - oak-savannah - as Kral's study (Freestone County) that was used to describe Seeps, on pages 3.6-12 and 3.6-13. The presence of Rubus duplaris Shinners in the proposed 42 mile pipeline route is within the realm of possibility (similar habitats within same zone).

Response: The September 26, 1975 list of Endangered and Threatened Wildlife and Plants was used to identify endangered and threatened species in the project area at the time the manuscript for the report was written (the preliminary draft was printed May 7, 1976).

It is recognized that Rubus duplaris Shinners is a threatened or endangered species in Texas and is found to the southeast of the project area in the counties of Henderson and Freestone. A change has been made in the Final EIS to include this species as possibly present in the project area in similar oak-savannah vegetative zones.

SECTION 10.0

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# APPENDIX A

## WATER QUALITY STANDARDS AND GENERAL CRITERIA
## APPLICABLE IN THE AREA

# APPENDIX A

## WATER QUALITY STANDARDS AND GENERAL CRITERIA APPLICABLE IN THE AREA

(This section is extracted in large part from the 1975 Texas Water Quality Board's publication entitled "Texas Water Quality Standards".)

A. Policy Statement

It is the policy of Texas to maintain the quality of water in the State consistent with the public health and enjoyment, the propagation and protection of terrestrial and aquatic life, the operation of existing industries, and the economic development of the State; to encourage and promote the development and use of regional and area-wide waste collection, treatment, and disposal systems to serve the waste disposal needs of the citizens of the State; and to require the use of all reasonable methods to implement this policy. (Texas Water Code Chapter 21, Section 21.002, 60th Legislature, Chapter 313, Section 1.02, as amended).

B. Antidegradation Statement

In implementing the legislative policy expressed in the Texas Water Quality Act, it is the policy of the Texas Water Quality Board that the waters in the State whose existing quality is better than the applicable water quality standards herein as of the date when these standards become effective will as provided hereafter be maintained at their high quality, and no waste discharges may be made which will result in the lowering of the quality of these waters unless and until it has been demonstrated to the Texas Water Quality Board that the change is justifiable as a result of desirable economic or social development. Therefore, the Board will not authorize or approve any waste discharge which will result in the quality of any of the waters in the State being reduced below the water quality standards without complying with the Federal and State laws applicable to the amendment of water quality standards. Anyone making a waste discharge from any industrial, public or private project or development which would constitute a new source of pollution or an increased source of pollution to any of the waters in the State will be required, as part of the initial project design to provide the highest and best degree of waste treatment available under existing technology consistent with the best practice in the particular field affected under the conditions applicable to the project or development.

C. Description of Standards

The General Statement is an integral part of the standards and the standards shall be interpreted in accord with the General Statement.

These standards consist of three parts:

1. General Criteria applicable to all surface waters of the State at all times to the maximum extent feasible

2. Numerical Criteria applicable to specific surface waters designated in the standards

3. Water uses

In determining the suitability of waters of the State for various uses, the following water quality criteria were used as guidelines. Nothing in these water quality standards limits the authority of the Commissioner of Health of the State of Texas to take such public health protective measures as he may deem necessary.

a. Contact recreation waters

Surface waters suitable for contact recreation shall not exceed a logarithmic mean (geometric mean) fecal coliform content from a representative sampling of not less than 5 samples collected over not more than 30 days, as determined by either multiple-tube fermentation or membrane filter techniques, of 200/100 ml, nor shall more than 10 percent of total samples during any 30-day period exceed 400/100 ml.

Simple compliance with bacteriological standards does not insure that waters are safe for primary contact recreation, such as swimming. Long-standing public health principles mandate that watershed sanitary surveys be conducted in order to adequately evaluate the sanitary hazards potentially present on any natural watercourse.

b. Noncontact recreation waters

Surface waters for general or noncontact recreation should with specific and limited exceptions be suitable for human use in recreation activities not involving significant risks of ingestion. These waters shall not exceed a logarithmic mean (geometric mean) fecal coliform content of 2,000/100 ml and a maximum of 4,000/100 ml, except in specified mixing zones adjacent to outfalls.

In waters designed for recreation use other than primary contact recreation, the fecal coliform content should not exceed a logarithmic mean (geometric mean) fecal coliform content of 1,000/100 ml, nor equal or exceed 2,000/100 ml in more than 10 percent of the samples, except in specified mixing zones adjacent to outfalls.

c. Domestic raw water supply

It is the goal that the chemical quality of all surface waters used for domestic raw water supply conform to the U.S. Public Health Service, Drinking Water Standards, revised 1962, or latest revision. However, it must be realized that some surface waters are being used that cannot meet these standards. Since in these cases it is the only source available, these surface waters may be deemed suitable for use as a domestic raw water supply, where the chemical constituents do not pose a potential health hazard.

It is desirable that the total coliform content should not exceed 100/100 ml and the fecal coliform content 20/100 ml; however, domestic water supply should not be considered unacceptable if an adequate number of samples show monthly arithmetic averages for total coliform to be less than 10,000/100 ml and fecal coliform to be less than 2,000/100 ml.

The evaluation of raw water cannot be reduced to simply counting bacteria of any kind and the foregoing must be used with judgment and discretion and this paragraph is not intended to limit the responsibilities and authorities of responsible local governments or local health agencies.

d. Irrigation waters

The suitability of water for use as irrigation water is influenced by:

(1) the total salt concentration or salinity hazards;

(2) the amount of sodium and its relation to other cations;

(3) the concentration of boron and other constituents that may be toxic; and

(4) The bicarbonate content in relation to calcium and magnesium.

The suitability of water for irrigation will be based on the irrigation water classification system prepared by the USDA salinity laboratory. The various salinity classes are:

Class #1 - low-salinity water can be used for irrigation with most crops on most soils with little likelihood that soil salinity will develop.

Class #2 - medium-salinity water can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.

Class #3 - high-salinity water cannot be used on soil with restricted drainage.

Class #4 - very high-salinity water is not suitable for irrigation under ordinary conditions but may be used occasionally under special circumstances. The soil must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching and highly salt-tolerant crops must be selected.

The SAR (sodium adsorption ratio) should not exceed 8 for waters safe for irrigation. Sampling and analytical procedures and schedules are not specified but would be as appropriate for adequate protection of irrigation waters.

e. Shellfish waters

In shellfish areas in the bays and outside the buffer zones, the coliform criteria shall be limited and guided by the U. S. Public Health Service Manual, "Sanitation of Shellfish Growing Areas," 1965 revision, or latest revision.

D. General Criteria

The general criteria enumerated below are applicable to all surface waters of the State at all times and specifically apply with respect to substances attributed to waste discharges or the activities of man as opposed to natural phenomena. Natural waters may, on occasion, have characteristics outside the limits established by these criteria; in which these criteria do not apply. The criteria adopted herein relate to the condition of waters as affected by waste discharges or man's activities. The criteria listed following do not override a specific exception to any one or more of the following if the exception is specifically stated in a specific water quality standard.

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

2. Essentially free of floating debris and settleable suspended solids conducive to the production of putrescible sludge deposits or sediment layers which would adversely affect benthic biota or other lawful uses.

3. Essentially free of settleable unsuspended solids conducive to changes in the flow characteristics of stream channels, to the untimely filling of reservoirs and lakes, and which might result in unnecessary dredging costs.

4. The surface waters in the State shall be maintained in an aesthetically attractive condition.

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

6. There shall be no foaming or frothing of a persistent nature.

7. There shall be no discharge of radioactive materials in excess of that amount regulated by the Texas Radiation Control Act, Article 4590(f), Revised Civil Statutes, State of Texas and Texas Regulation for Control of Radiation.

Radioactivity levels in the surface waters of Texas, including the radioactivity levels in both suspended and dissolved solids for the years 1958 through 1960, were measured and evaluated by the Environmental Sanitation Services Section of the Texas State Department of Health in a report prepared for and at the direction of the Health Department by the Sanitary Engineering Research Laboratory at the University of Texas. The document is entitled, "Report on Radioactivity -- Levels in Surface Waters -- 1958-1960" pursuant to contract No. 4413-407 and is dated June 30, 1960. This document comprises an authoritative report on background radioactivity levels in the surface waters in the State and quite importantly sets out the locations where natural radioactive deposits have influenced surface water radioactivity. The impact of radioactive discharges that may be made into the surface waters of Texas will be evaluated and judments made on the basis of the information in the report which was at the time made, and may still be the only comprehensive report of its kind in the nation.

Radioactivity in fresh waters associated with the dissolved minerals (measurements made on filtered samples) shall not exceed those enumerated in U. S. Public Health Service, Drinking Water Standards, revised 1962, or latest revision, unless such conditions are of natural origin.

8. The surface waters of the State shall be maintained so that they will not be toxic to man, fish and wildlife, and other terrestrial and aquatic life.

With specific reference to public drinking water supplies, toxic materials not removable by ordinary water treatment techniques shall not exceed those enumerated in U. S. Public Health Service, Drinking Water Standards, 1962 edition, or later revision.

For a general guide, with respect to fish toxicity, receiving waters outside mixing zones should not have a concentration of nonpersistent toxic materials exceeding 1/10 of the 96-hour TLm, where the bioassay is made using fish indigenous to the receiving waters. Similarly, for persistent toxicants, the concentrations should not exceed 1/20 of the 96-hour TLm.

In general, for evaluations of toxicity, bioassay techniques will be selected as suited to the purpose at hand. However, bioassays will be conducted under water quality conditions (temperature, hardness, pH, salinity, dissolved oxygen, etc.) which approximate those of the receiving stream as closely as practical.

9. As detailed studies are completed, limiting nutrients identified, and the feasibility of controlling excessive standing crops of phytoplankton or other aquatic growths by nutrient limitations is determined, it is anticipated that nutrient standards will be established on the surface waters of the State. Such decisions will be made on a case-by-case basis by the Board after proper hearing and public participation. The establishment of a schedule for decisions as to the need for nutrient standards for specific waters and what standards should be adopted is not feasible at this time.

10. The surface waters of the State will be maintained so that no oil, grease, or related residue will produce a visible film of oil or globules of grease on the surface, or coat the banks and bottoms of the watercourse.

E. Numerical Criteria

The numerical criteria apply to the specific waters identified. Stream standards apply only to waters where standards are established and specifically apply with respect to substances attributed to waste discharges or the activities of man as opposed to natural phenomena.

Chemical concentration parameters, with the exception of dissolved oxygen and pH, apply to the approximate midpoint of the segment with reasonable gradients applying toward segment boundaries. The numerical values shown represent arithmetic average conditions over a period of one year. Whenever an unusual chemical concentration is found, an investigation of its origin will be made and such action as is warranted initiated.

The dissolved oxygen values are minimum values which are applicable except as qualified in Section F. For short periods of time, diurnal variations of 1.0 mg/l below the standard specified in the table shall be allowed for not more than 8 hours during any 24-hour period.

The pH range represents maximum and minimum conditions throughout the segment except as qualified in Section F.

The temperature limitations are intended to be applied with judgment and are applicable to the waters specifically identified herein with the qualifications enumerated in Section F. Temperature standards are composed of two parts, a maximum temperature and a maximum temperature differential attributable to heated effluents.

Natural high temperatures, in excess of 96°F, occur regularly in Texas waters during the summer months. For example, 2.3% of United States Geological Survey measurements made during the summer months on the Double Mountain Fork of the Brazos River near Aspermont, Texas, during the period 1958 through 1971 exceeded 96° F. It is consequently concluded that the 90°F maximum temperature suggested by the National Technical Advisory Committee is not applicable to Texas conditions.

Fresh Water Streams:

| | |
|---|---|
| Maximum Temperature | See regulations for Specific Waters |
| Maximum Temp. Diff. | 5°F rise over ambient |

Fresh Water Impoundments:

| | |
|---|---|
| Maximum Temperature | See regulations for Specific Waters |
| Maximum Temp. Diff. | 3°F rise over ambient |

Tidal River Reaches, Bay and Gulf Waters:

| | Fall, Winter Spring | Summer |
|---|---|---|
| Maximum Temp. Diff | 4°F | 1.5°F |
| Maximum Temperature | 95°F | 95°F |

The temperature requirements shall not apply to off-stream or privately owned reservoirs, constructed principally for industrial cooling purposes and financed in whole or part by the entity or successor entity using, or proposing to use, the lake for cooling purposes.

F. Application of Standards

1. Flow Conditions

The flow conditions specified herein apply to river and coastal basin waters. They do not apply to bay and gulf waters, or lakes and reservoirs.

(a) Chemical parameters: The water quality standards for chemical parameters, including chlorides, sulfates and total dissolved solids, exclusive of dissolved oxygen and pH, represent annual arithmetic mean concentrations which will not be exceeded for any year where the sampling median flow for the year under consideration equals or exceeds 50% of the median flow for the period of record for the existing hydrological conditions.

The sampling median flow for the year under consideration is defined for the purposes of this section to be the median of the flow measurements made on the days samples were collected. The "median flow for the period of record" is defined as the 50% value secured from available data. Existing hydrologic conditions mean, for the purpose of this section, the existing consumptive water uses; or any other factor which would significantly affect the hydraulic regime of the flow measuring station or other point under consideration.

When the flow is zero, no data will be collected and the annual arithmetic mean concentration is defined as the mean of the data collected when a flow exists.

(b) The dissolved oxygen concentrations represent minimum values and shall apply at all times that the daily flow exceeds the base flow condition. The base flow condition is defined as either the 7-day minimum average flow for the existing hydrologic conditions with a recurrence interval of 2 years or 0.1 cfs, whichever value is higher.

(c) Temperature: same as dissolved oxygen.

(d) Other Parameters and General Criteria: The general criteria and the numerical criteria not specifically discussed above shall apply at all times regardless of flow unless specifically excepted under Section F - 1,2.

2. Mixing Zones

Where mixing zones are specifically defined in a valid waste control order issued by the Texas Water Quality Board or a National Pollutant Discharge Elimination System permit, the defined zone shall apply.

Where the mixing zone is not so defined, a reasonable zone shall be allowed. Because of varying local physical, chemical, and biological conditions, no single criterion is applicable in all cases. In no case, however, where fishery resources are considered significant, shall the mixing zone allowed preclude the passage of free-swimming and drifting aquatic organisms to the extent of significantly affecting their populations. Normally mixing zones should be limited to no more than 25 percent of the cross-sectional area and/or volume of flow of the stream or estuary, leaving at least 75 percent free as a zone of passage unless otherwise defined by a specific Board Order or permit.

G. Numerical Water Quality Standards for the Sabine River

The Sabine River is subject to numerical water quality standards. These standards vary by reach. From U.S. 271 near Gladewater to Lake Tawakoni the applicable water uses and criteria are:

1. Water uses deemed desirable

(a) contact recreation

(b) noncontact recreation

(c) propagation of fish and wildlife

(d) domestic raw water supply

2. Numerical criteria (annual arithmetic mean concentrations)

(a) chloride (mg/l) - average not to exceed 200

(b) sulfate (mg/l) - average not to exceed 100

(c) total dissolved solids (mg/l) - average not to exceed 500

(d) dissolved oxygen (mg/l) - not less than 5.0

(e) pH range - 6.0-8.5

(f) fecal coliform per 100 ml - log average (geometric mean) not more than 200

(g) temperature ($^{o}F$) - $90^{o}$ maximum (or $32.2^{o}C$)

H. Grand Saline Creek Watershed

The Grand Saline Creek and its tributaries are subject to the general water quality criteria. These criteria were described previously.

I. Watersheds affected by the pipeline

Lake Fork Creek, Big Sandy Creek, and Big Cypress Creek watersheds are subject to the general water quality criteria.

J. World Health Organization Drinking Water Standards

The World Health Organization drinking water standards are included to further demonstrate the characteristics of generally acceptable water quality:

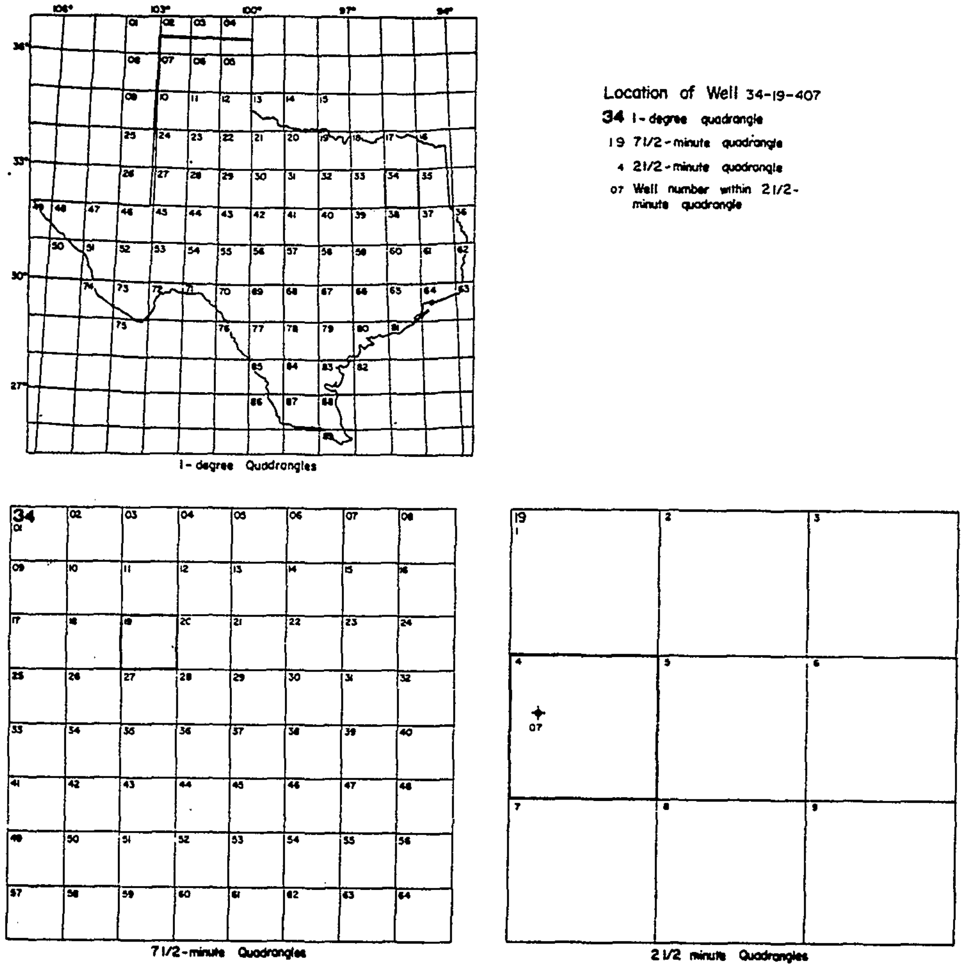
International Standards

| Characteristics | Permissible | Excessive |
|---|---|---|
| Total solids | 500 | 1500 |
| Iron | 0.3 | 1.0 |
| Manganese | 0.1 | 0.5 |
| Copper | 1.0 | 1.5 |
| Zinc | 5.0 | 15.0 |
| Calcium | 75 | 200 |
| Magnesium | 50 | 150 |
| Sulphate | 200 | 400 |
| Chloride | 200 | 600 |
| pH | 7.0-8.5 | $< 6.5$ or $> 9.2$ |
| Magnesium & Sodium Sulphate | 500 | 1000 |
| Nitrate | 0.28-0.6 | |

(Source: Principles of Water Quality Control by T.H.Y. Tebbett)

# APPENDIX B

## RECORDS OF WELLS AND TEST HOLES WITHIN 5-MILE RADIUS OF KLEER MINE SITE




## WELL-NUMBERING SYSTEM

The well-numbering system is that used by the Texas Water Development Board. Under this system every 1 degree quadrangle in Texas is the well number. Each 1-degree quadrangle is divided into 7½-minute quadrangles which are given 2-digit numbers from 01 to 64. These are the third and fourth digits of the well number. Each 7½-minute quadrangle is subdivided in 2½-minute quadrangles given a single digit number from 1 to 9. This is the fifth digit of the well number. Finally, each well within a 2½-minute quadrangle is given a 2-digit number in the order in which it was inventoried, starting with 01. These are the last two digits of the well number. In addition to the seven-digit number, a two-letter prefix is used to designate the county. The prefix for Van Zandt County is YS.

TABLE B-1 Records of wells and test holes within 5-mile radius of Kleer Mine site

| No. | Owner | Date Completed | Depth of Well (ft) | Diameter (in) | Water Bearing Units* | Altitude of Land Surface (ft) | Water Level | | Use of Water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Above (+) or Below Land Surface = Datum (ft) | Date of Measurement | | |
| YS-34-18-601 | Pan American Petr. Corp. | 1963 | 329 | 10 | Twi | 465 | 100<br>106 | October 1963<br>March 1969 | Ind | Supplies Edgewood gas-processing plant. Co. Well No. 6. Reported 132 ft drawdown pumping 69 gpm in March 1969 |
| YS-34-18-602 | Pan American Petr. Corp. | 1964 | 480 | 12 | Twi | 465 | 120<br>158<br>158 | Feb. 12, 1964<br>December 1967<br>March 1969 | Ind | Co. well No. 10. Drilled and logged to 550 ft. Base of Wilcox at 473 ft. Pumping test by driller, January 1964: 242 ft drawdown discharging 445 gpm for 12 hrs. Reported discharged 241 gpm in March 1969. Pumped intermittently because of large drawdown and yield |
| YS-34-18-603 | J.E. Pipes | 1939 | 57 | 6 | Twi | 442 | 40.3 | July 9, 1969 | D | Bored. Tile to bottom |
| YS-34-18-604 | A.D. Hatton Estate | 1959 | 222 | 4 | Twi | 449 | -- | -- | D | Drilled. Reported to have pumped 8 days without breaking suction |
| YS-34-18-605 | Hatton Estate | 1936 | 33 | 36 | Twi | 448 | 25.0 | July 9, 1969 | D | Dug. Reported dependable supply |
| YS-34-18-606 | W.A. McCoy | 1959 | 12,096 | -- | -- | 482 | -- | -- | -- | Oil test. Base of Wilcox at 377 ft |
| YS-34-18-901 | J.B. Wells | Old | 46 | 36 | Twi | 512 | 37.4 | July 9, 1969 | D | Dug. Reported to pump off with heavy use |
| YS-34-18-902 | N. Cox | Before 1962 | 420 | 5 | Twi | 542 | 79.4 | July 9, 1969 | D | |

TABLE B-1 Continued

| No. | Owner | Date Completed | Depth of Well (ft) | Diameter (in) | Water Bearing Units* | Altitude of Land Surface (ft) | Water Level: Above (+) or Below Land Surface Datum (ft) | Water Level: Date of Measurement | Use of Water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| YS-34-19-101 | J.V. Curnutt | -- | 52 | 6 | Twi | 403 | 43.4 | May 20, 1969 | D | Bored. Tile to bottom |
| YS-34-19-102 | H.E. Crawford | Old | 40 | 30 | Twi | 444 | 33.3 | May 20, 1969 | D | Dug. Concrete tile to bottom |
| YS-34-19-401 | City of Grand Saline | 1954 | 471 | 7 | Twi | 408 | 60 | 1954 | U | City Well No. 1. Casing corroded. Abandoned in 1962. Reported to have pumped 275 gpm with a drawdown of 110 ft in 1954 |
| YS-34-19-402 | Grand Saline | 1955 | 506 | 8 | Twi | 435 | 130.9 | March 14, 1961 | P | City Well No. 2. Reported drilled to base of Wilcox |
| YS-34-19-403 | Morton Salt Co. | 1936 | 318 | 8 | Twi | 433 | 44<br>55 | June 1936<br>December 1954 | U | Company Well No. 1. Pumping test by W.F. Guyton and Associates Dec. 17, 1954: drawdown of 118 ft discharging 130 gpm for 48 hrs. Casing collapsed in 1965. Replaced by well YS-34-19-413 drilled 36 ft north of this well |
| YS-34-19-404 | Morton Salt Co. | 1955 | 392 | 8 | Twi | 433 | 78<br>90 | 1955<br>1958 | U | Company Well No. 3. Abandoned and plugged in 1965. Replaced by well YS-34-19-414. Drilled 22 ft west of this well |
| YS-34-19-405 | City of Grand Saline | 1962 | 500? | 8 | Twi | 430 | -- | -- | P | City Well No. 3. Reported discharge 250 gpm |
| YS-34-19-406 | Grand Saline | 1964 | 500 | 8 | Twi | 405 | 135.4 | March 26, 1969 | P | City Well No. 4. Reported discharge 250 gpm |

TABLE B-1 Continued

| No. | Owner | Date Completed | Depth of Well (ft) | Diameter (in) | Water Bearing Units* | Altitude of Land Surface (ft) | Water Level: Above (+) or Below Land Surface Datum (ft) | Water Level: Date of Measurement | Use of Water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| YS-34-19-407 | City of Grand Saline | 1954 | 392 | 7 | Twi | 502 | 133 | December 1964 | U | Abandoned municipal well. Reported drawdown of 33 and 44 ft pumping 50 and 60 gpm in 1954 |
| YS-34-19-408 | Pan American Petr. Corp. | 1964 | 531 | 12 | Twi | 440 | 115<br>160.6 | Feb. 20, 1964<br>Nov. 7, 1969 | Ind | Company Well No. 9. Drilled and logged to 554 ft. Pumping test by driller Feb. 1964: drawdown of 220 ft discharging 565 gpm for 40 hrs. Reported drawdown of 112 ft pumping 283 gpm in March 1969 |
| YS-34-19-409 | Pan Am. Petr. | -- | 185 | 10 | Twi | 482 | 88 | March 1968 | Ind | Company Well No. 13. Pump set at 166 ft. Reported discharge 145 gpm |
| YS-34-19-410 | Earl Parsons | 1953 | 340 | 5 | Twi | 425 | -- | -- | D | Water high in iron content. Reported discharge 75 gpm |
| YS-34-19-411 | A.B. Germany | 1955 | 197 | 4 | Twi | 453 | 127.0 | May 20, 1969 | D | Reported discharge 5 gpm |
| YS-34-19-412 | Morton Salt Co. | 1951 | 311 | 8 | Twi | 450 | 73<br>167.6 | December 1954<br>August 1, 1969 | S | Old Company Well No. 2. Reported crooked hole. Pumped 76 gpm for 1 1/2 hrs and had 71 ft of drawdown in December 1954. Supplies rodeo arena in Grand Saline |
| YS-34-19-413 | Morton Salt Co. | 1965 | 519 | 10 | Twi | 433 | 97<br>119.2<br>135.1 | July 1965<br>March 27, 1969<br>July 21, 1969 | Ind | New Company Well No. 1. Replaced well YS-34-19-403, 36 feet south of this well. Reported drawdown of 23 ft pumping 180 gpm for 4 hrs in 1965 |

TABLE B-1 Continued

| No. | Owner | Date Completed | Depth of Well (ft) | Diameter (in) | Water Bearing Units* | Altitude of Land Surface (ft) | Water Level: Above (+) or Below Land Surface Datum (ft) | Water Level: Date of Measurement | Use of Water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| YS-34-19-414 | Morton Salt Co. | 1965 | 515 | 10 | Twi | 430 | 88<br>125.4 | June 1965<br>March 27, 1969 | Ind | New Company Well No. 2. Reported drawdown of 97 ft pumping 235 gpm for 4 hrs in 1965 |
| YS-34-19-415 | City of Grand Saline | 1967 | 544 | 10 | Twi | 505 | 197 | May 24, 1967 | P | City Well No. 5 (Tower Well No. 2). Replaced Well YS-34-19-407 (Tower Well No. 1) 140 ft northeast of this well. Pumping test by driller May, 1967: drawdown of 107 ft discharging 525 gpm for 28 hrs |
| YS-34-19-501 | M.E. Fowler | 1967 | 170 | 4 | Twi | 400 | 45.0 | May 8, 1969 | D | |
| YS-34-19-601 | Glencrest Ranch | 1967 | 400 | 4 | Twi | 430 | 80 | 1967 | D,S | Reported good water sand from 186 to 308 ft and 368 to 396 ft |
| YS-34-19-701 | Pan American Petr. Corp. | 1964 | 565 | 12 | Twi | 475 | -- | -- | Ind | Company Well No. 11. Drilled and logged to 570 ft. Base of Wilcox at 565 ft. Reported drawdown of 92 ft pumping 261 gpm in March 1969 |
| YS-34-19-702 | Cecil Eberhart | 1965 | 400 | 2 | Twi | 445 | -- | -- | D | |
| YS-34-19-703 | H.G. & H.F. Fisher | 1961 | 9,405 | -- | -- | 440 | -- | -- | -- | Oil test. Base of Wilcox at 610 ft |
| YS-34-19-704 | Ike Turner | 1944 | 4,992 | -- | -- | 440 | -- | -- | -- | Oil test. Base of Wilcox at 678 ft |

TABLE B-1 Continued

| No. | Owner | Date Completed | Depth of Well (ft) | Diameter (in) | Water Bearing Units* | Altitude of Land Surface (ft) | Water Level: Above (+) or Below Land Surface Datum (ft) | Water Level: Date of Measurement | Use of Water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| YS-34-19-705 | Dodd | 1939 | 4,397 | -- | -- | 424 | -- | -- | -- | Oil test. Base of Wilcox at 725 ft |
| YS-34-19-801 | W.D. King | 1945 | 168 | 4 | Twi | 367 | + | May 19, 1969 | D,S | Well was flowing 2 gpm May 19, 1969. Water is pumped to house with 3/4 HP booster pump |
| YS-34-19-802 | M.C. Carrol | 1969 | 332 | 2 | Twi | 425 | 60 | 1969 | D | Reported tested well at 1,000 gallons per hour when drilled. Water is soft and low in total dissolved solids |
| YS-34-19-803 | A.L. Hollowell | 1960 | 295 | 4 | Twi | 473 | -- | -- | D | Supplies 2 houses |
| YS-34-19-901 | W.D. King | 1950 | 89 | 4 | Twi | 360 | + | May 19, 1969 | S | Flowing 2 gpm May 1969 |
| YS-34-19-902 | L.L. Etheridge | Old | 25 | 30 | Twi | 425 | 4.4 | May 19, 1969 | D | Dug. Well reportedly goes dry during droughts |
| YS-34-19-903 | J.B. Wilson | Old | 30 | 30 | Tc | 461 | 5.75 | May 19, 1969 | S | Dug. Water level reportedly fluctuates with rainfall. Water high in iron content |
| YS-34-26-303 | Milton Hitt | 1949 | 44 | 30 | Twi | 492 | 8 - 10<br>37.1 | 1949<br>July 14, 1969 | D | Dug. Concrete tile to bottom |
| YS-34-27-101 | A.M. Griffin | 1955 | 305 | 4 | Twi | 433 | 34.5 | May 21, 1969 | D | Replaced well 175 ft deep which reportedly yielded water high in iron and sulfate |

TABLE B-1 Continued

| No. | Owner | Date Completed | Depth of Well (ft) | Diameter (in) | Water Bearing Units* | Altitude of Land Surface (ft) | Water Level: Above (+) or Below Land Surface Datum (ft) | Water Level: Date of Measurement | Use of Water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| YS-34-27-102 | C.R. Fisher | 1918 | 13 | -- | Twi | 469 | 3.3 | May 21, 1969 | D | Dug and used as cistern until ground water broke through cistern wall. Well reportedly goes dry. Water is acidic and high in iron content |
| YS-34-27-103 | J.D. Collins | 1965 | 290 | 4 | Twi | 445 | 15.2 | May 21, 1969 | D | Reported water is of good quality |
| YS-34-27-201 | Pruitt-Sand Flat Water Supply Corp. | 1968 | 330 | 8 | Twi | 460 | 87 | March 1968 | P | Development test by driller, March 1968: drawdown of 53 ft pumping 56 gpm for 24 hrs. Water is soft and low in dissolved solids. Supplied 142 customers in 1969 |
| YS-34-27-202 | F.D. Barton | Old | 44 | 26 | Twi | 472 | 31.4 | May 21, 1969 | D | Dug. Estimated dishcarge 10 gpm |
| YS-34-27-301 | J.G. Parket | Old | 35 | 24 | Twi | 452 | 13.6 | May 21, 1969 | -- | Dug. Water reported high in iron content |
| YS-34-27-302 | A.L. Cade | 1962 | 4,502 | -- | -- | 420 | -- | -- | -- | Oil test. Base of Wilcox at 580 ft |

Note: After White, 1973

Use of water: D, domestic; Ind, industrial; P, public supply; S, stock; U, unused

Water bearing units: Twi, Wilcox Group; Tc, Carrizo Sand

# APPENDIX C

# NOISE DEFINITIONS AND GUIDELINES

## APPENDIX C

## NOISE DEFINITIONS AND GUIDELINES

### NOISE DEFINITIONS

The range of sound pressures that can be heard by humans is very large. This range varies from two ten-thousand-millionths ($2 \times 10^{-10}$) of an atmosphere for sounds barely audible to humans to two thousandths ($2 \times 10^{-3}$) of an atmosphere for sounds which are so loud as to be painful. The decibel notation is used to present sound levels over this wide physical range. Essentially, the decibel unit compresses this range to a workable range using logarithms. It is defined as:

> Sound pressure level (dB) = $20 \log_{10} (\frac{P}{P_o})$ where $P_o$ is a reference sound pressure required for a minimum sensation of hearing.

Zero decibels is assigned to this minimum level, and 140 decibels to sound which is painful. Thus a range of more than one million is expressed on a scale of zero to 140.

The human ear does not perceive sounds at low frequencies in the same manner as those at higher frequencies. Sounds of equal intensity at low frequency do not seem as loud as those at higher frequencies. The A-weighted network is provided in sound analysis systems to simulate the human ear. A-weighted sound levels are expressed in units of dBA. These levels in dBA are used by the engineer to evaluate hearing damage risk (OSHA) or community annoyance impact and are also used in federal, state, and local noise guidelines and ordinances.

Sound is not constant in time. Statistical analysis is used to describe the temporal distribution of sound and to compute single number descriptors for the time-varying sound. This report contains the statistical A-weighted sound levels:

$L_{eq}$ - This is the equivalent steady sound level which provides an equal amount of acoustic energy as the time-varying sound.

$L_d$ - Equivalent sound level, $L_{eq}$, for the daytime period (0700-2200) only.

$L_n$ - Equivalent sound level, $L_{eq}$, for the nighttime period (2200-0700) only.

$L_{dn}$ - Equivalent day/night sound level, defined as:

$$L_{dn} = 10 \log_{10} \left( [15 \times 10^{L_d/10} + 9 \times 10^{(L_n+10)/10}]/24 \right)$$

Note: a 10 dB correction factor is added to the nighttime equivalent sound level when computing $L_{dn}$.

FEDERAL GUIDELINES AND STATE NOISE REGULATION

The U.S. Environmental Protection Agency has established guidelines for limits of $L_{dn}$ requisite for the protection of public health and welfare ("Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," USEPA, 550/9-74-004, March 1974).

According to EPA quidelines, outdoor ambient sound levels, $L_{dn}$, below 55 dB will not degrade public health and welfare. (The state of Texas has no noise regulation pertaining to the construction or operation of the proposed project.)

## SUMMARY OF NOISE LEVELS IDENTIFIED AS REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

| Effect | Level | Area |
|---|---|---|
| Hearing Loss | $L_{eq(24)} \leq 70$ dB | All areas |
| Outdoor activity interference and annoyance | $L_{dn} \leq 55$ dB | Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use. |
| | $L_{eq(24)} \leq 55$ dB | Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc. |
| Indoor activity interference and annoyance | $L_{dn} \leq 45$ dB | Indoor residential areas |
| | $L_{eq(24)} \leq 45$ dB | Other indoor areas with human activities such as schools, etc. |

$L_{eq(24)}$ represents the sound energy averaged over a 24-hour period.

$L_{dn}$ represents the $L_{eq}$ with a 10 dB nighttime weighting.

# APPENDIX D

# TERRESTRIAL AND AQUATIC SPECIES THAT MAY OCCUR IN THE VICINITY OF THE PROJECT

TABLE D-1 Mammals

| Family / Scientific Name / Common Name | |
|---|---|
| Didelphidae | |
| *Didelphis marsupialis* | Opossum |
| Soricidae | |
| *Cryptotis parva* | Little Short-tailed Shrew |
| Talpidae | |
| *Scalopus aquaticus* | Eastern Mole |
| Vespertilionidae | |
| *Pipistrellus subflavus* | Georgia Bat |
| *Eptesicus fuscus* | Big Brown Bat |
| *Nycticeius humeralis* | Evening Bat |
| *Lasiurus borealis* | Red Bat |
| Dasypodidae | |
| *Dasypus novemcinctus* | Armadillo |
| Leporidae | |
| *Sylvilagus floridanus* | Eastern Cottontail |
| *Sylvilagus aquaticus* | Swamp Rabbit |
| Sciuridae | |
| *Sciurus carolinensis* | Eastern Gray Squirrel |
| *Sciurus niger* | Fox Squirrel |
| Geomyidae | |
| *Geomys bursarius* | Pocket Gopher |
| Heteromyidae | |
| *Perognathus hispidus* | Hispid Pocket Mouse |
| Castoridae | |
| *Castor canadensis* | Beaver |
| Cricetidae | |
| *Reithrodontomys montanus* | Gray Harvest Mouse |
| *Reithrodontomys fulvescens* | Long-tailed Harvest Mouse |
| *Peromyscus gossypinus* | Cotton Mouse |
| *Peromyscus leucopus* | White-footed Wood Mouse |

TABLE D-1 Continued

| Family<br>Scientific Name<br>Common Name | Family<br>Scientific Name<br>Common Name |
|---|---|
| *Sigmodon hispidus* | Mustelidae |
| Hispid Cotton Rat | *Mustela frenata* |
| *Neotoma floridana* | Long-tailed Weasel |
| Florida Wood Rat | *Mustela vison* |
| *Pitymys pinetorum* | Mink |
| Pine Vole | *Mephitis mephitis* |
| | Common Striped Skunk |
| Muridae | *Spilogale putorius* |
| *Rattus norvegicus* | Eastern Spotted Skunk |
| Norway Rat | |
| *Rattus rattus* | Felidae |
| Roof Rat | *Lynx rufus* |
| *Mus muswlus* | Bobcat |
| House Mouse | |
| | Cervidae |
| Capromyidae | *Odocoileus virginianus* |
| *Myocater coypus* | White-tailed Deer |
| Nutria | |
| | |
| Canidae | |
| *Canislatrans* | |
| Coyote | |
| *Urocyon cinereoargenteus* | |
| Gray Fox | |
| | |
| Procyonidae | |
| *Bassariscus astutus* | |
| Ringtail | |
| *Procyon lotor* | |
| Raccoon | |

TABLE D-2 Amphibians

Family
Scientific Name
Common Name

**Proteidae**

*Necturus beyeri*
Gulf Coast Waterdog

**Ambystomidae**

*Ambystoma texanum*
Small-Mouth Salamander

*Ambystoma opacum*
Marbled Salamander

*Ambystoma maculatum*
Spotted Salamander

*Ambystoma tigrinum*
Eastern Tiger Salamander

**Salamandridae**

*Notophthalmus viridescens*
Central Newt

**Plethodontidae**

*Desmognathus auriculatus*
Central Dusky Salamander

*Eurycea quadridigitata*
Dwarf Salamander

**Sirenidae**

*Siren intermedia*
Lesser Intermedia

Family
Scientific Name
Common Name

**Pelobatidae**

*Scaphiopus holbrooki*
Eastern Spade-foot

**Bufonidae**

*Bofo woodhousei*
Woodhouse Toad

**Hylidae**

*Hyla versicolor*
Eastern Gray Tree Frog

*Hyla crucifer*
Springpeeper

*Hyla cinerea*
Green Tree Frog

*Hyla chrysocelis*
Southern Gray Tree Frog

*Pseudacris streckeri*
Strecker's Chorus Frog

*Pseudacris triseriata*
Upland Chorus Frog

*Acris crepitans*
Cricket Frog

**Ranidae**

*Rana pipiens*
Leopard Frog

*Rana palustris*
Pickerel Frog

TABLE D-2 Continued

| Family<br>Scientific Name<br>Common Name |
|---|
| *Rana catesbeiana* |
| Bullfrog |
| *Rana cyamitans* |
| Bronze Frog |
| Microhylidae |
| *Gastrophryne carolinensis* |
| Narrow-Mouthed Toad |

TABLE D-3 Reptiles

| Family<br>Scientific Name<br>Common Name |
|---|
| **Chelydridae** |
| *Chelydra serpentina* |
| Snapping Turtle |
| *Macroclemys temmincki* |
| Alligator Snapping Turtle |
| **Kinosternidae** |
| *Kinosternon subrubrum* |
| Mississippi Mud Turtle |
| **Emydidae** |
| *Terrapene ornata* |
| Ornate Box Turtle |
| *Terrapene carolina* |
| Three-Toed Box Turtle |
| *Chrysemys floridana* |
| Missouri Slider |
| *Pseudemys scripta* |
| Red-eared Turtle |
| **Iguanidae** |
| *Anolis carolinensis* |
| Green Anole |
| *Sceloporus undulatus* |
| Prarie Lizard |
| **Inguidae** |
| *Ophisaurus attenuatus* |
| Slender Glass Lizard |
| **Teidae** |
| *Cnemidophorus sexlineatus* |
| Six-lined Racerunner |
| **Scincidae** |
| *Lygosoma laterale* |
| Ground Skink |
| *Eumeces fasciatus* |
| Five-lined Skink |
| *Eumeces laticeps* |
| Broad-headed Skink |
| *Eumeces septentrionalis* |
| Prairie Skink |
| **Colubridae** |
| *Natrix grahami* |
| Graham's Water Snake |
| *Natrix erythrogaster* |
| Red-bellied Water Snake |
| *Natrix fasciata* |
| Broad-Banded Water Snake |
| *Natrix rhombifera* |
| Diamond-Backed Water Snake |
| *Storeria dekayi texana* |
| Texas Brown Snake |
| *Thamnophis proximus* |
| Ribbon Snake |
| *Tropidoclanian lineatum* |
| Texas Lined Snake |

TABLE D-3 Continued

| Family<br>Scientific Name<br>Common Name |
|---|
| *Heterodon platyrhinos* |
| Eastern Hognose Snake |
| *Diadophis punctatus* |
| Northern Ringneck Snake |
| *Coluber constrictor* |
| Black Racer |
| *Masticophis flagellum* |
| Eastern Coachwhip |
| *Opheodrys aestnus* |
| Roughgreen Snake |
| *Elaphe guttara* |
| Great Plains Rat Snake |
| *Elaphe obsoleta* |
| Rat Snake |
| *Lampropeltis getulus* |
| Speckled Kingsnake |
| *Tantilla gracilis* |
| Flat-headed Snake |
| Crotalidae |
| *Ancistrodon contortrix* |
| Southern Copperhead |
| *Ancistrodon piscivoris* |
| Western Cottonmouth |

TABLE D-4 Birds

| | Habitat Type | Occurrence |
|---|---|---|
| Order Podicipediformes<br>Grebes | | |
| Family Podicipedidae<br>Grebes | | |
| *Podilymbus podiceps*<br>Pied-billed grebe | bottomlands | common in winter |
| Order Pelecaniformes<br>Tropicbirds, Boobies, and Cormorants | | |
| Family Phalacrocoracidae<br>Cormorants | | |
| *Phalacrocorax auritus*<br>Double-crested cormorant | bottomlands | casual winter visitant |
| Family Anhingidae<br>Darters | | |
| *Anhinga anhinga*<br>Anhinga | bottomlands | casual winter visitant |
| Order Ciconiiformes<br>Herons, Bitterns, Ibises, Spoonbills, and Flamingos | | |
| Family Ardeidae<br>Herons and Bitterns | | |
| *Ardea herodias*<br>Great blue heron | bottomlands | common resident |
| *Butorides virescens*<br>Green heron | bottomlands | common summer |
| *Florida caerulea*<br>Little blue heron | bottomlands | summer uncommon |
| *Bubulcus ibis*<br>Cattle egret | grasslands | common resident |
| *Casmerodius albus*<br>Great egret | bottomlands | uncommon visitant |
| *Egretta thula*<br>Snowy egret | bottomlands | uncommon visitant |
| *Hydranassa tricolor*<br>Louisiana heron | bottomlands | uncommon summer |

TABLE D-4 Continued

| | Habitat Type | Occurrence |
|---|---|---|
| Order Anseriformes<br>Swans, Geese and Ducks | | |
| Family Anatidae<br>Swans, Geese and Ducks | | |
| *Anas platyrhynchos*<br>Mallard | bottomlands | common winter |
| *Anas crecca*<br>Green-winged teal | bottomlands | common migrant;<br>uncommon winter |
| *Anas discors*<br>Blue-winged teal | bottomlands | common migrant;<br>uncommon winter |
| *Aix sponsa*<br>Wood duck | bottomlands | uncommon resident |
| *Oxyura jamaicensis*<br>Ruddy duck | bottomlands | uncommon winter |
| Order Falconiformes<br>Vultures, Hawks, Kites,<br>Falcons, and Eagles | | |
| Family Cathartidae<br>American Vultures | | |
| *Cathartes aura*<br>Turkey vulture | all habitat types | common resident |
| *Coragyps atratus*<br>Black vulture | all habitat types | uncommon resident |
| Family Accipitridae<br>Kites, Hawks, Eagles,<br>and Harriers | | |
| *Accipiter striatus*<br>Sharp-shinned hawk | woodlands | uncommon winter |
| *Accipiter cooperii*<br>Cooper's hawk | woodlands | uncommon resident |
| *Buteo jamaicensis*<br>Red-tailed hawk | all habitat types | common winter |
| *Buteo lineatus*<br>Red-shouldered hawk | woodlands | common resident |
| *Buteo platypterus*<br>Broad-winged hawk | all habitat types | common migrant |
| *Circus cyaneus*<br>Marsh hawk | grasslands | common winter |

TABLE D-4 Continued

| | Habitat Type | Occurrence |
|---|---|---|
| Family Pandionidae<br>Ospreys | | |
| *Pandion haliaetus*<br>Osprey | bottomlands | common migrant |
| Family Falconidae<br>Caracaras and Falcons | | |
| *Falco sparverius*<br>American kestrel | grasslands | common winter |
| Order Galliformes<br>Grouse, Pheasants, Ptarmigans, Prairie Chickens, Quail and Turkeys | | |
| Family Phasianidae<br>Quail, Pheasants, and Partridge | | |
| *Colinus virginianus*<br>Bobwhite | grasslands & shrubs | common resident |
| Order Gruiformes<br>Cranes, Rails, and Allies | | |
| Family Rallidae<br>Rails, Gallinules, and Coots | | |
| *Rallus elegans*<br>King rail | bottomlands | casual summer |
| *Porzana carolina*<br>Sora | bottomlands | uncommon migrant |
| *Fulica americana*<br>American coot | bottomlands | common winter |
| Order Charadriiformes<br>Shorebirds, Gulls, and Allies | | |
| Family Charadriidae<br>Plovers, Turnstones, and Surfbirds | | |

TABLE D-4 Continued

| | Habitat Type | Occurrence |
|---|---|---|
| Order Columbiformes<br>Pigeons and Doves | | |
| Family Columbidae<br>Pigeons and Doves | | |
| *Columba livia*<br>Rock dove | farms, towns | common resident |
| *Zenaida macroura*<br>Mourning dove | all habitat types | common resident |
| Order Cuculiformes<br>Cuckoos, Roadrunners, and Anis | | |
| Family cuculidae<br>Cuckoos, Roadrunners, and Anis | | |
| *Coccyzus americanus*<br>Yellow-billed cuckoo | | common summer |
| *Coccyzus erythropthalmus*<br>Black-billed cuckoo | | casual migrant |
| *Geococcyx californianus*<br>Roadrunner | | uncommon resident |
| Order Strigiformes<br>Owls | | |
| Family Strigidae<br>Typical Owls | | |
| *Otus asio*<br>Screech owl | woodlands | uncommon resident |
| *Bubo virginianus*<br>Great horned owl | woodlands | common winter |
| *Strix varia*<br>Barred owl | bottomlands | common resident |
| *Asio otus*<br>Long-eared owl | woodlands | casual migrant |

TABLE D-4 Continued

| | Habitat Type | Occurrence |
|---|---|---|
| Order Caprimulgiformes<br>Goatsuckers | | |
| Family Caprimulgidae<br>Goatsuckers | | |
| *Caprimulgus carolinensis*<br>Chuck-will's-widow | woodlands | common summer |
| *Chordeiles minor*<br>Common nighthawk | open fields | common summer |
| Order Apodiformes<br>Swifts and Hummingbirds | | |
| Family Apodidae<br>Swifts | | |
| *Chaetura pelagica*<br>Chimney swift | open sky | abundant summer |
| Family Trochilidae<br>Hummingbirds | | |
| *Archilochus colubris*<br>Ruby-throated hummingbird | all habitats | common summer |
| Order Coraciiformes<br>Kingfishers | | |
| Family Alcedinidae<br>Kingfishers | | |
| *Megaceryle alcyon*<br>Belted kingfisher | bottomlands | common resident |
| Order Piciformes<br>Woodpeckers, Flickers, and Sapsuckers | | |
| Family Picidae<br>Woodpeckers, Flickers, and Sapsuckers | | |
| *Colaptes auratus*<br>Common flicker | bottomlands | common resident |

TABLE D-4 Continued

| | Habitat type | Occurrence |
|---|---|---|
| *Dryocopus pileatus* Pileated woodpecker | bottomlands | uncommon resident |
| *Centurus carolinus* Red-bellied woodpecker | bottomlands | common resident |
| *Melanerpes erythrocephalus* Red-headed woodpecker | bottomlands | uncommon resident |
| *Sphyrapicus varius* Yellow-bellied sapsucker | bottomlands | uncommon winter |
| *Dendrocopos villosus* Hairy woodpecker | bottomlands | uncommon resident |
| *Dendrocopos pubescens* Downy woodpecker | bottomlands | common resident |
| Order Passeriformes Perching Birds | | |
| Family Tyrannidae Tyrant Flycatchers | | |
| *Tyrannus tyrannus* Eastern kingbird | oak savannah | common summer |
| *Tyrannus verticalis* Western kingbird | oak savannah | casual migrant |
| *Muscivora forficata* Scissor-tailed flycatcher | oak savannah | |
| *Sayornis phoebe* Eastern phoebe | bottomlands, oak savannah | uncommon winter |
| *Empidonax virescens* Acadian flycatcher | oak savannah | uncommon summer |
| *Empidonax alnorum* Alder flycatcher | oak savannah | uncommon migrant |
| *Empidonax minimus* Least flycatcher | oak savannah | uncommon migrant |
| *Contopus virens* Eastern wood pewee | oak savannah | common summer |
| *Nuttallornis borealis* Olive-sided flycatcher | oak savannah | uncommon migrant |
| Family Alaudidae Larks | | |
| *Eremophila alpestris* Horned lark | grasslands | uncommon resident |

TABLE D-4 Continued

| | Habitat Type | Occurrence |
|---|---|---|
| Family Hirundinidae<br>Swallows | | |
| *Iridoprocne bicolor*<br>Tree swallow | open sky | casual migrant |
| *Riparia riparia*<br>Bank swallow | open sky | uncommon migrant |
| *Stelgidopteryx ruficollis*<br>Rough-winged swallow | open sky | common summer |
| *Hirundo rustica*<br>Barn swallow | open sky | common migrant |
| *Progne subis*<br>Purple martin | open sky | abundant summer |
| Family Corvidae<br>Jays, Magpies, and Crows | | |
| *Cyanocitta cristata*<br>Blue jay | woodlands | common resident |
| *Corvus brachyrhynchos*<br>Common crow | all habitat types | common resident |
| *Corvus ossifragus*<br>Fish crow | bottomlands | casual visitant |
| Family Paridae<br>Chickadees, Titmice, Verdins and Bushtits | | |
| *Parus carolinensis*<br>Carolina chicadee | woodlands | common resident |
| *Parus bicolor*<br>Tufted titmouse | woodlands | common resident |
| Family Sittidae<br>Nuthatches | | |
| *Sitta carolinensis*<br>White-breasted nuthatch | bottomlands | uncommon resident |
| *Sitta canadensis*<br>Red-breasted nuthatch | bottomlands | casual winter |
| *Sitta pusilla*<br>Brown-headed nuthatch | bottomlands | casual resident |

TABLE D-4 Continued

| | Habitat Types | Occurrence |
|---|---|---|
| Family Certhiidae<br>Creepers | | |
| *Certhia familiaris*<br>Brown creeper | woodlands | common winter |
| Family Troglodytidae<br>Wrens | | |
| *Troglodytes aedon*<br>House wren | thickets | uncommon winter |
| *Troglodytes troglodytes*<br>Winter wren | thickets | uncommon winter |
| *Thryomanes bewickii*<br>Bewick's wren | thickets | common winter |
| *Thryothorus ludovicianus*<br>Carolina wren | thickets | common resident |
| *Cistothorus platensis*<br>Short-billed marsh wren | bottomlands | casual winter |
| Family Mimidae<br>Mockingbirds and Thrashers | | |
| *Mimus polyglottos*<br>Mockingbird | all habitat types | common resident |
| *Dumetella carolinensis*<br>Gray catbird | thickets | common summer |
| *Toxostoma rufum*<br>Brown thrasher | bottomlands | common winter |
| Family Turdidae<br>Thrushes, Solitaires, and Bluebirds | | |
| *Turdus migratorius*<br>American robin | all habitat types | common resident |
| *Hylocichla mustelina*<br>Wood thrush | bottomlands | common summer |
| *Catharus guttatus*<br>Hermit thrush | bottomlands | common winter |
| *Catharus ustulatus*<br>Swainson's thrush | bottomlands | uncommon migrant |
| *Catharus minimus*<br>Gray-cheeked thrush | bottomlands | uncommon migrant |
| *Catharus fuscescens*<br>Veery | bottomlands | casual migrant |
| *Sialia sialis*<br>Eastern bluebird | oak savannah | common resident |

TABLE D-4 Continued

| | Habitat Type | Occurrence |
|---|---|---|
| Family Sylviidae<br>Arctic Warblers, Kinglets, Gnatcatchers | | |
| *Polioptila caerulea*<br>Blue-gray gnatcatcher | woodlands | common summer |
| *Regulus satrapa*<br>Golden-crowned kinglet | woodlands | common winter |
| *Regulus calendula*<br>Ruby-crowned kinglet | woodlands | common winter |
| Family Bombycillidae<br>Waxwings | | |
| *Bombycilla cedrorum*<br>Cedar waxwing | woodlands | common winter |
| Family Laniidae<br>Shrikes | | |
| *Lanius ludovicianus*<br>Loggerhead shrike | oak savannah | common resident |
| Family Sturnidae<br>Starlings | | |
| *Sturnus vulgaris*<br>Starling | farms, towns | common resident |
| Family Vireonidae<br>Vireos | | |
| *Vireo griseus*<br>White-eyed vireo | woodlands | common summer |
| *Vireo bellii*<br>Bell's vireo | woodlands | common summer |
| *Vireo flavifrons*<br>Yellow-throated vireo | woodlands | common summer |
| *Vireo solitarius*<br>Solitary vireo | woodlands | uncommon migrant |
| *Vireo olivaceus*<br>Red-eyed vireo | woodlands | common summer |
| *Vireo gilvus*<br>Warbling vireo | woodlands | uncommon migrant |

TABLE D-4 Continued

| | Habitat Type | Occurrence |
|---|---|---|
| Family Parulidae | | |
| Wood Warblers | | |
| *Mniotilta varia* | | |
| Black-and-white warbler | woodlands | common migrant |
| *Protonotaria citrea* | | |
| Prothonotary warbler | woodlands | common summer |
| *Vermivora peregrina* | | |
| Tennessee warbler | woodlands | uncommon migrant |
| *Vermivora celata* | | |
| Orange-crowned warbler | woodlands | uncommon winter |
| *Vermivora ruficapilla* | | |
| Nashville warbler | woodlands | common migrant |
| *Parula americana* | | |
| Northern parula | woodlands | common migrant |
| *Dendroica petechia* | | |
| Yellow warbler | woodlands | uncommon migrant |
| *Dendroica magnolia* | | |
| Magnolia warbler | woodlands | uncommon migrant |
| *Dendroica coronata* | | |
| Yellow-rumped warbler | woodlands | common winter |
| *Dendroica virens* | | |
| Black-throated green warbler | woodlands | uncommon migrant |
| *Dendroica fusca* | | |
| Blackburnian warbler | woodlands | uncommon migrant |
| *Dendroica dominica* | | |
| Yellow-throated warbler | woodlands | common summer |
| *Dendroica pensylvanica* | | |
| Chestnut-sided warbler | woodlands | uncommon migrant |
| *Dendroica castanea* | | |
| Bay-breasted warbler | woodlands | uncommon migrant |
| *Dendroica pinus* | | |
| Pine warbler | woodlands | common resident |
| *Dendroica discolor* | | |
| Prairie warbler | woodlands | common migrant |
| *Seiurus aurocapillus* | | |
| Ovenbird | | casual migrant |
| *Seiurus noveboracensis* | | |
| Northern waterthrush | bottomlands | uncommon migrant |
| *Seiurus motacilla* | | |
| Louisiana waterthrush | bottomlands | uncommon migrant |
| *Oporornis formosus* | | |
| Kentucky warbler | woodlands | common migrant |

TABLE D-4 Continued

| | Habitat Type | Occurrence |
|---|---|---|
| *Geothlypis trichas* | | |
| Common yellowthroat | woodlands | common summer |
| *Icteria virens* | | |
| Yellow-breasted chat | woodlands | common migrant |
| *Wilsonia citrina* | | |
| Hooded warbler | woodlands | uncommon migrant |
| *Wilsonia pusilla* | | |
| Wilson's warbler | woodlands | common migrant |
| *Wilsonia canadensis* | | |
| Canada warbler | woodlands | casual migrant |
| *Setophaga ruticilla* | | |
| American redstart | woodlands | common migrant |
| Family Ploceidae | | |
| Weaver Finches | | |
| *Passer domesticus* | | |
| House sparrow | farms, towns | abundant resident |
| Family Icteridae | | |
| Meadowlarks, Blackbirds, and Orioles | | |
| *Sturnella magna* | | |
| Eastern meadowlark | grassland | common resident |
| *Agelaius phoeniceus* | | |
| Red-winged blackbird | all habitat types | abundant winter |
| *Icterus spurius* | | |
| Orchard oriole | woodlands | common summer |
| *Icterus galbula* | | |
| Northern oriole | woodlands | common migrant |
| *Euphagus carolinus* | | |
| Rusty blackbird | all habitat types | common winter |
| *Euphagus cyanocephalus* | | |
| Brewer's blackbird | all habitat types | common winter |
| *Quiscalus quiscula* | | |
| Common grackle | all habitat types | abundant winter |
| *Molothrus ater* | | |
| Brown-headed cowbird | all habitat types | abundant winter |
| Family Thraupidae | | |
| Tanagers | | |
| *Piranga olivacea* | | |
| Scarlet tanager | woodlands | casual migrant |
| *Piranga rubra* | | |
| Summer tanager | woodlands | common summer |

TABLE D-4 Continued

| | Habitat Type | Occurrence |
|---|---|---|
| Family Fringillidae<br>Grosbeaks, Sparrows, Finches, and Buntings | | |
| *Cardinalis cardinalis*<br>Cardinal | woodlands | common resident |
| *Pheucticus ludovicianus*<br>Rose-breasted grosbeak | woodlands | uncommon migrant |
| *Guiraca caerulea*<br>Blue grosbeak | woodlands | common summer |
| *Passerina cyanea*<br>Indigo bunting | all habitat types | common summer |
| *Passerina ciris*<br>Painted bunting | all habitat types | uncommon summer |
| *Spiza americana*<br>Dickcissel | fields, grasslands | common migrant |
| *Carpodacus purpureus*<br>Purple finch | woodlands | uncommon winter |
| *Spinus tristis*<br>American goldfinch | all habitat types | common winter |
| *Pipilo erythrophthalmus*<br>Rufous-sided towhee | woodlands | common winter |
| *Passerculus sandwichensis*<br>Savannah sparrow | grasslands | common winter |
| *Ammospiza leconteii*<br>Le Conte's sparrow | grasslands | uncommon winter |
| *Pooecetes gramineus*<br>Vesper sparrow | grasslands | common migrant |
| *Chondestes grammacus*<br>Lark sparrow | grasslands | common migrant |
| *Aimophila aestivalis*<br>Bachman's sparrow | grasslands | uncommon summer |
| *Spizella passerina*<br>Chipping sparrow | grasslands | common winter |
| *Spizella pusilla*<br>Field sparrow | grasslands | common resident |
| *Zonotrichia querula*<br>Harris's sparrow | brushy areas | uncommon winter |
| *Zonotrichia leucophrys*<br>White-crowned sparrow | brushy areas | uncommon winter |
| *Zonotrichia albicollis*<br>White-throated sparrow | brushy areas | abundant winter |
| *Passerella iliaca*<br>Fox sparrow | grasslands | common winter |
| *Melospiza lincolnii*<br>Lincoln's sparrow | grasslands | common winter |
| *Melospiza georgiana*<br>Swamp sparrow | bottomlands | common winter |
| *Melospiza melodia*<br>Song sparrow | grasslands | common winter |

TABLE D-4 Continued

| | Habitat Type | Occurrence |
|---|---|---|
| *Charadrius semipalmatus* Semipalmated plover | bottomlands | casual migrant |
| *Charadrius vociferus* Killdeer | all habitats | common resident |
| Family Scolopacidae Woodcock, Snipe, and Sandpipers | | |
| *Capella gallinago* Common snipe | bottomlands | common winter |
| *Bartramia longicauda* Upland sandpiper | fields, grasslands | common migrant |
| *Actitis macularia* Spotted sandpiper | bottomlands | common migrant |
| *Tringa solitaria* Solitary sandpiper | bottomlands | uncommon |
| *Tringa melanoleuca* Greater yellowlegs | bottomlands | common migrant |
| *Tringa flavipes* Lesser yellowlegs | bottomlands | common migrant |
| *Catoptrophorus semipalmatus* Willet | | casual migrant |
| *Calidris melanotos* Pectoral sandpiper | bottomlands | common migrant |
| *Calidris bairdii* Baird's sandpiper | bottomlands | casual migrant |
| *Calidris minutilla* Least sandpiper | bottomlands | common migrant |
| *Calidris pusilla* Semipalmated sandpiper | bottomlands | common migrant |
| *Limnodromus griseus* Short-billed dowitcher | bottomlands | uncommon migrant |
| *Limnodromus scolopaceus* Long-billed dowitcher | bottomlands | uncommon migrant |
| Family Recurvirostridae Avocets and Stilts | | |
| *Recurvirostra americana* American avocet | bottomlands | casual migrant |

TABLE D-5 Plants
(Excluding Grand Saline Salt Marsh Habitat)

## FERNS

Ophioglossoceae

*Botrychium dissectum* Spreng. var. *tenuifolium* (Underw.) Farw.
Grape-fern

*Botrychium virginianum* (L.) Sw.
Rattlesnake-fern

*Ophioglossum crotalophoroides* Walt.
Adder's tongue

Osmundaceae

*Osmunda cinnamomea* L.
Cinnamon fern

*Osmunda regalis* L. var. *spectabilis* (Willd.) Gray
Royal fern

Polypodiaceae

*Asplenium platyneuron* (L.) D.C. Eat.
Ebony spleenwort

*Athyrium Filix-femina* (L.) Roth var. *asplenioides* (Michx.) Farw.
Southern lady fern

*Lorinseria areolata* (L.) Presl.
Chain fern

*Onoclea sensibilis* L.
Sensitive fern

*Polypodium polypodioides* (L.) Watt var. *Michauxianum* Weath.
Resurrection fern

TABLE D-5 Continued

*Viola rafinesquii* Greene
Field pansy

*Viola triloba* var. *dilatata* (Ell.) Brainerd.
Trilobe violet

*Viola villosa* Walt.
Carolina violet

Viscaceae

*Phoradendron serotinum* var. *pubescens* (Engelm.) M.C. Johnston
Mistletoe

Vitaceae

*Ampelopsis arborea* (L.) Koehne.
Pepper-vine

*Ampelopsis cordata* Michx.
Heart-leaf ampolopsis

*Cissus incisa* (Nutt.) Des Moul.
Marine-ivy

*Parthenocissus quinquefolia* (L.) Planch.
Virginia creeper

*Vitis aestivalis* Michx.
Summer grape

*Vitis cinerea* Engelm.
Graybark grape

*Vitis mustangensis* Buckl.
Mustang grape

*Vitis rotundifolia* Michx.
Muscadine

*Vitis vulpina* L.
Fox grape

Amaryllidaceae

*Hymenocallis eulae* Shinners
Late spider-lily

*Hymenocallis liriosme* (Raf.) Shinners
Spider-lily

*Hypoxis hirsuta* (L.) Cov.
Common gold-star-grass

*Polianthes virginica* (L.) Shinners
False aloe

*Polianthes virginica* f. *tigrina* (Engelm.) Shinners
Rattlesnake-master

Araceae

*Arisaema dracontium* (L.) Schott.
Green dragon

*Arisaema triphyllum* (L.) Schott.
Jack-in-the-pulpit

Commelinaceae

*Commelina diffusa* Burm. f.
Spreading day-flower

*Commelina erecta* var. *angustifolia* (Michx.) Fern.
Erect day-flower

*Commelina virginica* L.
Virginia day-flower

*Tradescantia hirsutiflora* Bush.
Hairy-flowered spiderwort

*Tradescantia ohioensis* Raf.
Ohio-spiderwort

TABLE D-5 Continued

Saururaceae

*Saururus cernuus* L.

Lizard's-tail

Scrophulariaceae

*Agalinis* sp.

Gerardia

*Aureolaria grandiflora* (Benth.) Penn. var. *serrata*(Torr.) Robins

False foxglove

*Castilleja indivisa* Engelm.

Indian paintbrush

*Gratiola neglecta* Torr.

Hedge-hyssop

*Gratiola virginiana* L.

Virginia hedge-hyssop

*Linaria canadensis* (L.) Dum.

Old field toad-flax

*Micranthemum umbrosum* (Walt.) Blake

Shade mud-flower

*Parentucellia viscosa* (L.) Caruel.

Parentucellia

*Pedicularis canadensis* L.

Wood-betony

*Penstemon laxiflorus* Penn.

Lax-flowered penstemon

*Penstemon tubaeflorus* Nutt.

Tube penstemon

TABLE D-5 Continued

*Eleocharis montevidensis* Kunth.

Sand spike rush

*Eleocharis obtusa* (Willd.) Schult.

Blunt spike rush

*Fimbristylis autumnalis* (L.) R. & S.

Slender fimbry

*Rhynchospora* spp.

Beak-rush

*Scleria traglomerata* Michx.

Whip nut-rush

*Scirpus americanus* Pers. var. *longispicatus* Britt.

Sword-grass

Gramineae

*Andropogon glomeratus* (Walt.) B.S.P.

Bushy beardgrass

*Andropogon virginicus* L.

Broomsedge

*Aristida longespica* Poir.

Slim-spike three-awn

*Aristida oligantha* Michx.

Prairie three-awn

*Arundinaria gigantea* (Walt.) Muhl.

Giant cane

*Bromus unioloides* H.B.K.

Rescue grass

*Cenchrus incertus* M.A. Curtis

Sandbur

TABLE D-5 Continued

*Crataegus marshallii* Eggl.
Parsley hawthorn

*Crataegus pyracanthoides* Beadle.
Big-tree hawthorn

*Crataegus spathulata* Michx.
Pasture haw

*Crataegus uniflora* Moench.
One-flower hawthorn

*Duchesnea indica* (Andrz) Focke.
India mock-strawberry

*Fragaria virginiana* Duchn.
Wild strawberry

*Geum canadense* Jacq.
White avens

*Gillenia stipulata* (Muhl.) Baill.
American-ipecac

*Potentilla simplex* Michx.
Cinquefoil

*Prunus angustifolia* Marsh.
Chickasaw plum

*Prunus mexicana* Wats.
Big-tree plum

*Prunus serotina* Ehrh.
Black cherry

*Prunus virginiana* L.
Common chockcherry

*Rosa carolina* L.
Carolina rose

TABLE D-5 Continued

*Paspalum dilatatum* Poir.

Dallis grass

*Paspalum floridanum* Michx.

Florida paspalum

*Paspalum notatum* Flugge.

Bahia grass

*Paspalum plicatulum* Michx.

Brown-seed paspalum

*Paspalum setaceum* Michx.

Thin paspalum

*Poa compressa* L.

Canada bluegrass

*Schizachyrium scoparium* (Michx.) Nash var.*frequens* (F.T. Hubb) Gould

Little bluestem

*Sorghum halepense* (L.) Pers.

Johnson grass

*Tridans flavus* (L.) Hitchc.

Purpletop

*Vulpia octoflora* (Walt.) Rydb.

Six-weeks fescue

Juncaceae

*Juncus bufonius* L.

Toad-rush

*Juncus coriaceus* Mack.

Leathery rush

TABLE D-5 Continued

Plantaginaceae

*Plantago aristata* Michx.
Buckthorn

*Plantago virginica* L.
Pale-seeded plantain

Polemoniaceae

*Ipomopsis rubra* (L.) Wherry
Standing cypress

*Phlox drummondii* Hook.
Drummond phlox

*Phlox pilosa* L.
Downy phlox

Polygalaceae

*Polygala incarnata* L.
Pink milkwort

*Polygala verticillata* L.
Whorled milkwort

*Polygala* sp.
Milkwort

Polygonaceae

*Brunnichia ovata* (Walt.) Shinners
Eardrop vine

*Eriogonum* sp.
Wild buckwheat

*Polygonum* spp.
Smart-weed

TABLE D-5 Continued

*Allium stellatum* Ker.
Prairie onion

*Erythronium albidum* Nutt.
White dog's tooth violet

*Nothoscordum bivalve* (L.) Britt.
False garlic

*Smilax Bona-nox* L.
Cat-brier

*Smilax glauca* Walt.
Saw-brier

*Smilax laurifolia* L.
Blaspheme-vine

*Smilax rotundifolia* L.
Common green-brier

*Yucca louisianensis* Trel.
Louisiana yucca

Orchidaceae

*Corallorhiza wisteriana* Conrad
Spring coral-root

*Habenaria ciliaris* (L.) R.
Yellow fringed orchid

*Habenaria clavellata* (Michx.) Spreng.
Green rein-orchid

*Listera australis* Lindl.
Southern twayblade

TABLE D-5 Continued

*Modiola caroliniana* (L.) G. Don.
Carolina modiola

*Sida rhombifolia* L.
Arrow-leaf sida

Melastomataceae

*Rhexia mariana* L.
Maryland meadow-beauty

*Rhexia virginica* L.
Common meadow beauty

Menispermaceae

*Cocculus carolinus* (L.) DC.
Red-berried moonseed

Moraceae

*Maclura pomifera* (Raf.) Schneid.
Bois d'arc

*Morus alba* L.
White mulberry

*Morus rubra* L.
Red mulberry

Myricaceae

*Myrica cerifera* L.
Wax-myrtle

Oleaceae

*Chionanthus virginica* L.
Fringe Tree

*Fraxinus americana* L.
White ash

TABLE D-3 Continued

Aceraceae

*Acer negundo* L.

Boxelder

*Acer rubrum* L.

Red maple

Amaranthaceae

*Froelichia floridana* (Nutt.) Moq.

Snake-cotton

Anacardiaceae

*Rhus aromatica* Ait.

Fragrant sumac

*Rhus copallina* L.

Wing-rib sumac

*Rhus glabra* L.

Smooth sumac

*Rhus toxicondendron* L. var. *toxicondendron*

Poison-oak

*Rhus toxicondendron* var. *vulgaris* Michx.

Poison ivy

Apocynaceae

*Trachelospermum difforme* (Walt.) Gray

Climbing dogbane

Aquifoliaceae

*Ilex decidua* Walt.

Possum-haw

*Ilex opaca* Ait.

American holly

TABLE D-5 Continued

*Desmodium ciliare* (Willd.) DC
Tick-trefoil

*Desmodium nudiflorum* (L.) DC
Bare-stem tick-clover

*Desmodium pauciflorum* (Nutt.) DC
Few-flowered tick-clover

*Erythrina herbacea* L.
Coral bean

*Galactia volubilis* (L.) Britt.
Downy milkpea

*Gleditsia triacanthos* L.
Honey locust

*Lespedeza cuneata* (Dumont) G. Don.
Chinese bush clover

*Lespedeza striata* (Thunb.) H. & A.
Japanese bush clover

*Lespedeza virginica* (L.) Britt.
Slender bush clover

*Melilotus albus* Lam.
White sweet clover

*Melilotus officinalis* (L.) Lam.
Yellow sweet clover

*Petalostemum candidum* (Willd.) Michx. var. *candidum*
Prairie clover

*Robinia Pseudo-Acacia* L.
Black locust

*Rhynchosia latifolia* (Nutt.) T. & G.
Broad-leaf snoutbean

TABLE D-5 Continued

*Carpinus caroliniana* Walt.
American hornbeam

*Ostrya virginiana* (Mill.) K. Koch.
Hop-hornbeam

Bignoniaceae

*Campsis radicans* (L.) Seem.
Trumpet-creeper

*Catalpa speciosa* Warder.
Catawba-tree

Boraginaceae

*Heliotropium indicum* L.
Turnsole

*Lithospermum caroliniense* (Walt.) MacM.
Puccoon

*Myosotis macrosperma* Engelm.
Forget-me-not

Cactaceae

*Opuntia compressa* (Salisb.) Macbr.
Prickly pear

Campanulaceae

*Lobelia appendiculata* A. Dc.
Ear-flowered lobelia

*Lobelia cardinalis* L.
Cardinal flower

*Lobelia puberula* Michx.
Downy lobelia

*Carya texana* Buckl.
Black hickory

*Carya tomentosa* Nutt.
Mockernut

*Juglans nigra*
Black walnut

Labiatae

*Monarda fistulosa* L.
Wild bergamont

*Monarda punctata* L.
Spotted beebalm

*Perilla frutescens* (L.) Britt.
Beefsteak plant

*Physostegia intermedia* (Nutt.) Engelm. and Gray ( *P. micrantha* of Lundell)
Intermediate physostegia

*Prunella vulgaris* L.
Common self-heal

*Salvia lyrata* L.
Lyre-leaf sage

*Scutellaria drummondii* Benth.
Drummond skullcap

*Scutellaria parvula* Michx.
Skullcap

Lauraceae

*Sassafras albidum* (Nutt.) Nees
Sassafras

TABLE D-5 Continued

*Ambrosia artemisiifolia* L.
Short ragweed

*Ambrosia trifida* L.
Giant ragweed

*Antennaria fallax* Greene
Everlasting

*Aster lateriflorus* (L.) Britt.
Aster

*Aster patens* Ait.
Skydrop aster

*Baccharis halimifolia* L.
Sea-myrtle

*Bidens bipinnatus* L.
Spanish-needles

*Cirsium horridulum* Michx.
Bull thistle

*Conyza canadensis* (L.) Cronq. var. *glabrata* (Gray) Cronq.
Horse-weed

*Coreopsis tinctoria* Nutt.
Plains coreopsis

*Croptilon divaricatum* var. *divaricatum* (Nut.) (Raf.)
Slender goldenweed

*Doellingria umbellata* (Mill.) Nees var. *latifolia* (Gray) House
Doellingria

*Echinaceae* sp.
Purple cone-flower

*Elephantopus carolinianus* Raeusch
Leafy elephant's foot

TABLE D-5 Continued

*Stillingia sylvatica* L.

Queen's delight

Fagaceae

*Castanea pumila* var. *ashei* Sudw.

Chinquapin

*Quercus alba*

White oak

*Quercus falcata* Michx.

Southern red oak

*Quercus lyrata* Walt.

Overcup oak

*Quercus marilandica* Muenchh.

Blackjack oak

*Quercus nigra* L.

Water oak

*Quercus phellos* L.

Willow oak

*Quercus shumardii* Buckl.

Shumard red oak

*Quercus sinuata* Walt.

Bastard oak

*Quercus stellata* Wang.

Post oak

*Quercus velutina* Lam.

Black oak

TABLE D-5 Continued

*Hieracium gronoxii* L.

Hawkweed

*Hymenopappus artemisiaefolius* DC

Wooly-white

*Hymenoxys* sp.

Bitterweed

*Lactuca floridana* (L.) Gaertn.

Florida lettuce

*Liatris elegans* (Walt.) Michx.

Pink-scale gay-feather

*Mikania scandens* (L.) Willd.

Climbing hemp-weed

*Pluchea camphorata* (L.) DC

Camphor-weed

*Pluchea foetida* (L.) DC

Stinking-fleabane

*Polymnia Uvedolia* (L.)

Bear's-foot

*Pyrrhopappus carolinianus* (Walt.) DC

False dandelion

*Rudbeckia hirta* L. var. *angustifolia* (T.V. Moore) Perdue

Brown-eyed susan

*Senecio imparipennatus* Klatt.

Groundsel

*Senecio* sp.

Groundsel

*Solidago petiolaris* Ait.

Downy goldenrod

*Solidago rugosa* Ait. var. *celtidifolia* (Small) Fern.
Wrinkled goldenrod

*Sonchus oleraceus* L.
Common sow-thistle

*Verbesina encilioides* (Cav.) Gray
Cowpen daisy

*Verbesina helianthoides* Michx.
Crown-beard

*Vernonia baldwinii* Torr.
Western ironweed

*Vernonia missurica* Raf.
Missouri ironweed

*Vernonia texana* (Gray) Small
Texas ironweed

Convolvulaceae

*Cuscuta* sp.
Dodder

*Ipomoea pandurata* (L.) Mey.
Wild potato

*Ipomoea sinuata* Ort.
Alamo vine

Cornaceae

*Cornus drummondii* C.A. Mey.
Rough-leaf dogwood

*Cornus florida* L.
Flowering dogwood

TABLE D-5 Continued

*Cornus foemina* Mill.

Red-osier dogwood

*Nyssa sylvatica* Marsh. var. *sylvatica*

Black gum

Ebenaceae

*Diospyros virginiana* L.

Common persimmon

Ericaceae

*Monotropa hypopithys* L.

American pinesap

*Monotropa uniflora* L.

Indian-pipe

*Vaccinium arboreum* Marsh.

Farkleberry

Euphorbiaceae

*Cnidoscolus texanus* (Muell. Arg.) Small

Bull nettle

*Croton capitatus* Michx.

Wooly croton

*Croton glandulosa* L.

Tropic croton

*Croton* spp.

Dove weed

*Euphorbia dentata* Michx.

Toothed spurge

*Euphorbia maculata* L.

Spurge

TABLE D-5 Continued

*Elephantopus tomentosus* L.
Hairy elephant's-foot

*Erigeron philadelphicus* L.
Philadelphia flebane

*Erigeron pulchellus* Michx.
Robin's plantain

*Erigeron* sp.
Flebane

*Eupatorium coelestinum* L.
Mist-flower

*Eupatorium compositifolium* Walt.
Yankee-weed

*Eupatorium hyssopifolium* L.
Hyssop-leaf eupatorium

*Gnaphalium obtusifolium* L.
Fragrant cudweed

*Helenium amarum* (Raf.) H. Rock
Bitterweed

*Helenium badium* (Gray) Green
Basin sneezeweed

*Helenium flexuosum* Raf.
Purplehead sneezeweed

*Helianthus angustifolius* L.
Swamp sunflower

*eterotheca latifolia* Buckl.
Gold aster

TABLE D-5 Continued

Gentianaceae

*Sabatia angularis* (L.) Pursh
Rose-pink

*Sabatia campestris* Nutt.
Prairie rose-gentian

Hamamelidaceae

*Liquidambar styraciflua* L.
Sweet-gum

Hippocastanaceae

*Aesculus pavia* L. var.*pavia*
Red buckeye

Hydrophyllaceae

*Hydrolea ovata* Choisy.
Hairy hydrolea

*Hydrolea uniflora* Raf.
Smooth hydrolea

Hypericaceae

*Ascyrum hypericoides* L.
St. Andrew's cross

*Hypericum drummondii* (Grev. & Hook) T.& G.
Nits-and-lice

Juglandaceae

*Carya aquatica* (Michx.) Nutt.
Water hickory

*Carya cordiformis* (Wang.) K. Koch.
Bitternut hickory

*Carya leiodermis* Sarg.
Swamp hickory

TABLE D-5 Continued

*Triodanis perfoliata* (L.) Nieuw.
Venus' looking glass

Caprifoliaceae

*Lonicera japonica* Thumb.
Japanese honeysuckle

*Lonicera sempervirens* L.
Trumpet honeysuckle

*Sambucus canadensis* L.
Common elder-berry

*Symphoricarpos orbiculatus* Moench.
Coral-berry

*Vibrunum rufidulum* Raf.
Southern black-haw

*Viburnum nudum* L.
Possum-haw

Caryophyllaceae

*Agrostemma githago* L.
Common corn-cockle

*Silene antirrhina* L.
Sleepy catchfly

Celastraceae

*Euonymus americanus* L.
Strawberry-bush

Compositae

*Achillea millefolium* L.
Common yarrow

TABLE D-5 Continued

Leguminosae

*Amorpha fruticosa* L.
Bastard indigo

*Apios americana* Medic.
American potato bean

*Astragalus distortus* T. & G.
False loco weed

*Astragalus* sp.
Milk-vetch

*Baptisia leucophaea* Nutt.
Plains wild indigo

*Baptisia Nuttalliana* Small
Nuttall wild indigo

*Baptisia sphaerocarpa* Nutt.
Green wild indigo

*Cassia fasciculata* Michx.
Partridge pea

*Centrosema virginianum* (L.) Benth.
Butterfly pea

*Cercis canadensis* L. var. *canadensis*
Redbud

*Clitoria mariana* L.
Pigeon-wings

*Crotalaria sagittalis* L.
Arrow crotalaria

*Desmanthus illinoensis* (Michx.) MacM.
Illinois bundle flower

TABLE D-5 Continued

*Ilex vomitoria* Ait.
Yaupon

Araliaceae

*Aralia spinosa* L.
Hercules' -club

Aristolochiaceae

*Aristolochia reticulata* Nutt.
Texas dutchman's -pipe

Asclepiadaceae

*Asclepias speciosa* Torr.
Showy-milkweed

*Asclepias tuberosa* L.
Butterfly-weed

*Asclepias viridis* Walt.
Antelope-horn

*Matelea cynanchoides* (Engelm.) Woods.
Matelea

*Matelea gonocarpa* (Walt.) Shinners
Milkvine

Berberidaceae

*Podophyllum peltatum* L.
May-apple

Betulaceae

*Alnus serrulata* (Ait.) Willd.
Smooth alder

*Betula nigra* L.
River birch

TABLE D-5 Continued

*Schrankia hystricina* (Britt. & Rose) Standl.
Bristly sensitive brier

*Strophostyles* spp.
Wild bean

*Tephrosia onobrychoides* Nutt.
Multi-bloom tephrosia

*Tephrosia virginiana* (L.) Pers
Devil's shoestring

*Trifolium campestre* Sturm.
Low hop clover

*Trifolium incarnatum* L.
Crimson clover

*Trifolium repens* L.
White clover

*Vigna unguiculata* (L.) Walp.
Cowpea

Linacea

*Linum medium* (Planch.) Britt. var. *texanum* (Planch.) Fern
Sucker flax

Loganiaceae

*Polypremum procumbens*
Polly-prim

Malvaceae

*Callirhoe Pavaver* (Cav.) Gray
Wine-cups

*Hibiscus lasiocarpos* Cav.
Wooly rose-mallow

TABLE D-5 Continued

*Spiranthes Grayi* Ames
Little ladies' tresses

*Spiranthes ovalis* Lindl.
Oval ladies' tresses

*Spiranthes vernalis* Engelm. & Gray
Spring ladies' tresses

*Tipularia discolor* (Pursh.) Nutt.
Crippled crane-fly

Palmae

*Sabal minor* (Jacq.) Pers.
Dwarf Palmetta

Typhaceae

*Typha latifolia* L.
Common cat-tail

Xyridaceae

*Xyris* spp.
Yellow-eyed grass

DICOTS

Acanthaceae

*Justicia lanceolata* (Chapm.) Small
Lance-leaved water-willow

*Ruellia caroliniensis* (Walt.) Steud.
Ruellia

TABLE D-5 Continued

Onagraceae

*Gaura sinuata* Ser.
Wavy-leaved gaura

*Ludwigia decurrens* Walt.
Primrose-willow

*Oenothera laciniata* Hill.
Cut-leaved evening primrose

*Oenothera speciosa* Nutt.
Showy primrose

Oxalidaceae

*Oxalis dillenii* Jacq.
Yellow wood-sorrel

*Oxalis violacea* L.
Violet wood-sorrel

Passifloraceae

*Passiflora incarnata* L.
Maypop

*Passiflora lutea* L.
Yellow passion-flower

Phrymaceae

*Phryma leptostachya* L.
Lopseed

Phytolaccaceae

*Phytolacca americana* L.
Pokeweed

*Juncus diffusissimus* Buckl.

Slimpod rush

*Juncus effusus* L. var. *solutus* Fern. & Wieg.

Common rush

*Juncus marginatus* Rostk.

Grassleaf rush

*Juncus nodosus* Cov.

Jointed rush

*Juncus validus* Cov. var. *validus*

Roundhead rush

Iridaceae

*Sisyrinchium pruinosum* Bickn.

Dotted blue-eyed grass

*Sisyrinchium langloisii* Greene

Pale blue-eyed grass

*Iris virginica* L.

Virginia iris

*Eustylis purpurea* (Herb.) Engelm. & Gray

Purple pleat-leaf

Lemnaceae

*Lemna valdiviana* Phil.

Duckweed

Liliaceae

*Allium canadense* L.

Canada garlic

*Allium canadensis* var. *mobilense* (Regel) M. Ownbey.

Wild onion

TABLE D-5 Continued

*Rumex hastatulus* Ell.

Heart sorrel

*Rumex plucher* L.

Fiddle dock

Portulacaceae

*Claytonia virginica* L.

Spring beauty

Ranunculaceae

*Clematis* sp.

Clematis

*Delphinium carolinianum* Walt.

Blue larkspur

*Ranunculus* sp.

Buttercup

*Thalictrum dasycarpum* Fisch. and All.

Purple meadow-rue

Rhamnaceae

*Berchemia scandens* (Hill.) K. Koch.

Rattan-vine

*Ceanothus americanus* L. var. *Pitcheri* T. & G.

New Jersey tea

Rosaceae

*Agrimonia rostellata* Wallr.

Woodland groovebur

*Crataegus brachyancantha* Sarg. & Engelm.

Blueberry hawthorn

TABLE D-5 Continued

*Chasmanthium sessiliflorum*

Sessile-flowered spike-grass

*Cynodon dactylon* (L.) Pers.

Bermuda grass

*Eragrostis* sp.

Lovegrass

*Eragrostis spectabilis* (Pursh.) Steud.

Purple love grass

*Erianthus* sp.

Plumegrass

*Leptoloma cognatum* (Schult.) Chase

Fall witchgrass

*Melica mutica* Walt.

Two-flowered melica

*Panicum* spp.

Panic grass

*Panicum commutatum* Schult.

Variable panicum

*Panicum latifolium* L.

Hairy bosc panicum

*Panicum laxiflorum* Lam.

Open-flower panicum

*Panicum oligosanthes* Schult.

Panicum

*Panicum villosissimum* Nash.

White-haired panicum

*Rosa setigera* Michx. var. *tomentosa* T. & G.
Prairie rose

*Rubus* sp.
Dewberry

Rubiaceae

*Cephalanthus occidentalis* L.
Common buttonbush

*Diodia teres* Walt.
Poor-joe

*Diodia virginiana* L.
Virginia buttonweed

*Galium* sp.
Bedstraw

*Galium uniflorum* Michx.
Bedstraw

*Hedyotis crassifolia* Raf.
Small bluets

*Hedyotis australis* Lewis & Moore
Southern bluets

*Mitchella repens* L.
Partridge-berry

Rutaceae

*Zanthoxylum clava-herculis* L.
Hercules-club

Salicaceae

*Salix nigra* Marsh. var. *nigra*
Black willow

TABLE D-5 Continued

Cyperaceae

*Bulbostylis capillaris*
Hair-sedge

*Carex blanda* Dew.
Woodland sedge

*Carex crebriflora* Wieg.
Sedge

*Carex frankii* Kunth.
Franks sedge

*Carex lurida* Wahl.
Lurid sedge

*Carex nigromarginata* Schwein. var. *Floridana* (Schwein.) Kikenth.
Black-margined sedge

*Carex* spp.
Sedge

*Cyperus flavescens* L.
Yellow flatsedge

*Cyperus odoratus* L.
Fragrant flatsedge

*Cyperus* sp.
Flatsedge

*Cyperus strigosus* L.
False nut-grass

*Eleocharis macrostachya* Britt.
Largespike spike rush

TABLE D-5 Continued

*Verbascum blattaria* L.
Moth mullein

*Verbascum thapus* L.
Flannel mullein

Solanaceae

*Physalis* sp.
Ground cherry

*Solanum americanum* Mill.
American nightshade

*Solanum carolinense* L.
Carolina horse-nettle

Tilliaceae

*Tilia americana* L.
American basswood

*Tilia caroliniana* Mill.
Carolina basswood

Ulmaceae

*Celtis laevigata* Willd.
Texas sugarberry

*Ulmus alata* Michx.
Winged-elm

*Ulmus americana* L.
American elm

*Ulmus crassifolia* Nutt.
Cedar elm

*Ulmus rubra* Muhl.
Slippery elm

TABLE D-5 Continued

*Polystichum acrostichoides* (Michx.) Schott.

Christmas fern

*Pteridium aquilinum* (L.) Kuhn var. *pseudocaudatum* (Clute)

Heller

Bracken

*Woodsia obtusa* (Spreng.) Torr.

Blunt-lobed woodsia

GYMNOSPERMS

Cupressaceae

*Juniperus virginiana* L.

Eastern red cedar

Pinaceae

*Pinus echinata* Mill.

Shortleaf pine

*Pinus elliottii* Engelm.

Slash pine

*Pinus taeda* L.

Loblolly pine

ANGIOSPERMS: MONOCOTS

Alismataceae

*Sagittaria latifolia* Willd.

Duck-potato

TABLE D-5 Continued

Umbelliferae

*Cicuta maculata* L.
Spotted cowbane

*Conium maculatum* L.
Poison hemlock

*Daucus pusillus* Michx.
Rattlesnake-weed

*Eryngium yuccifolium* Michx.
Button snake-root

*Hydrocotyle ranunculoides* L.
Floating pennywort

*Ptilimnium nuttallii* (DC) Britt.
Nuttall mock bishop's weed

Urticaceae

*Urtica urens* L.
Burning nettle

Verbenaceae

*Callicarpa americana* L.
American beautyberry

*Verbena halei* Small.
Slender vervain

*Vervain* sp.
Vervain

Violaceae

*Viola missouriensis* Greene
Missouri violet

TABLE D-6 Fish species probably occurring in the vicinity of the project, their relative abundance and general habitat preference

| Scientific Name | Common Name | Abundance in Area | Generalized Habitat |
|---|---|---|---|
| ORDER SEMIONOTIFORMES: GARS | | | |
| FAMILY LEPISOSTEIDAE: GARS | | | |
| Lepisosteus osseus | Longnose Gar | Uncommon | Warm, sluggish water. |
| L. platostomus | Shortnose Gar | Uncommon | Open, silty rivers. |
| L. oculatus | Spotted Gar | Common | Clear waters with abundant vegetation. |
| RDER AMIIFORMES: BOWFINS | | | |
| FAMILY AMIIDAE: BOWFINS | | | |
| Amia calva | Bowfin | Uncommon | Shallow lakes and sluggish rivers. |
| RDER CLUPEIFORMES: HERRINGS, ANCHOVIES | | | |
| FAMILY CLUPEIDAE: HERRINGS | | | |
| Alosa petenensè | Threadfin Shad | Abundant | Freshwater, brackish water preferred. |
| Dorosoma cepedianum | Gizzard Shad | Abundant | Large rivers, reservoirs, lakes, swamps, and may enter brackish water. |
| RDER SALMONIFORMES: TROUTS, SMELTS, PIKES | | | |
| FAMILY ESOCIDAE: PIKES | | | |
| Esox americanus | Grass Pickerel | Common | Quiet, weedy, nonturbid waters. |

TABLE D-6 Continued

| Scientific Name | Common Name | Abundance in Area | Generalized Habitat |
|---|---|---|---|
| ORDER SILURIFORMES: CATFISHES | | | |
| FAMILY ICTALURIDAE: FRESHWATER CATFISHES | | | |
| Ictalurus melas | Black Bullhead | Common | Larger streams, rivers, lakes. |
| **I. furcatus | Blue Catfish | Common | Larger rivers and reservoirs. |
| I. natalis | Yellow Bullhead | Common | Streams, ponds, lakes. |
| **I. punctatus | Channel Catfish | Common | Flowing streams, lakes, also ponds. |
| **Pylodictis olivaris | Flathead Catfish | Uncommon | Larger rivers and reservoirs. |
| Noturus gyrinus | Tadpole Madtom | Common | Rivers and streams, in weedy areas with muddy bottoms. |
| N. nocturnus | Freckled Madtom | Uncommon | Rivers, streams, lakes. |
| ORDER PERCOPSIFORMES: CAVEFISHES, PIRATE PERCHES | | | |
| FAMILY APHREDODERIDAE: PIRATE PERCHES | | | |
| Aphredoderus savanus | Pirate Perch | Common | Creeks, lakes. |

TABLE D-6 Continued

| Scientific Name | Common Name | Abundance in Area | Generalized Habitat |
|---|---|---|---|
| ORDER CYPRINIFORMES: MINNOWS, SUCKERS | | | |
| FAMILY CYPRINIDAE: MINNOWS, CARPS | | | |
| Campostoma anomalum | Stoneroller | Common | Clear streams with gravel or rubble bottoms. |
| Cyprinus carpio | Carp | Common | Warm rivers and lakes. |
| Hybognathus nuchalis | Silvery Minnow | Uncommon | Pools, backwaters, oxbows of rivers and streams. |
| Hybopsis aestivalis | Speckled Chub | Uncommon | Clean sand and fine gravel bottoms of large rivers. |
| Notropis atherinoides | Emerald Shiner | Uncommon | Large rivers and shallow lakes. |
| N. lutrensis | Red Shiner | Abundant | Lakes, larger creeks and rivers, in riffles and quite pools. Tolerant of fairly high turbidity. |
| N. fumeus | Ribbon Shiner | Uncommon | Larger creeks and streams, prefers sandy bottom. |
| N. umbratilis | Redfin Shiner | Uncommon | Streams, tolerant of turbidity. |
| N. buchanani | Ghost Shiner | Uncommon | Quiet water areas of larger creeks and rivers with permanant flow. |

TABLE D-6 Continued

| Scientific Name | Common Name | Abundance in Area | Generalized Habitat |
|---|---|---|---|
| N. sabinae | Sabine Shiner | Uncommon | Streams and rivers with sandy bottoms and clear water. |
| N. venustus | Blacktail Shiner | Common | Prefers flowing water of larger streams, sand or gravel bottom. |
| N. chalybaeus | Ironcolor Shiner | Common | Lakes, ponds. |
| N. atrocaudalis | Blackspot Shiner | Uncommon | Permanant creeks and strea |
| N. volucellus | Mimic Shiner | Uncommon | Pools and backwaters of creeks. |
| Notemigonus crysoleucas | Golden Shiner | Common | Lakes, ponds, sluggish streams. |
| Opsopoeadus emiliae | Pugnose Minnow | Abundant | Lakes, streams, weedy areas. |
| Pimephales vigilax | Bullhead Minnow | Common | Pools and backwaters of streams, lakes. |
| FAMILY CATOSTOMIDAE: SUCKERS | | | |
| Carpiodes carpio | River Carpsucker | Common | Rivers, lakes. |
| Erimyzon oblongus | Creek Chubsucker | Uncommon | Streams, creeks. |
| E. sucetta | Lake Chubsucker | Common | Lakes, large bodies of wate |
| Ictiobus bubalus | Smallmouth Buffalo | Common | Large rivers, also lakes. |
| Ictiobus cyprinellus | Bigmouth Buffalo | Uncommon | Large rivers, oxbows, shallow lakes. |
| Minytrema melanops | Spotted Sucker | Common | Creeks, streams, intolerant of turbid areas. |

TABLE D-6 Continued

| Scientific Name | Common Name | Abundance in Area | Generalized Habitat |
|---|---|---|---|
| ORDER ATHERINIFORMES: KILLIFISHES, LIVEBEARERS, SILVERSIDES | | | |
| FAMILY CYPRINODONTIDAE: KILLIFISHES | | | |
| Fundulus chrysotus | Golden Topminnow | Common | Quiet, weedy backwater areas along major streams, lakes. |
| F. notatus | Blackstripe Topminnow | Common | Larger rivers, also pools of small intermittan tributaries. |
| F. olivaceus | Blackspotted Topminnow | Uncommon | Clear streams with permanent flow, sandy or rocky bottoms. |
| FAMILY POECILIDAE: LIVEBEARERS | | | |
| Gambusia affinis | Mosquitofish | Abundant | Shallow pools, lakes, backwater areas. |
| FAMILY ATHERINIDAE: SILVERSIDES | | | |
| Labidesthes sicculus | Brook Silverside | Uncommon | Permanant pools of small tributaries, backwater areas of larger streams, reservoirs. |
| Menidia audens | Mississippi Silverside | Common | Open waters of large river. |

TABLE D-6 Continued

| Scientific Name | Common Name | Abundance in Area | Generalized Habitat |
|---|---|---|---|
| ORDER PERCIFORMES: BASSES, SUNFISHES, PERCHES | | | |
| FAMILY PERCICHTHYIDAE: TEMPERATE BASSES | | | |
| **Morone chrysops | White Bass | Uncommon | Deep water of lakes, large rivers streams, ponds. |
| **M. mississippiensis | Yellow Bass | Common | Streams, ponds, lakes. |
| FAMILY CENTRARCHIDAE: SUNFISHES | | | |
| **Lepomis cyanellus | Green Sunfish | Common | Streams, lakes, ponds. |
| **L. macrochirus | Bluegill | Abundant | Streams, lakes, ponds. |
| **L. gulosus | Warmouth | Common | Weedy areas of lakes, streams. |
| **L. punctatus | Spotted Sunfish | Common | Lakes, streams. |
| **L. microlophus | Redear Sunfish | Abundant | Lakes, creeks, rivers. |
| **L. megalotis | Longear Sunfish | Common | Clear lakes, ponds, stream |
| **L. humilis | Orangespotted Sunfish | Uncommon | Streams, lakes, tolerant o silty waters. |
| Elassoma zonatum | Banded Pygmy Sunfish | Uncommon | Lakes, streams. |
| **Micropterus salmoides | Largemouth Bass | Common | Weedy or brushy lakes, pon streams. |
| **M. punctulatus | Spotted Bass | Common | Clear streams, lakes. |

TABLE D-6 Continued

| Scientific Name | Common Name | Abundance in Area | Generalized Habitat |
|---|---|---|---|
| ***Pomoxis annularis* | White Crappie | Common | Lakes, ponds, rivers. |
| ***P. nigromaculatus* | Black Crappie | Common | Weedy areas of larger streams, lakes. |
| FAMILY PERCIDAE: PERCHES | | | |
| *Etheostoma chlorosomum* | Bluntnose Darter | Uncommon | Sandy, lowland streams. |
| *E. gracile* | Slough Darter | Common | Quiet or slow flowing waters with soft bottoms. Also ponds and oxbow lakes. |
| *Percina caprodes* | Logperch | Uncommon | Gravelly bottoms of lakes, streams. |
| FAMILY SCIAENIDAE: DRUMS | | | |
| *Aplodinotus grunniens* | Freshwater Drum | Common | Larger lakes and streams. |



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*Information derived from:

1) Douglas, Neil H., 1974. Freshwater Fishes of Louisiana. Claitors Publ. Div., Baton Rouge.
2) Hubbs, Clark, 1972. A Checklist of Texas Freshwater Fishes. Tech. Series No. 11, Texas Parks and Wildlife Department, Austin, Texas.
3) McCune, Richard (ed.), 1971. Freshwater Fishes of Texas. Bulletin 5-A. Texas Parks and Wildlife Dept., Austin.
4) Pflieger, William L., 1971. Distributional Study of Missouri Fishes. Univ. of Kansas Press, 570 pages.
5) Additional information provided by Steve Smith, District Management Supervisor, Texas Parks and Wildlife Department, Tyler.

Game Fish Species

# APPENDIX E

# ESTIMATES OF EMISSIONS PRODUCED BY HYDROCARBON FLARING AND VAPOR LOSSES AND MODEL USED TO CALCULATE DOWNWIND GROUND LEVEL CONCENTRATIONS

## APPENDIX E

## ESTIMATES OF EMISSIONS PRODUCED BY HYDROCARBON FLARING AND VAPOR LOSSES AND MODEL USED TO CALCULATE DOWNWIND GROUND LEVEL CONCENTRATIONS

### Odor

A number of substances, both man-made and naturally occurring, can cause odors in air and water; for example, petrochemical facilities or the musty earthy odors typical of freshly plowed soil, or stagnant marsh areas. Only traces of some organic compounds are required to produce noticeable effects. However, one problem in odor research is the isolation and identification of specific chemical compounds which cause the odors; another problem is determining the source of the compounds.

Man-made sources of hydrocarbon odors are incineration of waste products, evaporation of industrial solvents, or the combustion of coal, oil and wood. The leading source of hydrocarbon emissions, however, is the processing and use of petroleum products. In this processing-use chain, gasoline is the major source of hydrocarbons due to emissions from evaporation or use of the internal combustion engine.

Natural sources such as forests and vegetation also emit large amounts of hydrocarbons of the terpene class. In addition, bacterial decomposition of organic matter produces large amounts of methane. Hydrogen sulfide is naturally produced in large quantities during the decay of organic matter on land or in swamps or marshy areas. Hydrogen sulfide is also emitted by some industrial operations. The sketchy data available for a comparison of natural and man-made sources of hydrogen sulfide suggest that the industrial contribution of this gas, on a global basis, is not significant. Most hydrogen sulfide is believed to be produced from natural sources.

Contaminant losses from petroleum storage and production facilities consist of escaping or vented natural gas, and evaporative hydrocarbons derived principally from storage tanks. These losses consist mostly of ethane and methane. Negligible quantities of sulfur dioxide, nitrogen oxides and particulate matter are released from internal combustion engines or other combustion equipment associated with crude oil production facilities.

Hydrocarbons (HC) emitted from storage sources are mostly of the lower boiling volatile hydrocarbons. These HC are not significant in smog formation but do produce odors and, therefore, they are prevented from entering the atmosphere by use of storage control systems. These systems involve the collection of the vapors or their redistribution to other storage areas by means of a vapor balancing system. This collection is followed by absorption or incineration (flaring) of the excess odor producing vapors. Control system efficiencies of 85 to 100 percent are possible when vapor recovery or vapor disposal systems are in operation.

Estimate of $H_2S$ and $SO_2$ Emissions Produced by Hydrocarbon Flaring

The odor compounds emitted from an unflared cavern vent can be estimated by assumed worst case conditions: all the vapor in HC, with a content of 0.1 percent (1000 ppm) odor compounds. Vapor density is calculated by assuming: 1.2 X the specific gravity of air at standard temperature and pressure (0.075 lb/ft$^3$), which equals 0.09 lb/ft$^3$; the volume of a barrel of oil is 5.65 ft$^3$.

Therefore: 50,000 bbls/day = 282,000 ft$^3$/day
= 25,380 lbs/day

0.1 percent of this is $H_2S$ or 25.5 lbs/day = 0.14 gm/sec $H_2S$

If this concentration is flared, the weight of $SO_2$ is about double that of the converted $H_2S$.

Therefore: 50 lbs/day = 0.27 gm/sec $SO_2$

Estimate of Vapor Losses of Hydrocarbons and $H_2S$ by Leakage

About 5 percent of the crude oil pumped can be considered volatile, with a leakage rate of about $10^{-4}$ of the throughput. The leakage rate for the remainder may be on the order of $10^{-6}$ or less, and can therefore be neglected. Odor compounds can be conservatively estimated as 0.1 percent of the leaking material. Consequently, per 50,000 barrels per day, the hydrocarbon loss is estimated by:

$$\left(50{,}000\ \frac{\text{barrels}}{\text{day}}\right)\left(300\ \frac{\text{lbs}}{\text{barrel}}\right)(5\%)(10^{-4}) = 75\ \text{lbs/day or 0.4 gm/sec hydrocarbons.}$$

The odor compound, or 0.1 percent of this rate, would amount to 0.08 lbs/day or 0.0004 gm/sec $H_2S$.

Vapor Losses from Storage Caverns

Petroleum vapor loss from the cavern will occur as the cavity is vented during filling. Vapor loss may also occur during storage if the cavern is vented and permitted to "breathe" with changes in atmospheric pressure. Petroleum fluids of lower molecular weight evaporate readily on contact with air which is not already saturated with petroleum vapors. As the cavern is initially filled, the vapor space above the liquid will become charged with hydrocarbon vapor evolving from the rising liquid. If the vapor-air mixture is not expelled from the cavern at the same rate as liquid entry, pressure buildup from compression will result.

As the cavern is evacuated, fresh air may be introduced to prevent a vacuum. Additional vapor will be evaporated to saturate this fresh air, but no vapor loss will be experienced during withdrawal. These accumulated vapors will be expelled during the next filling cycle, along with a small amount of additional vapors evolved during the filling.

If the cavern is not vented during storage, there will be a small pressure buildup due to continued boil-off of dissolved petroleum fractions in the crude which are normally in vapor form at storage temperature and pressure. This pressure buildup would amount to about one-half atmosphere for crudes contemplated in the storage program, but could range to more than 2 atmospheres for crudes rich in $C_2$ and $C_3$ components fresh out of the ground. Boil-off is distinct from evaporation of compounds which are normally liquid at storage conditions, the distinction being whether the vapor pressure of the fraction is less than or greater than atmospheric pressure at the storage temperature.

"Breathing" of a vented cavern involves inflow and outflow of air due to fluctuations in barometric pressure. The liquid level in the cavern remains steady, but the vapor space density fluctuates slightly. Even gauge holes into the vapor space would permit significant breathing. Gauge tubes immersed into liquid, however, do not permit breathing venting, and the evaporation losses from the liquid surface in the tubes is generally insignificant. It is not expected that the caverns would be vented during storage, so breathing losses are not anticipated. Operation of the caverns at greater than atmospheric pressures caused by boil-off does not affect any of the considerations of oil-water interchange during a shaft or fill-pipe failure. Water sealing in the sumps will still occur so long as the shaft seals are intact.

The vapor pressure of the crude at storage conditions ($75^{o}$ to $98^{o}$F) will range from 2 to 3 psia for the types of crude specified in the program. Thus, a saturated mixture of air and vapor would consist of about 15 to 20 percent hydrocarbons, with the specific gravity of the mixture ranging between 1.2 and 1.5 relative to air. Since 80 percent saturation may be used as representative of average conditions, the density of vapors during initial fill would be about .09 lbs per cubic foot -- 20 percent being hydrocarbons. The average amount of hydrocarbons expelled per 100,000 barrels introduced into the cavern initially would total 11,280 pounds, or 0.04 percent by weight. In time, however, the average molecular weight of the hydrocarbons would increase as heavier fractions ($C_7$ - $C_{15}$) evolve into the vapor space. Under the worst conditions considered in flaring vent emissions, the weight loss would amount to nearly 0.17 percent.

Emissions from Tanker Transfers

The following emission factors are given in EPA (1975) for tanker transfer operations:

| | |
|---|---|
| Tanker Loading: | 0.008 percent per psia true vapor pressure (TVP) |
| Tanker Unloading: | 0.007 percent per psia TVP |

Loading emissions are released as the vessel is filled, displacing the fumes in the storage compartment. For tankers, unloading emissions are vented as ballast is taken aboard, displacing the vapors left in storage compartments. Typically, 40 percent ballasting would produce 0.0028 percent release per psia true vapor pressure. For barges which do not ballast, the unloading emission would not be vented until refilling.

Losses in Transit

Transit losses are estimated at 0.001 percent per psia TVP per week in transit. Transit time from the Gulf to the storage site (excluding transfer time) is less than one day. The design Reid Vapor Pressure (RVP) for the storage site is 3 psia, which is a 2 psia TVP at 75°F mean temperature (used in calculations). For light Arabian crudes at high temperatures (RVP = 8 psia, T = 90°F), emission losses could be four times as high for all loss modes.

Model Used to Calculate Downwind Ground Level Concentrations

Calculation of the downwind concentrations by hydrocarbons released during crude oil transfer uses the sector spread technique (Turner, 1969). A point source emission was assumed at ground level. The effluents are assumed to be evenly distributed over a 22-1/2$^{0}$ wind sector via meandering of the plume, and the wind is assumed to be constant over the entire trajectory.

The equation used is:

$$C = (Q) \left(\frac{2.032}{u \sigma_z X}\right)$$

where:

X is the downwind distance (meters), u is the wind speed (meters/sec), $\sigma_z$ is the vertical dispersion coefficient (meters), Q is the effluent source term (gm/sec), and C is the downwind concentration (gm/meters$^3$).

In addition, continuous emission from the source is assumed; therefore, diffusion in the direction of transport may be neglected. None of the material emitted is assumed to be lost from the plume as it moves downwind and there is complete reflection at the ground. Finally, the material diffused is assumed to remain suspended in the air over long periods of time (i.e., a stable gas or aerosol less than ~ 20 microns in diameter).

Because the construction activity will take place over an area of several acres, an area source model was used to calculate downwind concentrations. For the purposes of computation, the area was assumed to be .25 km on a side. A worst case concentration 500 meters downwind was computed at the center point of the plume.

The equation used is:

$$C = \frac{Q}{\pi \sigma_y \sigma_z u}$$

where:

u is the mean wind speed (meters/sec), $\sigma_z$ and $\sigma_y$ are the vertical and horizontal dispersion coefficients respectively (meters), Q is the pollutant source term (gm/sec), and C is the downwind concentration (gm/m$^3$).

To allow for the area source, a virtual distance $X^1$ is found that approximates the distance required for a point source to disperse into an area equivalent to the site. The distance $(X + X^1)$ is then used to determine a new horizontal dispersion coefficient of the plume ($\sigma_y$). The above equation is then used with the new value for $\sigma_y$.

In addition, the area source method uses the following assumptions: The effluents are assumed to be normally distributed along the plume centerline; continuous emission from the source is assumed; there is no removal of pollutants from the plume and there is complete reflection at the ground; the diffused material remains suspended in the air over long periods of time.

Air Pollution Potential

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

Nocturnal radiation inversions that form under clear skies and light winds allow radiative heat loss from the earth's surface. The inversions limit the atmosphere's horizontal and vertical dilution efficiency within the inversion layer. Based on a study by Hosler (1961) low-level inversions in the vicinity of the site can be expected with the following frequencies:

| Season | Frequency (Percent of all hours) |
|---|---|
| Winter | 35 |
| Spring | 25 |
| Summer | 25 |
| Autumn | 40 |
| Annual | 31 |

Radiation inversions usually break up by late morning due to surface heating.

Mean Mixing Heights

One key index to air pollution potential is mixing height, which indicates the depth of atmosphere available for the distribution of pollutants. The higher the mixing height, the lower the pollution potential. Using U.S.

radiosonde station temperature and wind data, Holzworth derived average urban morning minimum and afternoon maximum mixing heights (incorporating an urban nocturnal heat island effect), and mean wind speeds within these layers throughout the contiguous United States. Mean morning and afternoon urban mixing heights in the general vicinity of the site were 500 and 1450 meters, respectively. The morning heights are among the lowest in the contiguous United States. The afternoon heights are representative of average conditions compared with other stations in the United States. This points out the effects of afternoon heating in this region, which raises the level of atmospheric inversion. The low morning mixing heights are attributable to strong nocturnal cooling of the surface, which is conducive to the formation of early morning inversions that inhibit vertical atmospheric motion.

The episodic occurrence of limited atmospheric dispersion conditions in the United States has also been studied by Holzworth (1974). Holzworth's data presents the frequency of slowest dispersion (worst stagnation or lowest ventilation rates) episodes lasting 1, 2, 3, 4, and 5 consecutive days at each of 62 National Weather Service Stations. The various episodes of least dilution are not necessarily those that would result in the most undesirable transport and diffusion of pollutants from a single source. The information is most appropriate for determining the potential for a general pollution problem for areas the size of large urban complexes.

The results of Holzworth's study indicate that the southernmost region of Texas is a favorable location relative to other locations in the United States for each of the episode dispersion periods. Calculation of ventilation factors for 5 different air stagnation periods at Shreveport (the nearest station to the site) shows that out of 62 stations, Shreveport ranked 33rd best for the 1-day episode duration, 5th best for the 2-day episode duration, 13th best for the 3-day episode duration, 9th best for the 4-day episode duration, and 6th best for the 5-day episode duration. The favorable conditions can be attributed to the relatively high wind velocities of the south central United States and to the flat surface features of the area, which do little to retard the wind flow in the lower layers of the atmosphere. There was only one occurrence during the 5-year period of a limited dispersion condition with mixing heights less than 750 meters and transport wind less than 4 meters per second; and one occurrence of the more severe condition of 4-meters-per-second winds with mixing heights less than 250 meters.

Stability

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

Table E-1 lists the seasonal and annual distribution of stability classes for Dallas, Texas, the closest site for which stability data were available. During the winter and spring seasons, there is a relatively high occurrence of neutral and stable conditions. The stability frequencies become more evenly distributed over all the stability classes during the summer and fall months. There is a relatively small percentage of unstable conditions at the site, which seems unusual for an area that experiences strong solar heating at the surface. This is due to the high atmospheric moisture content and associated cloud cover that moderate the surface heating so that a smaller percentage of unstable conditions is realized. On a diurnal basis most of the atmospheric instability occurs during the mid-day, followed by stable conditions at night. The method used in this determination of stability will, in most instances, fail to detect extreme surface inversion (stable) or lapse (unstable) conditions in the lowest several hundred feet that would probably be apparent from instrumented tower data.

TABLE E-1 Frequency distribution by stability class, Dallas, Texas (1969-1973)

| Stability | Dec/Jan/Feb | Mar/Apr/May | Jun/Jul/Aug | Sept/Oct/Nov | Annual |
|---|---|---|---|---|---|
| A | 0.1 | 0.1 | 1.7 | 0.4 | 0.7 |
| B | 1.9 | 5.3 | 10.4 | 4.8 | 5.6 |
| C | 6.8 | 8.8 | 16.4 | 8.8 | 10.2 |
| D | 28.7 | 28.8 | 21.2 | 23.5 | 25.5 |
| E | 35.3 | 32.7 | 19.1 | 30.7 | 29.3 |
| F | 27.2 | 23.9 | 31.3 | 32.3 | 28.7 |

# APPENDIX F

# ARCHAEOLOGICAL AND HISTORICAL RECONNAISSANCE
# OF
# THE FEA PIPELINE ROUTE

# Introduction

Archival and field work were performed by James E. Bruseth and Kimball M. Banks, Research Archaeologists, under the direction of Dr. S. Alan Skinner, Director of the Archaeology Research Program and Assistant Professor with the Department of Anthropology, Southern Methodist University

This report summarizes the results of an archaeological reconnaissance of the proposed FEA pipeline. The pipeline will extend from the Morton Salt Mine, located south of Grand Saline, Texas, to a point about 6 miles north of Winnsboro, Texas. Thirty-two sites and localities were recorded, and information on an additional 11 previously recorded sites was obtained. A total of 43 sites and localities are discussed in this report.

The archaeological reconnaissance of the proposed FEA pipeline consisted of 4 parts: (1) records check of the Texas Archaeological Research Laboratory files in Austin; (2) a check of the Historical Sites Inventory for historic places located near the pipeline; (3) contacts with local collectors; and (4) an on-the-ground survey of approximately half of the pipeline route. Areas to be surveyed were selected based on past field experience by the Archaeology Research Program in Wood, Hopkins, and Franklin Counties. These areas consist primarily of stream floodplains and adjacent upland areas.

The archaeological sites found have been divided into two classes for the remainder of this report. The first class includes sites which are considered to represent substantial visits by prehistoric or historic people. Sites of this category are termed "site" and given an official S.M.U. site number, i.e., X41VN1. The second category of site is termed "locality" and refers to random occurrences of artifacts, usually singly. Such areas are not felt to represent substantial visits by prehistoric or historic people.

Previously located sites situated within a half mile of either side of the pipeline are included within this report. A number of sites fall into this category. This information is included in case pipeline relocation is considered. Since the pipeline route was not flagged in the field, the on-the-ground survey covered approximately a 400-meter wide swath. Preference was given for pastures and thinly wooded areas since ground exposure tends to be poor in thickly wooded areas. The survey was nondestructive in that no artifacts were collected.

Fieldwork was conducted over two separate weekends in April 1976. Sites, once located, were photographed, plotted on U.S.G.S. topographic maps, and described by use of a detailed survey form. The survey forms and photographic negatives are on file at the Archaeology Research Program, Southern Methodist University.

## Background Information

The following information is presented as a brief outline of northeastern Texas archaeology. Two basic periods of prehistoric occupation are found in northeastern Texas, the Archaic and the Neo-American. The Archaic period lasted from approximately 3500 B.C. until about A.D. 500. People of this period subsisted on a hunting and gathering economy, used spears with dart points for hunting, and lacked a pottery making technology. An earlier Paleo-Indian period is proposed for the area on the basis of scattered projectile point finds which are considered indicative of this time period. However, no published sites of this early period have yet been reported. The Neo-American period lasted from approximately A.D. 500 to historic contact (ca. A.D. 1650). This period is characterized by a sedentary, horticultural economy. The bow and arrow were used in hunting, and pottery was commonly used for cooking and food storage. The Indians of this period are the ancestors of the historic Caddo.

The historic period begins with French and Spanish exploration in northeastern Texas and ends during the early part of this century.

## Historic Places

Two historical places are located in close proximity to the pipeline. Both sites have official Texas Historical markers. The first is the Morton Salt mine, the origin of the pipeline. Since the early 1800's, salt mining has been an important activity in this area - first by the Cherokee Indians, later by the Confederacy during the Civil War, and today by the Morton Salt Company.

The second place of historical significance is the Rock Hill Baptist Church located 10 miles north of Quitman and near the pipelines' intersection with Brushy Creek. The church was first formed in 1870 and the church building was built in 1892.

No other historic sites within the pipeline right-of-way are included on, or are in the process of being nominated to, the State or Federal Registers of Historic Places.

## Archaeological Sites

### Locality A

This locality consists of a single flake found on an upland projection into Grand Saline Creek adjacent to X41VN1. No other artifacts were located despite ground exposure comparable to X41VN1. No additional work is recommended for this area.

### X41VN1

This site was located during the first day of fieldwork. The site is situated on an upland projection into the Grand Saline Creek floodplain. The site is presently in pasture. It appears to have been cut recently since large trees are piled east of the site. Artifacts encountered consisted of approximately a dozen chips and flakes. No ceramics or archaeological features were found. The site probably represents occupation during the Archaic period. Subsurface testing is recommended for this site before a definitive assessment is made.

### X41VN2

This site was located during the survey of the Grand Saline floodplain adjacent to Grand Saline Creek. The site has recently been cleared and put into pasture. It was heavily disturbed by the clearing. Also, a road was cut through the eastern half of the site, destroying that portion. Six flakes, 1 biface fragment, and 1 bone fragment were noted on the surface of the site. Due to the absence of ceramics, an Archaic temporal placement is assumed. No further work is recommended for this site because of its disturbed condition.

Locality B

This locality was located during survey on a high upland bluff projecting into the Grand Saline Creek floodplain. The locality is presently in pasture. Two flakes were found on the surface; despite intensive checking, no other artifacts could be located. Because of the small artifact sample, no temporal placement for the site can be made and further work is not recommended for the area.

X41VN3

This site is situated along Chrestman Branch, a tributary of Grand Saline Creek. This area has experienced heavy erosion, and the artifacts at present are located in red clay. The site covers an area of about 50 by 50 meters. It is doubtful that there is any depth to the site. Ten flakes and chips and 1 mano fragment were found on the surface. Based on these artifacts, an Archaic period occupation is postulated for the site. No further work is recommended for the site due to the heavy erosion.

X41VN4

This site was previously located by Mr. B.D. Skiles, an amateur archaeologist from Mineola, Texas. The site is situated on a floodplain rise near the intersection of Grand Saline Creek and U.S. Highway 80. Mr. Skiles reported that Archaic points had been found in the past as well as flakes, mussel shell, and bone. A midden composed of dark humic soil is located on top of the rise. The site covers the entire knoll, or about 50 x 100 meters. Site depth is based on a test pit 5 feet square. Site occupation is thought to have been during the Archaic period. Further testing is recommended for this site prior to any disturbance.

X41VN5

This site is situated along an upland projection into the Sabine River floodplain. The site has been recently plowed. Artifacts were spread over a 5-acre area and consisted mainly of flakes, chips, biface fragments, and core fragments. Fire-cracked rock was also observed, and two reworked Gary points were noted (Suhm, Krieger and Jelks, 1954). Approximately 10 sherds were found at the site; one had incised decorations. Neo-American period occupation of the site is postulated, based on the presence of ceramics. The two Gary points (Suhm, Krieger, and Jelks, 1954) suggest that a separate Archaic component may be present. Testing in order to ascertain site depth is recommended in the event this site will be disturbed by the pipeline.

X41VN6

This location probably represents an old homesite. All that remains today are some crockery sherds and a shallow depression near the sherds. Further testing is warranted to adequately evaluate the site.

X41VN7 (41VN47UT) and X41VN8 (41VN48-UT)

These two sites were located during a reconnaissance of the proposed Carl L. Estes Lake (Malone, 1972). Both sites are located along an upland projection into the Sabine River floodplain. One arrow point, 1 plain sherd, and several petrified wood flakes were observed on site 41UN47; only flakes were observed on site 41UN48. A midden is reported for site 41UN47. Site 41UN47 is 30 by 40 meters in size; site 41UN48 is 20 by 30 meters. Neo-American and/or Archaic period occupations are postulated for both sites. Further testing is recommended for these two sites before any construction-related disturbance.

X41WD107

This site was reported to us by Mr. Skiles. He reports finding some lithic artifacts, consisting primarily of flakes and chips, exposed in gopher backdirt piles. Estimated site size is 30 by 50 meters. The site is situated in the level floodplain of the Sabine River and is presently in pasture. In the event this site will be threatened by pipeline construction, additional testing is recommended.

X41WD108 (41WD1-UT)

This site was first reported in 1934 by A.T. Jackson of the University of Texas. He uncovered 3 burials at the site associated with two pottery vessels, a clay pipe, and mussel shell fragments. The site is situated on a terrace remnant jutting into the Sabine River floodplain. Presently the site is partly in woods and partly in pasture. It is estimated to be 50 by 100 meters. Our survey of the site located a broken biface and approximately a dozen flakes and chips. On the basis of Mr. Jackson's work at the site, a Neo-American temporal placement is given. The pipeline, as it is presently routed, will cut through this site. Additional testing is mandatory before construction begins.

X41WD109

Mr. Skiles informed us of this site. It is located on the upland overlooking the Sabine River. The site was originally detected by a dark brown midden. Mr. Skiles excavated the midden and found numerous pottery sherds and a broken greenstone celt. Our inspection of the site located another possible midden about 20 meters south of the first midden; however, no artifacts were associated with it. This site represents a Neo-American period occupation. Testing of the other possible midden to determine whether it is cultural is necessary before disturbance of the site. The midden excavated by Mr. Skiles is not recommended for additional investigation.

X41WD110

This site consists of a log cabin located in a pasture in the uplands overlooking the Sabine River. The cabin is very weathered in appearance, possesses a board floor, and has been reroofed with galvanized tin. Mr. Skiles estimated the cabin to be 70 years old. In case this structure is threatened by the pipeline, relocation of the cabin is recommended.

X41WD111

This site was referred to us by Mr. Marvin Ballard. We did not visit the site but have relied on Mr. Ballard's description. He told us that as a boy he would pick up arrowheads, flakes and decorated sherds in the area. Exact location and limited testing is recommended for this site if the pipeline should be moved so as to involve this area.

X41WD122 (41WD36-UT)

This site was recorded during a reconnaissance of the proposed Carl L. Estes Lake (Malone, 1972). It consists of a series of low knolls in a pasture surrounded by trees. Artifacts were observed eroding out of one knoll. Mr. Ballard also told us of this site and said that he used to find large stones with animal carvings on them. He collected two celts from the site. The site survey from the Carl L. Estes Lakes reconnaissance recommends no further work. However, certain information given by Mr. Ballard suggests that more of the site remains to be found, probably in the wooded areas surrounding the site. A survey of the area around the field is recommended in case the pipeline is rerouted through this area.

X41WD112

This site was reported by Mr. Skiles. It is situated along an upland projection into Alum Branch, a tributary of Lake Fork Creek. The site is presently in pasture. An extremely dark midden, containing charcoal fragments, bone, mussel shells, sherds, and flakes, is reported by Mr. Skiles. Site area is 20 by 20 meters. The site was occupied during the Neo-American period. Testing is necessary before any disturbance occurs.

X41WD113

This site was found by Mr. Skiles after recent clearing along Alum Branch. The site consists of two areas, one located on the upland slope and another down the slope and partially in the floodplain. The first area consists of sherds and flakes; the second contains predominantly flakes. The areas are 10 by 15 meters and 10 by 10 meters, respectively. Mr. Skiles believes the first area to represent Neo-American and historic components, and the second area to represent Archaic period occupation. Both areas have been heavily damaged by clearing activities and no further work is recommended.

X41WD114 (41WD40-UT)

This site, reported by Mr. Skiles, is located on an upland remnant knoll in the Lake Fork Creek floodplain. Presently the site is in pasture. Mr. Skiles reported that he and Mr. Bob Turbeville of Jamestown Colony excavated what appeared to be the interior of a house. The house pattern was manifested by postmolds remaining in the clay below the soil on the site. The postmolds were not apparent within the soil horizon. The structure was rectangular in shape. A number of early Archaic dart points were found, as well as some ceramics, indicating an occupation from both the Archaic and Neo-American periods. This site has been thoroughly excavated, and no further work is recommended. However, another portion of the site located near the bank of Alum Branch is reported by Mr. Skiles and would warrant investigation if the pipeline were routed through this area.

X41WD115

This site was also shown to us by Mr. Skiles. It is situated on the upland overlooking Lake Fork Creek. Lithic artifacts are the only surface artifacts observable and extend across a large area of approximately 5 acres. The site is presently in pasture. Although no erosional gullies or other natural cuts into the soil were observed, it is doubtful that the site has any depth. This assessment is based on similar site situations upstream in Lake Fork Creek reservoir. The site likely represents numerous reoccupations by Archaic hunters. However, subsurface testing should be conducted to substantiate this before destruction by pipeline construction.

X41WD116

Mr. Skiles reported this site to us. It is located on wooded upland projection into the Lake Fork Creek floodplain. Mr. Turbeville excavated this site in 1971 and uncovered a dark midden and a whole vessel, possibly of the type Maxy Noded Redware. In addition, several excavated bison vertebrae are reported. The site represents a Neo-American period occupation. Mr. Skiles feels that other middens may be associated, although he has not found any. A thorough examination of the upland projection should be conducted if the pipeline is routed through this area. No work is recommended on the midden due to previous excavations.

X41WD117

This site is located on the same landform as site X41WD116, about 100 meters north. Mr. Skiles also reported this site to us. A portion of a vessel was found at this site which may represent a burial with all traces of the skeletal material leached away. This burial might be part of a cemetery associated with site X41WD116. Additional checking for other associated burials is recommended before any disturbance of this area.

X41WD9, X41WD11, X41WD22, and X41WD30

These four lithic sites were located during the survey of Lake Fork Reservoir. All four sites consist exclusively of lithics and include points, flakes, chips. firecracked rock, and cores. None of the four sites is recommended for continued work (Bruseth, Bagot, and Banks, n.d.).

X41WD118

This site was located on an upland slope above Rainwater Creek. At present the site is in pasture. Two flakes and a piece of polished ocher were observed on the surface. Site area is about 50 by 50 meters. The site has been badly disturbed by erosion and terracing, and no further work is recommended.

X41WD119

This site consists of four flakes that were found during reconnaissance at the source of Taylor Branch. The flakes were found in a sandy pasture surrounding a pond. No other artifacts were located. No further work is warranted on this site due to the low density and scattered nature of the deposit.

X41WD120

This site is situated on an upland remnant adjacent to a tributary of Glade Branch. Currently the site is in open pasture with scattered large oak trees. The site area is estimated to be 20 by 50 meters. One sherd, 1 flake, and a small end-scraper constitute the artifacts observed on the surface. Site occupation was during the Neo-American period. Additional work is warranted to ascertain the significance of this site.

X41WD121

This site is located in a pasture on a floodplain rise approximately 150 meters north of site X41WD120. Site area is about 75 by 75 meters. Ten sherds and 3 flakes were found on the surface. On the basis of these artifacts, a Neo-American occupation of the site is postulated. The site deposit appears to be undisturbed, and testing is necessary before a potential alteration of the site by construction.

Locality C

One flake and a possible mano were found in the Glade Branch floodplain during this reconnaissance and constitute this locality. The floodplain of Glade Branch is composed of washed-in top soil from surrounding upland areas. Recent oil well activity has heavily disturbed the land surface in this vicinity. The artifacts probably represent site material eroded out of context and into Glade Branch. No further work is recommended for this area.

X41HP50

This site was not visited but referred to us by Mr. Larry Ellison, a local landowner. Mr. Ellison said that when he was young, he picked up points in the area situated along the upland slope of Big Sandy Creek. Actual pin-pointing and testing will be necessary if the pipeline is relocated through this area.

X41HP51

This is an historic mill site that was operated by Mr. Ellison's grandfather prior to 1920. All that remains today are cement blocks which were part of the foundation. Corn and syrup were the major products of the mill. No work is recommended for this site.

Locality D

This locality consists of 1 flake found near an abandoned house north of Highway 11 and overlooking Big Sandy Creek. No further work is recommended for this locality.

Locality E

A dart point was found on a dirt road and constitutes this locality. The point may have been carried in for road fill. No work is necessary.

X41HP52

This site was found in the Big Sandy Creek floodplain. Three flakes were observed on the surface of a floodplain knoll. Due to the low artifact density, no testing is recommended for this site.

X41HP53 and X41HP54

The location and description of these sites were given to us by Stanley Johnson, landowner of the sites. Site X41HP53 consisted of a dark midden and contained numerous pottery sherds. The midden has disappeared in recent years due to repeated cultivation. Partially complete vessels are reported from the sites, indicating the possibility that a cemetery may be present. Points have been collected in the field surrounding the site. Site X41HP54 is similar in that it once consisted of a midden which has disappeared due to plowing. Pottery sherds and mussel shells are reported from this site. If either of these two sites is threatened by pipeline construction, testing is recommended.

X41FK41 (41FK10-UT)

This site is situated on an upland remnant in the Coon Creek floodplain. Presently the site is in pasture, and a road cuts through the site. Approximately 40 flakes and chips, 20 sherds (including engraved and brushed sherds), and a mano fragment were observed on the surface. The site area is 100 by 30 meters. Soil is deep in this locality, and the site deposit may extend a meter or more. The site was occupied during the Neo-American period. Although the site has been disturbed by clearing and recent relic seekers, a road testing is recommended in order to assess adequately the potential of the site. An existing pipeline cuts through the southeastern section of the site; depending on the exact location of the new pipeline, additional work may be unnecessary.

X41FK42

One sherd and a flake were observed on the surface of this site during reconnaissance. Despite moderate exposure, no additional material was found. This site is situated on the upland overlooking Coon Creek. Due to the sparse artifact frequency, no further work is warranted.

X41FK43

The historic site probably represents an old homesite. Three pieces of crockery and a flake were found. The crockery represents historic occupation, and the flake suggests prehistoric occupation. Ground exposure was poor. Site area is about 30 by 30 meters, and present land use is pasture. Testing is recommended at this site for adequate assessment.

X41FK44

This site is located on the upland overlooking Little Cypress Creek. At present it is part of a pasture. It has been disturbed by an existing pipeline. Artifacts from a 50- by 20-meter area consisted of a Gary point (Suhn, Krieger, and Jelks, 1954), a broken arrow point, flakes, chips, and bone fragments. An Archaic period occupation is considered likely, based on the lack of ceramics. Depending on the exact location of the pipeline, limited testing may be needed to assess affected parts of the site.

X41FK45 (41FK4-UT)

This site was recorded and subsequently excavated by Mr. A.T. Jackson of the University of Texas in 1934. Funding was supplied through the Works Progress Administration. Mr. Jackson recorded two middens about 20 meters in diameter and a cemetery containing 11 graves. Ninety vessels were excavated from the graves, averaging slightly over 8 per grave. Testing in the midden disclosed numerous sherds, flakes, chips, faunal remains, and charcoal. The middens are thought to represent locations where houses were situated. The site represents a Neo-American settlement. No further work is considered necessary at this site since it is similar to several undisturbed sites in this part of Texas (c.f. X41HP53 and X41HP54).

Conclusion

Forty-three historic and prehistoric sites and localities are discussed in this report. Nineteen are considered sufficiently damaged or insignificant so as not to warrant additional work. The remaining 24 do warrant additional attention. The nature of the recommended work at each site varies depending on the site.

Pipeline relocation in order to miss the sites is considered the most favorable alternative from an archaeological standpoint. Any sites which cannot be avoided by the pipeline will need to be tested. Testing may shown that the site is insignificant and does not warrant any further work or that the site is significant and should be further investigated through excavation.

After the pipeline has been field surveyed, a detailed survey of the exact right-of-way is recommended. Such a survey is necessary to insure that no significant archaeological sites will be destroyed. An adequate survey will need to include subsurface testing at certain sites due to the nature of the heavy ground cover. Through continued cooperative action between archaeologists and concerned private corporations, the archaeological resources of the state of Texas can be preserved for future generations.

All sites that are located in the final pipeline right-of-way will be eligible for nomination to the National Register of Historic Places and should be nominated following an intensive survey.

Acknowledgements

Credit for much of the success of this survey must be given to Mr. B.D. Skiles, amateur archaeologist from Mineola, Texas. Mr. Skiles assisted on all four days of the reconnaissance and his familiarity with the archaeology of the area greatly assisted us.

Credit must also go to Carolyn Spock of the Texas Archaeological Research Laboratory, who collected and copied information from the T.A.R.L. files on previously recorded archaeological sites in the area. Also, Mr. John W. Clark of the State Historical Commission assisted in sending information concerning Texas historical markers in the counties transversed by the pipeline.

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APPENDIX G

# OIL SPILL RISK ANALYSIS METHODOLOGY

APPENDIX G

# OIL SPILL RISK ANALYSIS METHODOLOGY

## G.1 PIPELINE SPILLS

The risk for pipeline spills is considered to be a function of operation time and pipeline length. Historically, the U.S. rate of crude spills (1968-73 data base) in pipelines has been about 185 per year for an estimated exposure average of 145,000 miles of pipeline. This is 128 x $10^{-5}$/year/mile (also expressible as 1.28 spills/year/1000 miles) compared to a European rate of 110 x $10^{-5}$/year/mile. However, the historical data base includes pipe in excess of 30 years of age. It is considered appropriate to adjust the spill basis for new pipelines in a manner such as:

| Failure Mode | Historical Basis | Projected Basis New Pipe |
|---|---|---|
| External Corrosion | 54 x $10^{-5}$/yr/mi | 5 x $10^{-5}$/yr/mi |
| External Equipment | 32 | 24 |
| Defective Pipe | 12 | 5 |
| Miscellaneous | 9 | 7 |
| Internal Corrosion | 9 | 4 |
| System Defects | 5 | 2 |
| External Events | 5 | 2 |
| Defective Repairs | 2 | 1 |
| | 128 x $10^{-5}$/yr/mi | 50 x $10^{-5}$/yr/mi |

If a 42-mile pipeline were kept full of oil, as is standard practice in order to take advantage of additional storage volume and to simplify operations, the estimated spill risk per year would be:

(42 miles) (50 x $10^{-5}$/yr/mi) = 0.021/year.

The chances of spills over the 22-year life of the project can be computed from the binomial formula:

$$p(k) = \frac{y!}{(y-k)!k!} p^k n^{y-k}$$

where: p = chance of having a spill per event

n = chance of not having a spill

y = number of events

k = number of spills

or $p(0) = n^{22}$ - chance of no spills in 22 years

$p(1) = 22\ pn^{21}$ - chance of exactly 1 spill in 22 years

$p(2) = 22\ (\frac{21}{2})\ p^2\ n^{20}$ - chance of exactly 2 spills in 22 years

+ . . . . . . all other spills

Thus, $(0.979)^{22}$ = 62.69% chance of no spills in 22 years.

$22(0.62693)(\frac{0.021}{0.979})$ = 29.59% chance of 1 spill in 22 years.

$(21/2)(0.29586)(\frac{0.021}{0.979})$ = 6.66% chance of 2 spills in 22 years.

and a 1.06% chance of 3 or more spills.

There is a small systemic error introduced by the computational method, which excludes the chance of 2 spills in 1 year. This chance can be computed from daily risk and is negligible:

$$66430\ (0.999942)^{363}\ (0.000058)^2 = 0.02\%$$

If the pipeline were emptied of oil when not in use, the period of exposure would become:

5 fills: (30 million bbl x 5)/50,000 bbl/day = 3000 days

5 empties: 150 days x 5 = 750 days

3750 days = 10.3 yrs.

The spill probability is then:

none: $(0.979)^{10.3}$ = 80.36%

one: $10.3(0.80364)(\frac{0.021}{0.979})$ = 17.76%

two: $(9.3/2)(0.17755)(\frac{0.021}{0.979})$ = 1.77%

Thus, there is less risk than would be incurred by keeping the pipeline full of oil at all times.

The spill probabilities for each watershed can be computed in proportion to the length of pipeline within each watershed (see Table 4.3-3):

| Watershed | Percentage of Total Pipeline Length Within Watershed |
|---|---|
| Grand Saline Creek | 16.9 |
| Lake Fork Creek | 50.1 |
| Big Sandy Creek | 5.5 |
| Sabine River Basin | 14.6 |
| Big Cypress Creek | 12.9 |

In considering risk reduction by increasing pumping rates and cutting down the use period, it is axiomatic that the pumping pressure must be within the pipeline design rating. The pipeline itself is at risk during standby periods even if purged of oil; there is a purging fluid spill risk instead of an oil spill risk.

The maximum credible spill for the pipeline can be judged from various combined static and pumping losses. The maximum pumping rate in order to handle 30 million barrels in 150 days would be about 140 barrels per minute. A 22-inch line would contain about 2500 barrels per mile. The leak detection capability varies with the size of the leak. However, a state of the art system is assumed:

| Break Severity | Loss Description | | Volume Of Oil Loss |
|---|---|---|---|
| Total Break: | 1 mile of line + 10 minutes pumping | - | 4,000 barrels |
| 10% Break : | 1 mile of line + 1 hour pumping | - | 3,340 barrels |
| 2% Break : | 1 mile of line + 12 hours pumping | - | 4.516 barrels |

These situations are contrived by assuming worst conditions. The metering system should be able to react to a cumulative difference of 200 barrels in one hour or more, but could be set for lower sensitivity to avoid unnecessary shutdowns due to line operating pressure surges. A maximum credible spill of 5,000 barrels is assumed. Suction can be applied to the pipeline from the pumping station or terminal to minimize oil loss after shutdown.

The average crude spill from the Office of Pipeline Safety data base (DOT, 1969-74) is 1083 barrels. The size distribution may be approximated as:

| Spill Size | Percent Occurrence | Contribution To Expectation |
|---|---|---|
| Under 100 bbl | 49% | 245 bbl |
| 1000 - 2000 bbl | 45% | 675 bbl |
| 2000 - 5000 bbl | 6% | 210 bbl |
| | | 1130 bbl |

1130/1083 bbl = 4.3% error.

G.2 Tanker Spills

Tanker spill risk modes include collisions, ramming (collision with fixed objects), structural failures (generally leaks), foundering (buoyancy loss), fire and explosions, groundings, and breakdowns. For transport by 30 MDWT tankers through Sabine Pass and up the Neches River to Nederland, the accident rate (resulting in spills) is taken at 0.0758 spills per vessel-year. Approximately 143 round trips, at 2 days each, would be required for each fill period (30 millions barrels). In addition, a port call spill incident rate of $2.6 \times 10^{-4}$ is projected for tanker movements at Nederland. Thus 0.097 spills per fill, or 0.485 spills during the assumed project lifetime, are expected.

Based on data for accidents in U. S. harbors (U. S. Coast Guard, 1973) and data on world tanker accidents (J. J. Henry, 1973), the average size of oil spills resulting from a tanker accident is taken to be 770 barrels. The size distribution of spills can be determined by numerically fitting the applicable probability function f(s) to the expectation integral:

$$\int_0^\infty sf(s) = 770$$

The probability function that is judged most applicable is the log normal, because of its use in describing many natural random events (earthquakes, rainfalls), and its position in the theory of extremes:

$$f(s) = \frac{1}{rs\sqrt{2\pi}} \exp\left(- \ln s/s_0\right)^2 / 2r^2$$

where $s_0 = 770$, and r is between 1.1 and 1.5

Published numerical fits of oil spill data have focused on gamma-family distributions, which diverge from log normal only at the upper extreme. The distribution given in Table 4.3-3 for the 30 MDWT tanker transport shows the numerically approximate result:

| Size (bbl) | Percent Occurrence | Contribution to Expectation (bbl) |
|---|---|---|
| 0 - 200 | 25.8 | 25.8 |
| 200 - 500 | 26.9 | 94.2 |
| 500 - 1,000 | 30.1 | 225.8 |
| 1,000 - 2,000 | 11.9 | 178.5 |
| 2,000 - 5,000 | 3.99 | 139.7 |
| 5,000 - 10,000 | 0.97 | 72.8 |
| 10,000 - 20,000 | 0.20 | 30.0 |
| 20,000 - 50,000 | 0.03 | 10.5 |
| 50,000 - 60,000 | 0.001 | 0.6 |
| | | 777.9 |
| | | (1 percent error) |

This distribution has not been carried to infinite size, but has been truncated at a maximum credible size of 60,000 barrels. The maximum credible size is the largest spill which can reasonably be expected from tanker accidents in the river. The basis for such a limit is both physical and actuarial. The physical basis depends upon (1) compartmentalization of tanks so that containment integrity of most of the tanker remains unimpaired after a collision; and (2) water sealing the tanks when their water level rises above the rupture. The actuarial basis depends upon the fact that rupture of more than two compartments in the primary (initial) failure mode is extremely rare.

## G. 3 Tanker Transfer Spills

The two most generally applied measures of loading and unloading spill occurrences are:

a. Volume loss rate: The amount of gross throughput spilled over a substantial operating period, generally ranging from $0.5 \times 10^{-6}$ to $9 \times 10^{-6}$ units spilled per unit throughput.

b. Lightering spill frequency: The number of spills per tanker call, generally ranging from 1 per 18 to 1 per 20.

U. S. data collection rules were changed in 1970, requiring many terminals to include as an event those spills that create a sheen on the water. (Some operators had done this previously). The effect of including more small events is to shift the average spill size to rather low values. It has been observed that wave and/or roughness exposures increase the frequency of transfer spills. It is possible that average spill size may be correlated to cargo sizes and pumping rates. Such trends can be noted in comparing records of different ports, but have not been correlated into a form suitable for predictive estimation.

An estimate of $0.3 \times 10^{-6}$ for the volume loss rate in sheltered single point and conventional moorings was made in a 1974 projection for Washington State (Oceanographic Institute of Washington, 1974). Part of the data base used in that study was supplied by the Standard Oil Company of California, for which the pertinent parameters are (COFRC, 1975):

Volume loss rate - $1 \times 10^{-6}$
Spills per port call - 1 in 62.5
Average spill size - 7.1 bbl

These data covered two sites, one of which had a port call record of one spill per 120 calls. This was the more sheltered site, and its performance record is often used as an estimate of the unloading spill frequency. Loading spills have been generally documented as more frequent than unloading spills, but applicable exact comparisons are not available. The spill frequency at Nederland has been estimated to be 1 in 90 tanker calls to be conservative.

The volume spill rate of $0.5 \times 10^{-6}$ may be reasonable, but a more pessimistic rate of $1 \times 10^{-6}$ has been assumed for unloading the vessels. For loading spills, the volume spill rate was assumed to double to $2 \times 10^{-6}$. Thus, lightering operations have a spillage rate of $3 \times 10^{-6}$.

The resultant projected transfer spills per fill cycle become:

Lightering operations

| | |
|---|---|
| Number of calls | 143 |
| Number of spills | 8 (1 in 18) |
| Volume spilled | 90 barrels ($3 \times 10^{-6}$ of throughput) |
| Maximum credible spill | 1000 barrels |

Nederland Terminal Transfer

| | |
|---|---|
| Number of calls | 143 |
| Number of spills | 1.6 (1 in 90) |
| Volume spilled | 30 barrels ($1 \times 10^{-6}$ of throughput) |
| Maximum credible spill | 500 barrels |

## G.4 TERMINAL SPILLS

The average rate of occurrence of terminal spills in the Department of Transportation data base (1968-73) is about 50 per year. For an estimated 9.1 million barrels per day throughput average associated with the systems reporting these discharges, the accident rate is $1.5 \times 10^{-8}$ incidents per barrel throughput. However, oil moving from production to consumption can pass through from 5 to 15 separate terminals, so the average incident rate per terminal is much lower.

The chance of spilling oil in a terminal also varies with the number and type of operations involved. Distributing oil among several tanks is more risk-prone than filling a single tank, because about a sixth of the spills are due to operator error, rather than equipment failures. The Kleer terminal, with a single reservoir, is the simplest possible type of terminal.

A spill frequency of $1.5 \times 10^{-9}$ per barrel (10% of total rate) can be assigned to an average U.S. terminal. Because of the comparative simplicity of the Kleer terminal--the lack of switching operations and interconnecting linkages--this terminal is estimated to have a failure rate of 1/3 the U.S. 1968-73 average, or $5 \times 10^{-10}$ events per barrel throughput. Since the throughput per fill or withdrawal is 30 million barrels, the frequency of terminal spill per fill is .015, or 1 chance in 67.

The chance of spills in 10 fill/empty events is:

| | | |
|---|---|---|
| no spills: | $(0.985)^{10}$ | = 85.97% |
| 1 spill : | $10(0.85973)(\frac{0.015}{0.985})$ | = 13.09% |
| 2 spills : | $4.5(0.13092)(\frac{0.015}{0.985})$ | = 0.90% |

A negligible error is introduced by a computing basis that excludes the chance of 2 spills in one filling. By taking the chance per million barrels, one finds that chance of 2 spills in 1 filling as:

$$435\ (0.9995)^{28}\ (0.0005)^{2} = 0.011\%$$

which is insignificant.

The use of throughput as the parameter basis for exposure may not be completely valid. Volume in storage would appear to be equally suitable as a risk variable in terminals, and some combination of these two may be the most appropriate descriptor of an average terminal spill risk. Adequate data to establish such a descriptor do not exist, so the use of judgemental models in describing terminal spills is necessary. Underground salt dome storage terminals, however, are not typical of the average terminal in the 1968-73 base. If terminal spill risk is equally dependent on events related to throughput and events related to volume, the assertion that the Kleer (and similar) terminals should result in 1/3 the spill frequency of an average terminal is equivalent to assuming that volume-related spills have been virtually eliminated, and throughput-related spills (mainly pumping) have been reduced 30 percent.

The average spill size for terminals is not separable from that for pipelines, since both are reported in the same data base. The average spill is reported to be 1083 barrels. However, with the elimination of storage reservoir spills (Winnsboro storage tanks are contained within dikes, thus eliminating the environmental exposure), Kleer becomes an atypical sample. Using accidental draining of the terminal piping system as an average instead of the historical value, the estimated average spill would be 300 barrels.

The maximum credible spill size which would be determined using situations applicable to pipelines (full flow rupture, and slowly detected partial rupture plus drainage from the system) leads to a maximum credible spill of about 1000 barrels for the terminal. However, since the terminal is an extension of the pipeline, the maximum credible spill size has been taken arbitrarily (and conservatively) as the same as a pipeline (i.e., 5000 barrels). Also, with pipeline supply, the terminal could have periods of very low staffing levels, which increases the chance of larger spills.

The fitted spill distribution (by histogram approximation) is:

| Spill Size | Percent Occurrence | Contribution To Expectation |
|---|---|---|
| 0 - 200 bbl | 45.5 | 34.10 (adjusted) |
| 200 - 500 | 41.5 | 145.25 |
| 500 - 1000 | 10.0 | 75.00 |
| 1000 - 2000 | 2.5 | 37.50 |
| 2000 - 5000 | 0.5 | 17.50 |
| | | 309.83 (3% error) |

## G.5 COMMENTS ON TECHNICAL ASPECTS OF RISK

### G.5.1 Maximum Spills

The risk analysis in an EIS is aimed at revealing both a reasonable picture of what is likely to occur, and also a reasonable picture of the worst that may occur. The use of maximum credible spill events which are not the worst imaginable might seem incompatible with this latter goal. In particular, discounting the chances of a spill of 30 million barrels may not seem reasonable. A pipeline spill of 160,000 barrels has been recorded in the United States; also, a barge spill of 5000 barrels. The key ingredient in those large spills was negligence. The pipeline was reported to have flowed ruptured for 10 days. The barge was loaded with an open porting valve, and no one noticed. It can be considered likely that at some time in this program, someone will repeat such an error, but it will not go unnoticed beyond the required inspection period. There are possible ways to spill the cavern contents (for example, by permitting uncontrolled solution mining in adjacent salt), but these can be disregarded as results of irresponsible actions.

Another common factor in catastrophic incidents is frequently unrecognized risks. The primary factor in discounting the chances of releasing the total cavern contents at Kleer Mine is recognition of the necessity of a fail-safe shaft seal.

### G.5.2 Expectation

Statements of expectation, such as: "the expected number of spills is 0.8" and "the spill expectation is 25 barrels per year, with maximum credible spill of 5000 barrels," frequently confuse readers not familiar with the concept. Expectation is the average over a hypothetical, large sample. If the event described above were hypothetically replicated 5 times, then a spill would be expected in 4 of them. If the situation were hypothetically extended over several thousand years, some of the events would be of 5000-barrel size.

The larger spills have low probabilities of occurrence, such that their return periods (inverse of the annual probability) are long. A 2000- to 5000-barrel pipeline spill has a return period of around 750 years. About 5000 years would be needed to provide a sample period in which the spectrum of events would approach the statistical average conditions, compared to the assumed 22 years of project lifetime. The spill could in fact occur during the 22-year period, but it is unlikely.

### G.5.3 Distribution

The statement that spill sizes are log-normally distributed means basically that the larger spills tend to occur less frequently than smaller ones. The use of spill size intervals (histogram fitting) and the truncation of the distribution at a maximum credible spill size introduces some mathematical error, relative to the log normal function, which does not detract from the descriptive usefulness of the results.

The suitability of the log normal distribution has been demonstrated only for certain types of spills, but not for the extremes of those spills. Its use in predicting pipeline and terminal spill descriptions is assumed here, based upon: (1) the fundamental position of the log normal in the theory of extremes (predicting large events from a sample of small ones), and (2) the wide range of random causes generating spills.

### G.5.4 Accuracy

The parameters used to describe spill risks are subject to many sources of error, such as:

- Errors in the data, primarily size estimation of reported spills.
- Error in the exposure base.
- Use of incomplete exposure bases (as discussed for terminal spills).
- Finite size of the data record.
- Systemic changes which change event probabilities from those recorded in the data base. In many instances, such systemic changes have been projected in the parameters.

The accuracy of the data typically ranges from ± 2 to ± 10 percent; the accuracy of the exposure base, from ± 5 to ± 10 percent; and the overall accuracy of projection, from ± 10 to ± 20 percent. With the introduction of judgemental factors and approximations, probable error could range even more widely. Because the full impact of regulatory action in reducing casualty and operating spills has been largely ignored in the spill estimations, the most likely error has been to overpredict spillage.

The major source of variability in the results lies not in errors in the projection parameters, but with the random occurrence of events over a short time period. Suppose there is 1 spill in 22 years from a pipeline rupture. Such a spill could involve any size outflow (with the larger less likely) from 10 to 5000 barrels. The variability of impact from the Kleer project makes the question of whether the return period for a 2000- to 5000-barrel spill should be 850 or 650 years, instead of 750 years, somewhat academic. In the context of storing one billion barrels, however, the error is more significant. If the expectation of spillage (0.001%) is applied to one billion barrels, one is speaking of 10,000 barrels ± 2000 barrels as the expectation. However, one cannot say that other storage methods and locations in the program would have as low an expectation as the salt dome caverns.

## G.6 DEGRADATION AND CLEANUP OF OIL

The ideal spreading of petroleum on the surface of water involves 3 phases. The areal spreading passes first quickly through a gravity controlled regime, then into a viscous spreading regime (area varying as the square root of the time) and finally a surface tension spreading regime (area varying as the 3/2 power of time). Eventually, at a theoretical ultimate area, spreading will cease because surface tension forces between the oil and water are balanced.

In nature, oil slicks tend to be patchy, with some lumping of oil globules and oil-water emulsions forming if there is any turbulent mixing. The ideal homogeneous model remains a convenient description of averaged conditions, however. The shift to surface tension spreading occurs within 10 hours for a 2000-barrel spill, and within 20 hours for a 10,000-barrel spill. The average surface density of the slick at the onset of surface tension spreading is about 10 barrels per acre; at the theoretical spreading limit, the density is about 1 to 2 barrels per acre. Wind can accelerate spreading up to a factor of 10. The spreading velocity at the onset of surface tension spreading is a deceptively low 0.03 feet/second in still water, and up to 0.3 feet/second with the wind.

Oil skimmers concentrate the oil film behind sweeping booms, and then skim and separate the film, frequently with an oleophilic wick or belt. The relative velocity of a boom with respect to the water is limited to about 1.0 knot (maximum 1.5 knots) to avoid underflow of the oil. In open bay waters, 150- to 400-foot widths can be covered (20 to 50 acres per hour). In waters restricted by banks, jetties, sand bars, etc., widths of 15 to 50 feet only can be achieved (2 to 7 acres per hour).

Booms across streams or tributaries are effective in holding oil spills in or out of low current areas and are effective in reservoirs. Booming rivers and streams will not be effective if the current exceeds 1 knot, the stream is too shallow, or the stream is rocky and turbulent. The recovery effort has to be multi-staged, picking up as much as possible at each strike point. The use of surface tension agents (herders) in channels and other enclosed waters requires advance approval in developing the spill contingency plan. They may not be suitable for reservoirs. Because of toxicity, it is unlikely that detergents will be used more than sparingly for cleaning boats and, in some cases, rocks. Sinking agents are currently explicitly prohibited. EPA regulations also preclude petroleum-based oil solvents for cleaning vessels since their ultimate deposition in the water is equivalent to a spill--i.e., creates a sheen. Such solvents are also toxic to local aquatic life.

If a spill is contained in an area with sand-defined banks (as opposed to marsh edge along the channel), then between 60 and 75 percent of the oil can ultimately be recovered. If the spill disperses into a marsh, or dissipates into open water, recovery efficiency will decline. Spills occurring during squally, windy weather may also be dispersed by the wind, reducing ultimate recovery.

Up to 25 or 30 percent of the lighter oil fractions can be assumed permanently lost into the air and water (primarily the air) by evaporation and dissolution. The ultimate fate of oil not evaporated or recovered will depend on the exposure to air and potential microbial action. The three major processes are:

1. Degradation - chemical breakdown and consumption of the material by bacteria, photo-oxidation, or other chemical paths.
2. Weathering - continuing evaporation of lighter fractions until only residue tars remain.
3. Preservation - if globules form which weather at the surface, creating a hard protective shell, inner portions are protected from further degradation and will be preserved.

For oil deposited in wetland areas, slow degradation is the most probable ultimate fate. For globules in the water, eventual deposition in sediments and partial preservation in the sediments is likely.

APPENDIX H

OIL SPILL CONTAINMENT AND
RECOVERY PLAN

APPENDIX H

## OIL SPILL CONTAINMENT AND RECOVERY PLAN

### OIL SPILL CONTINGENCY PLANS

A Spill Prevention, Control and Countermeasure Plan (SPCC) must be prepared by an operator of a nontransportation-related oil facility that might be capable of discharging by accident, equipment failure, or operator error enough oil into navigable water of the United States to create a visible sheen, discoloration, subsurface sludge, or emulsion, pursuant to the provisions of the Federal Water Pollution Control Act, P.L. 92-500 (Amendments of 1972). The Kleer Mine facility, therefore, would be subject to the provisions of these regulations. Departments, agencies, and instrumentalities of the Federal government are subject to the regulations to the same extent as private operators. The purpose of the SPCC is to outline the method of operations, measures, and equipment to be used to prevent spills, and to describe the available equipment to be used and the planned program of response in the event of a spill.

The pipeline may or may not be a transportation facility, as defined by a memorandum of understanding between the U.S. EPA and the Department of Transportation (35 FR 11677 et seq.). The line lies intrastate but is engaged in the interstate transport of oil. Whether it would come under Texas guidelines for the SPCC, Department of Transportation, or the EPA (i.e., either 40 CFR 109 or 40 CFR 112 as the basis), the thrust of the requirements is the same.

In the event of a spill, the EPA must be notified. Under the National Oil and Hazardous Materials Pollution Contingency Plan (40 CFR 1510), an Environmental Response Team headed by an On-Scene Coordinator (OSC) will take steps to assure that the best and most appropriate cleanup measures are taken. The operator of the facility involved in the spill is primarily responsible for cleanup efforts. The operator could be either the FEA, or a contractor. The OSC may authorize the use of various cleanup agents, sorbents, or other chemicals, if they can assist in cleanup efforts without increasing ecological stress or damage. Since either drinking water sources or primary contact recreational waters would likely be involved in a spill from the

Kleer facility or pipeline, the use of chemical agents would be very closely regulated. If at all permitted, only those agents meeting prior approval would be used according to plans prepared in advance as part of the SPCC.

If necessary, an emergency strike force may be organized to commit available manpower and equipment resources to the containment and cleanup effort. Such a situation might arise during flood periods, when commercial cleanup contractors might not have sufficient equipment to risk operations. Helicopter support as a safety backup to skimming operations is one example of the support that a strike force would be able to provide, but which is not generally available to commercial operators.

If wastewater or treated wastewater should be discharged from the Kleer Mine facility as a result of pipeline purging, or collection of oily rainwater behind protective berms, then the procedures for the National Pollutant Discharge Elimination System (NPDES) will apply to the facility (40 CFR 125, as amended) under PL 92-500, sections 402 and 405. Primary concerns in meeting the requirements for the discharge permit would be to insure that accumulations of oil could not accidentally discharge through the waste system untreated, and that toxic rust-inhibitors from the purging water would not be discharged. Biodegradable rust inhibitors are now available, but by their nature, they are not as persistent as the metallic salt-based types once used, and they have to be replaced more often.

A complete SPCC does not have to be prepared until the facility begins operations. For purposes of the Environmental Impact Statement, it is sufficient to outline the elements of such a plan as the efficacy of cleanup technology pertinent to the spill risk associated with the Kleer storage program.

## FACILITY SPILLS

SPCC guidelines (40 CFR 112) provide that where experience indicates reasonable potential for equipment failure, appropriate and/or diversionary structures or equipment to prevent discharged oil from reaching a navigable water course should be used, including:

1. Dikes, berms, and impervious retaining walls.
2. Curbing.
3. Culverting, gutters, or other drainage systems.
4. Weirs, booms, or other barriers.
5. Spill diversion ponds.
6. Retention ponds.
7. Sorbent materials.

Although the laws are aimed at the primary constitutional basis of federal authority, namely navigable waters and their tributaries, emphasis on ecological resource protection at the site would be aimed not at Grand Saline Creek, but at the saline marshland adjacent to the facility (see Appendix I). Unfortunately, Grand Saline Creek is exposed to other spill sources, such as the pipeline; the Sabine River, its discharge receptor, also has other oil spill sources. Thus, there is little environmental gain in considering trying to shield the entire watershed from a pipeline rupture. Any spills near the facility should be contained behind berms, and any pipeline spills near the facility should be diverted from the marsh. The cavern filling and emptying operations in themselves should not generate oily wastewater at the site since no water seeps into the salt cavern. Oily wastewater from a small spill, leak, equipment cleaning, and pipeline purging operations would be passed through an oil separator, some type of reactor, such as an activated filter, and then into a sump. Outflow from the sump would be regulated to prevent any oil from being discharged.

The elements of the preventive plan at the site would involve an approach based upon routine inspections of equipment on a regular basis, and upon procedural routines that constantly seek differences in the amounts of oil being moved. The plan would include:

1. <u>Monitoring of Flow Volumes</u> - During oil transfers, automatic pressure monitoring equipment will be relied upon for quick detection and response to any major failures in the system. Small losses of oil will

be detected by comparison on a regular (hourly) basis of metering through the facility, by the readings at the Kleer facility and at the Winnsboro Terminal. Two automatic systems would be used: 1) a sensitive system would be used to advise of all pressure surges, pump flutter, or other minor conditions; and 2) a less sensitive fault detector would be used to shut down the system automatically upon alarm.

2. Emergency Shutdown Capability - This procedure would allow anyone spotting a leak at the facility, such as in the meter provers, to activate alarm procedures, shutting in all valves. Activation switches would be located at several strategic points, including one at the outer perimeter. All major control valves would have manual overrides so that they could be operated to close the system in a power failure. Off and on positions of all equipment must be clearly indicated.

3. Personnel and Training - Adequate numbers of personnel must be on hand during operations to ensure safe operation, and to assist in emergency containment routines. Because of the automation that can be incorporated into terminal designs, adequacy would probably be set by the number of persons who could close all necessary valves manually following a power failure within a set period of time. Persons designated "in charge" should pass qualification demonstrations and be able to communicate adequately with all other personnel in the event that some shifts may use the Spanish language.

4. Operating Procedures - These procedures would specify the operation of the meter proving loops, startup of pumps, selection of lines, and site inspection procedures. The most effective prevention of large spills from small leaks is routine inspection of the area on a regular, frequent basis. Other regulations establish lighting standards, equipment specifications, and record keeping. The use of a checklist to ensure procedure compliance would be required. Any employee should be authorized to shut in the system upon detection of a leak or malfunction, and no employee should be authorized to start up the system without conference after a problem shut-in. If the system is controlled remotely, i.e., if equipment at Kleer should be controlled by operators at Winnsboro, such control should not be permitted until relinquished by the supervisors of the remote facility.

5. Equipment Maintenance Program - Equipment service and life is documented. Regular pressure and stress tests are conducted; bolt and coupling flanges, coupling seals, and gaskets, are examined for wear, abrasion, and so forth on a regular basis.

Staffing competent, trained personnel for positions that are not permanent (i.e., those lasting only for a filling or emptying cycle) may be difficult. Training of personnel will have to be emphasized. During emptying cycles for strategic drawdown, it could be assumed that some personnel will be available from the petroleum industry. Much of the regional labor pool in Texas has some familiarity with the petroleum-related equipment as a result of the background of petroleum activities throughout Texas, Arkansas, and Oklahoma.

The elements of the cleanup plan would include:

1. Inspection of the Berms - Deterioration of the berms due to rain erosion, varmint (groundhogs, rodents, and so forth) burrowing, cattle, and so forth would be promptly repaired. Rodent burrows could require grouting and/or screens in the ground to prevent undermining of the barriers.

2. Containment of Spilled Oil - Accumulations of oil would be promptly collected and removed from exposure to rainwater, which could lift them over a berm or otherwise disperse them. Any zones of accumulation would be checked to ensure that soil impermeability was sufficient to prevent migration of the oil. Supplies of sorbent material will be available for fixing spills too small for liquid recovery.

3. Response Mobilization - If any oil should escape into the environment because of the loss of dike integrity or unusual conditions (such as sprayed oil), guidelines for notifying and mobilizing additional response teams would be followed.

PIPELINE SPILLS

The first actions in the event of a pipeline spill will be to shut down the pumps, apply suction on the line, and attempt to plug the break to reduce static draining of the line. Because of the rolling nature of the terrain, the static draining of the line would be expected to be limited for a break anywhere along the route. The National Oil Spill Contingency Plan requires that closing off the escape of the oil shall receive first priority.

Immediately upon location of the line rupture and estimation of the amount of oil spilled, a response team would be organized according to a zone plan. Strike points at which equipment would have access to the watercourses can be established in advance as part of the SPCC. Because the mobilization and assembly of the teams will require from 4 to 12 hours, advance planning of the contingency is important.

It is expected that cleanup contractors serving the petroleum industry in the region would be drawn upon. Some of these would actually be oil industry cooperatives, which are available for emergency use on a fee basis. Personnel would have to be recruited. This may be done in advance on the basis of volunteer fire departments. Booming equipment for the reservoirs would probably be flown in from Gulf locations, since the spill risks are too low to justify stockpiling them.

# APPENDIX I

## THE ECOLOGY OF THE GRAND SALINE SALT MARSH

APPENDIX I

# THE ECOLOGY OF THE GRAND SALINE SALT MARSH

## LOCATION

The Grand Saline salt marsh is located just northeast of the Morton Salt Company mine, near Grand Saline, Van Zandt County, Texas (Figure I-1), Grand Saline is located approximately 70 miles east of Dallas.

The marsh is within the flood plain of Grand Saline Creek and its tributaries, with an elevation varying from 360 to 362 feet above sea level. The marsh is flooded 3 to 7 times during most years and remains flooded for periods of 2 to 10 days. The stream channels within the marsh are 2 to 6 feet deep and constitute the deepest water in the marsh.

## HISTORY

The Grand Saline salt marsh has been utilized by man for some time. The earliest documented reference to the marsh cites the area as a prime source of salt for the east Texas Indian tribes in the early 1830's (Grand Saline Sun, 1976). Subsurface brine from the marsh was also evaporated to produce salt for the Confederacy during the Civil War. Approximately 200,000 pounds of salt was produced daily from the marsh for the duration of the war (Buckley, 1874).

While the historical aspects of the marsh could be developed to a much larger extent, the information presented herein provides adequate background to indicate that it has been subject to disturbances over an extended time period. Consequently, although the marsh is a unique community for this part of Texas, it cannot be considered pristine.

## CLIMATE

Average rainfall is approximately 43 inches and the average growing season 250 days. Monthly temperature average ranges from 35$^{o}$F in January to 94$^{o}$F in July. Prevailing winds are generally from the southeast with occasional northerly shifts during the winter.

## GEOLOGY

### General

There are 17 known interior salt domes in eastern Texas and several in northern Louisiana. Powers and Hopkins (1922) identified 5 characteristic manifestations of interior salt domes. These are: 1) barren or sparsely covered saline prairies; 2) springs of either fresh, slightly brackish or mineralized water; 3) exposures of tilted rocks; 4) outcrops of older formations; and 5) peculiar topographic forms consisting of a central depressed area surrounded by a ring of hills with steep slopes facing inward, or else of a central hill surrounded by stream courses that form a circle.

Mulchberger, Clabaugh and Hightower (1962) noted a similar topographic expression of east Texas salt domes: "The topographic expression of the salt domes is commonly a central low area with saline springs and marshy areas, surrounded by low cuestas and circular drainage."

### Specific

The Grand Saline salt dome is expressed at the surface by outward, radial dips in the Wilcox formation (the only formation exposed in the vicinity of the dome) and a topographic depression occupied in part by the Grand Saline salt marsh. The marsh is the result of ground water forced up and over the underground salt dome, carrying dissolved salts to the surface through springs and seeps (see Figure 3.3-4).

## SOILS

### Introduction

Examples of soils in the marsh are described and included. These soils are wetter, contain a much higher salt content and support different vegetation than the associated Nahatche soils in the flood plain of Grand Saline Creek. There are no established soil series. Each soil has been classified according to the standard of the National Cooperative Soil Survey -- the national system of soil classification.

A specific location is provided for each soil described. An approximate location is shown in Figure I-1. Soil colors are for moist soil conditions unless otherwise noted. Munsell color charts were used to determine soil colors. Soils are described using standard terminology.

An analysis was made of each layer of the soils described, and results are included. The hydrometer method was used to determine particle size or soil texture. The salts were not extracted from the samples and may have influenced the results to some extent.

Physical and Chemical Characterization

A. Site 3 East

Classification: Fine, mixed, acid, thermic Aeric Haplaquents

Location: Intersection of U.S. Highway 80 and Farm Road 857 in Grand Saline, south 0.6 mile on Farm Road 857 to small bridge; 830 feet north, 56 degrees east of bridge. This site is under a thick stand of inland salt grass.

Horizon Description:

A1 -- 0 to 5 inches, dark gray (10YR 4/1) silty clay, light gray (10YR 7/1) dry, with many fine distinct dark yellowish brown mottles; weak medium subangular blocky structure; friable moist, very hard dry; many fine and medium roots; neutral, pH 6.6; clear smooth boundary.

A12 -- 5 to 10 inches, dark grayish brown (10YR 4/2) silty clay, brown (10YR 5/3) dry, with common fine and medium distinct light gray and yellowish brown mottles; weak coarse platy structure; firm moist, very hard dry; common medium and fine roots; slightly acid, pH 6.3; gradual boundary.

C1 -- 10 to 20 inches, mottled dark grayish brown (10YR 4/2), dark gray (10YR 4/1) grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) clay; massive; very firm moist, very hard dry; few fine and medium roots; strongly acid, pH 5.5; gradual boundary.

C2 -- 20 to 48 inches, dark gray (10YR 4/1) clay, with few fine strong brown and grayish brown mottles; massive; very firm moist, very hard dry; few fine roots; slightly acid, pH 6.0.

Site 3 East Hydrometer Particle Size Data

| Horizon or Layer | Thickness (Inches) | % Sand | % Silt | % Clay | USDA Texture |
|---|---|---|---|---|---|
| A11 | 0-5 | 14 | 42 | 42 | silty clay |
| A12 | 5-10 | 10 | 42 | 48 | silty clay |
| C1 | 10-20 | 10 | 32 | 58 | clay |
| C2 | 20-48 | 16 | 32 | 52 | clay |

B. Site 1 South

Classification: Fine loamy, mixed, thermic Aquollic Salorthids

Location: Intersection of U.S. Highway 80 and Farm Road 857 in Grand Saline, south 0.6 mile on Farm Road 857 to small bridge; 1500 feet south, 15 degrees west of bridge. This site is currently void of vegetation.

Horizon Description:

A1 -- 0 to 1 inch, brown (10YR 5/3) fine sandy loam, very pale brown (10YR 8/3) dry; vesicular structure; very friable moist, soft and crusty dry; slightly acid, pH 6.5; abrupt smooth boundary.

A12 -- 1 to 3 inches, dark brown (10YR 3/3) fine sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; friable moist, hard and crusty dry; few fine and medium roots; slightly acid, pH 6.5; clear smooth boundary.

C1 -- 3 to 17 inches, mottled pale brown (10YR 6/3) brown (10YR 5/3) and yellowish brown (10YR 5/6) loam; weak medium and coarse subangular blocky structure with common fine and medium vesicles within peds; very friable moist, slightly hard dry; few fine and medium roots; very strongly acid, pH 4.7; clear smooth boundary.

C2 -- 17 to 36 inches, dark grayish brown (10YR 4/2) silty clay loam with common fine and medium distinct gray, yellowish brown and few fine distinct light gray mottles; massive; firm moist, very hard dry; few fine and medium roots; extremely acid, pH 4.3; gradual boundary.

C3 -- 36 to 48 inches, dark grayish brown (10YR 4/2) silty clay, with few fine distinct yellowish brown and grayish brown mottles; massive; firm moist, very hard dry; few fine roots; very strongly acid, pH 5.0.

<u>Site 1 South Hydrometer Particle Size Data</u>

| Horizon or Layer | Thickness (Inches) | % Sand | % Silt | % Clay | USDA Texture |
|---|---|---|---|---|---|
| A1 and A12 | 0-3 | 62 | 24 | 14 | fine sandy loam |
| C1 | 3-17 | 46 | 38 | 16 | loam |
| C2 | 17-36 | 20 | 44 | 36 | silty clay loam |
| C3 | 36-48 | 18 | 40 | 42 | silty clay |

C. <u>Site 2 South</u>

<u>Classification</u>: Fine, mixed, thermic Aquollic Salorthids

<u>Location</u>: Intersection of U.S. Highway 80 and Farm Road 857 in Grand Saline; south 0.6 mile to small bridge; 900 feet south, 15 degrees west of bridge. This site is currently void of vegetation.

<u>Horizon Description</u>:

A1 -- 0 to 4 inches, very dark brown (10YR 2/2) clay, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; firm moist, very hard and crusty dry; very strongly acid, pH 4.7; abrupt smooth boundary.

C1 -- 4 to 9 inches, variegated platy layers of dark gray (2.5Y N4/) light gray (2.5Y N6) yellowish brown (10YR 5/6) and yellowish red (5YR 4/8) clay; firm moist, very hard dry; medium acid, pH 5.8; abrupt smooth boundary.

C2 -- 9 to 24 inches, dark gray (10YR 4/1) clay, with a few fine distinct light gray and reddish brown mottles; massive; firm moist, very hard dry; few fine and medium roots; slightly acid, pH 6.2; gradual boundary.

C3 -- 24 to 65 inches, dark grayish brown (10YR 4/2) clay, with common medium faint dark gray and light gray mottles; massive; firm moist, very hard dry; few fine roots; very strongly acid, pH 5.0.

## Site 2 South Hydrometer Particle Size Data

| Horizon or Layer | Thickness (Inches) | % Sand | % Silt | % Clay | USDA Texture |
|---|---|---|---|---|---|
| A1 | 0-4 | 28 | 18 | 54 | clay |
| C1 | 4-9 | 20 | 38 | 42 | clay |
| C2 | 9-24 | 24 | 32 | 44 | clay |
| C3 | 24-65 | 20 | 28 | 52 | clay |

## Relationship to other Saline Soils

The soils in the marsh are mainly clayey with textures of clay, silty clay and silty clay loam. Generally, clay content ranges from 36 to about 58 percent; silt content 18 to 44 percent; sand content 10 to 28 percent. In alluvial fans where small drains empty into the marsh and along natural levees of stream channels, the surface layer or upper part is sandier, with a texture of fine sandy loam or loam. Site 1 South is an example in an alluvial fan. These sandier sediments are deposited by flood waters from soils in the watershed of the surrounding area.

The marsh soils are unique to this area because of the high content of salts, especially sodium chloride. Soils in the surrounding area have an SAR (sodium absorption ratio) of generally less than 5 and a sodium content of less than 150 ppm (parts per million); the marsh soils have an SAR of 61 to 342 and a sodium content of 2445 to 58,313 ppm. Sea water contains about 35,000 ppm salts, mainly sodium. It should be noted that these samples were taken following heavy rains in early spring. Much higher salinities probably exist when evapotranspiration losses are high (in July, August and September).

Soils with a high content of salts along the Gulf Coast of Texas generally have an SAR of less than 30 and a sodium content of less than 15,000 ppm. These concentrations are lower than in the marsh soils.

Soils high in salts in the western part of Texas usually have an SAR of less than 30 and a sodium content of less than 15,000 ppm. However, these soils typically have a higher content of other neutral salts, such as calcium and magnesium, than the marsh soils.

The pH of the marsh soils ranges from 4.3 to 6.6. Soils in the surrounding area have a similar pH range. Saline soils along the coast and in west Texas commonly have pH values of 7.0 to 8.0. The low pH of the Grand Saline salt marsh soils is a result of several factors, mainly a high content of sulphates plus relatively low amounts of calcium and magnesium salts.

The organic matter content in the salt marsh soils varies from 2.16 to 0.28 percent. The upper 9 inches, or surface layers, contain greater amounts. There is generally a decrease in organic matter from the upper part of the soil to the lower part, which is typical in most soils. Soils in the surrounding area contain approximately the same organic matter content as the marsh soils.

## VEGETATION

The Grand Saline salt marsh supports a relatively sparse community of vegetation. For ease of discussion, vegetational aspects of the marsh will be discussed in relation to wetness. Floristic aspects are discussed separately in a single section.

About 70 percent of the marsh contains standing water or is wet throughout most years. This portion of the marsh supports halophytic (salt-tolerant) plant communities and is wetter, less saline and generally lower in elevation than areas void of vegetation. *Distichlis spicata* var. *stricta* is monodominant throughout the entire marsh in areas not characterized by potholes or pools. In these areas *Distichlis* was dominant to the exclusion of other warm-season species. However, *Phalaris caroliniana*, *Elymus virinianus* and *Alopecurus carolinianus* are frequently observed during the late winter and early spring.

The areas of *Distichlis* seem to pond water in their center. A brief study of microtopographic variation substantiated this observation (Lane, 1976). Because of the standing water in the central portion of a *Distichlis* stand, the plants around the margins generally exhibit the most robust growth. When the area is flooded, these plants apparently trap more silt and increase the elevation, ponding more water in the center and continuing the outward movement of a Distichlis stand. The occurrence of Distichlis rhizomes to a depth of 4 feet in unvegetated areas of the marsh lends additional credibility to this explanation. Moreover, Myrica cerifera, a species which requires relatively low salinities, colonizes these high areas. Evidence of a past history of such colonization by other species is shown by dead Maclura pomifora which stand scattered throughout unvegetated portions of the marsh (Figure I-2).

There are small depressions or "pot holes" within the vegetated areas, but most occur in the northeastern portion of the marsh east of Farm Road 857. Water in these ponds is some 6 inches to 3 feet deep. The "pot holes" are 5 to 30 feet across and 6 to 100 feet long.

At the pot hole perimeters, Distichlis abruptly disappears as a dominant and is replaced by Eleocharis lanceolata, which forms several concentric vegetational zones characteristic of the pot holes. As water depth increases, Eleocharis is replaced by a rather unusual combination of Scirpus maritimus var. paludosus and Scirpus californicus. Unique aspects of these two Scirpus species occurring together are discussed in the floristic section of this appendix. The final emergent species found in deeper water is Typha domingensis. When water depth increases to the point that emergent vegetation cannot survive, a dense growth of Potamogeton pusillus characterizes the ponds.

Most of the larger "pot holes" have all the previously mentioned zones; some smaller ones have only one or two. The portion of the marsh west of Farm Road 857 is interspersed with small, steep-banked ponds that are bordered by Distichlis and characterized by a dense growth of Potamogeton pusillus. In an effort to determine the effect of soil salinity on the zonal character of the "pot holes," soil samples were collected from each zone and conductivity determined from soil saturation extracts. The results are presented below:

| Zone | Conductivity μmhos |
|---|---|
| Distichlis | $7.8 \times 10^3$ |
| Eleocharis | $9.4 \times 10^3$ |
| Scirpus | $4.77 \times 10^3$ |
| Typha | $8.55 \times 10^3$ |

These conductivity data do not indicate any direct relationship between "pot hole" vegetational zones, salinity, and plant distribution. Although the short-term nature of the study precluded water depth measurements throughout the growing season, it is possible that water depth may well be the overriding environmental factor responsible for "pot hole" zonation.

## AREAS DEVOID OF VEGETATION

Barren areas currently with no vegetation comprise about 30 percent of the marsh. During the process of drying, the soils develop noticeable white salt residues that crust on their surfaces. The only extant vegetation on these areas are scattered aggregations of *Spergularia echinosperma*. However, *Spergularia* generally occurs relatively near *Distichlis* stands. The center of the crusted areas is totally devoid of vegetation.

These barren areas have produced vegetation in the past, as evidenced by plant roots to a depth of at least 4 feet in the soil. Aerial photographs of the area taken in 1940, 1950, 1958 and 1973 indicate that the vegetation pattern has changed continuously throughout the years (Figure I-1). This is attributed to changes in elevation caused by deposition of flood sediments and by action of the salt dome below.

The largest area currently void of vegetation is over 60 acres in the southern part of the marsh. It extends from the railroad track east to Farm Road 857. Other unvegetated areas are relatively small and are interspersed with areas supporting vegetation.

A part of the large unvegetated area is an old lake bed. According to the Soil Survey of Van Zandt County, published in 1928 (U.S. Soil Conservation Service), a 30-acre area in the southeast part of the marsh was previously inundated by a body of water referred to as Lake McCullough.

## FLORISTIC ASPECTS OF THE GRAND SALINE SALT MARSH

The distribution of species collected in the marsh was determined using Correll and Johnston (1970), Correll and Correll (1972), and Ungar (1972) as references. Further distribution checks were made using the herbarium collection at Southern Methodist University.

The marsh exhibits a mixture of both inland and coastal marsh species. For example, Distichlis spicata var. stricta and Scirpus maritimus var. paludosus commonly occur in inland salt marshes, while Spergularia echinosperma, Scirpus californicus and Potamogeton pusillus are species with strong coastal affinities.

The marsh contains at least one uncommon species, Eleocharis lanceolata, which Correll and Johnston consider rare in north central and northeast Texas. Cool season species such as Phalaris caroliniana and Elymus canadensis appear to be representative of this portion of the Post Oak Belt.

It is very possible that grazing pressure from domestic livestock has combined with salt production to alter both floristic and vegetational aspects of the salt marsh. The entire marsh has been heavily grazed on a seasonal basis for many years and still is. Evidence that grazing and/or salt extraction pressures have eliminated or severely reduced the abundance of some species within the marsh occurs just east of the confluence of Grand Saline Creek and the salt marsh. This area is bounded on the west by a steep hill, on the south by a fence, and on the east by Grand Saline Creek. Consequently, only a narrow entrance on the north side provides ready access to the area. In this area, along the banks of Grand Saline Creek, several clones of Spartina pectinata were observed. This is a very palatable halophytic grass generally associated with more xeric salt marshes. It is possible that difficulty of access reduced grazing pressure to the point that this species was able to survive. The area where the Spartina pectinata occurs is very similar to pot hole microenvironments found throughout the marsh. Additional evidence of reduced grazing pressure in this area is the occurrence of the highly palatable (and consequently uncommon) Zizaniopsis miliacea on the hillside in nonsaline soil.

Although the observed mixture of coastal and inland species is somewhat unusual, migratory waterfowl which utilize the area during both winter and spring migrations provide a transport mechanism for seeds of these species. Additionally, many coastal wading birds utilize the area (Frentriss, 1976; also see section 3.6).

## RELATIONSHIP TO PREVIOUSLY DESCRIBED COMMUNITIES

### Coastal Marshes

The Grand Saline salt marsh, like many coastal marshes, occurs in an area of high rainfall and is periodically flushed by fresh water. However, it is unlike most coastal marshes because it has no tidal influence. It is very different from the coastal marshes along the Gulf coast east of the Trinity River (Chabreck, 1972; Harcombe, 1976). It is somewhat similar to the salt marshes along the lower Texas coast because in these marshes Distichlis spicata var. stricta is often monodominant and Scirpus californicus is a conspicuous community component (Tharp, 1925[1]). However, Distichlis spicata var. stricta is restricted to the coastal regions and Scirpus californicus has a much broader distribution in these coastal marshes.

### Inland Marshes

Ungar's treatment of the vegetation of inland salt marshes of North America north of Mexico (1972) is used as the primary reference for identifying any similarities between previously described inland salt marshes and the Grand Saline marsh.

The environment of inland salt marshes is much different from coastal marshes. Ungar (1965; 1972) summarized the inland differences as:

1. Occasional (and less regular) inundation due to absence of tidal action.
2. Greater seasonal moisture stress.
3. High concentrations of sulfate, bicarbonates and carbonates in addition to chlorides.

The same species of Distichlis stricta[2] may occur in the Grand Saline marsh as in the meadows of Utah and Kansas (Ungar, 1965). However, the species in the Utah and Kansas marshes usually occur in different proportions. The dynamics characterized as typical of inland salt marshes

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[1]In some areas, Tharp may have misidentified Distichlis spicata var. stricta as Sporobolus virginicus. It is virtually impossible to differentiate between these species on vegetative characters.

[2]Distichlis spicata var. stricta of Correll and Johnston (1970).

by Ungar are much like those observed or believed to occur in the Grand Saline salt marsh. These similarities are:

1. Strong dominance by a rhizomatous graminoid
2. Microtopographic changes resulting from soil accumulation
3. Rapid vegetational changes in annual and perennial species
4. Control of species distribution by microenvironmental conditions
5. Very distinct zonation
6. A cycling vegetation pattern, indicated by vegetation advances and retreats onto salt pans

UNIQUENESS

As previously stated, there are some 17 inland salt domes in east Texas. The surface of many of these domes contained, at one time, salt marshes much like the Grand Saline salt marsh. However, subsidence, inundation and commercial exploitation have destroyed most of the marshes. A field survey conducted in the spring of 1976 could locate only remnants of 2 other salt marshes. Both of these occupied less than an acre and were under severe grazing stress. The occurrence of a salt marsh in a forest climate is remarkable. Typically, soluble salts in such areas have been leached from the soil for some time.

To involve governmental agencies and universities early in the decision-making process and to test the opinion that the Grand Saline salt marsh is indeed a unique area, representatives of the U. S. Bureau of Sport Fisheries and Wildlife, Texas Parks and Wildlife Department, and Rice University were invited to visit the marsh with independent ecologists and U. S. Soil Conservation Service soil scientists. Moreover, these representatives were asked to submit written statements regarding the ecological value of the area. Key phrases from each statement describe the ecological conditions succinctly:

a. Texas Parks and Wildlife -- "... attempts to preserve or enhance this area would be well justified. The uniqueness of a naturally occurring salt marsh in east Texas seems cause enough for preservation. Perhaps acreage-wise the loss of the Grand Saline salt marsh would not be particularly significant, but certainly the qualitative character of the east Texas environment would be seriously degraded by loss of another of the diverse habitats of the region."

b. Rice University -- "The marsh at Grand Saline ... is certainly a rare, if not unique, plant assemblage, and as such, I strongly recommend that it be preserved. Such an area is valuable as a study area for plant taxonomists, geographers and ecologists, since the vegetation is so distinct from that of surrounding areas."

c. U.S. Fish and Wildlife Service -- "The presence of an inland salt marsh in the Post Oak Savannah Land Resource Area of Texas is indeed an unusual situation. We understand that other salt marshes existed in this general area in the past but have been lost due to inundation and other causes, leaving the Grand Saline salt marsh as the only such area within a radius of several hundred miles. The entire marsh is estimated to be some 200 acres in extent. A small stream through the area drains into Grand Saline Creek, a tributary of the Sabine River. The Grand Saline inland salt marsh is truly a unique area and should be preserved as an example of an uncommon habitat type. The natural value of the marsh is attested by its inclusion in the publication, The Natural Areas of Texas (Preliminary Listing; 1973, compiled by the Texas Natural Area Survey)".

## ANIMAL COMMUNITIES

Benthic macroinvertebrates were sampled in the salt marsh. Individuals collected included ostracods; *Cyclops vernalis*, a crustacean; *Asellus*, an isopod; *Berosus*, a coleoptera; and Diptera in the families Chironomidae and Ceraptopogonidae. All these benthic groups are opportunistic in nature and are to be expected in this region. Therefore, no unique benthic community appears to inhabit the site. Water salinity between sampling locations varied from 4 to 15 ppt.

The Grand Saline salt marsh represents a unique habitat which is utilized by a wide range of shorebirds and waterfowl. Bird species observed on the salt marsh during recent site visits include the killdeer (*Charadrius vociferus*), great blue heron (*Ardea herodias*), common snipe (*Capella gallinago*), spotted sandpiper (*Actitis macularia*), stilt sandpiper (*Micropalama himantopus*), solitary sandpiper (*Tringa solitaria*), pectoral sandpiper (*Calidris melanotos*), long-billed dowitcher (*Limnodromus scolopaceus*), lesser yellowlegs (*Tringa flavipes*), sora (*Porzana carolina*), blue-winged teal (*Anas discors*), and the rarely seen Wilson's phalarope (*Steganopus tricolor*).

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13. Ungar, I.A., 1965, An ecological study of the vegetation of the Big Salt marsh, Stafford County, Kansas, University of Kansas Science Bulletin 46: 1-98.

14. Ungar, I.A., 1972, The vegetation of inland salt marshes of North America, north of Mexico, In: Grundfragen und Methodgen in der Pflanzen sociologie, Tuxen, R., ed: Dr. W. Junk, Hague, pp. 397-411.

15. U.S. Soil Conservation Service, 1928, Soil survey of Van Zandt County, Texas: Government Printing Office, Washington, D.C.

IN REPLY REFER TO:

(FS)

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

POST OFFICE BOX 1306
ALBUQUERQUE, NEW MEXICO 87103

June 7, 1976

AUG 2

Dames and Moore
Attn: Mr. Brown Collins, Ecologist
Suite 200
2020 North Loop West
Houston, Texas 77018

Dear Mr. Collins:

On May 4, 1976, Wildlife Biologist Jon Nickles of our Service met with you; Soil Scientists Gaylon Lang and Bob Ward of the Soil Conservation Service; Biologist Carl Frentress of the Texas Parks and Wildlife Department; Dr. William Mahler, Botanist at Southern Methodist University; and Paul Harcombe, Botanist at Rice University; to make a field examination of an inland salt marsh immediately southeast of Grand Saline, Texas. The purpose of the investigation was to assess the biological and edaphic attributes of the salt marsh and to discuss measures needed to preserve the area.

The Federal Energy Administration proposes to store oil in abandoned salt mine caverns which underlie the marsh and are owned by the Morton Salt company. Surface development for this project would include a pump house on about one acre of land and a 22-inch-diameter underground pipeline from Grand Saline to Winnsboro, Texas, a distance of approximately 30 miles. We understand that the location of the pump house and pipeline will be outside the marsh area and their construction will have no impact on the marsh itself.

The presence of an inland salt marsh in the Post Oak Savannah Land Resource Area of Texas is indeed an unusual situation. We understand that other salt marshes existed in this general area in the past but have been lost due to inundation and other causes, leaving the Grand Saline salt marsh as the only such area within a radius of several hundred miles. The entire marsh is estimated to be some 200 acres in extent. A small stream through the area drains into Grand Saline Creek, a tributary of the Sabine River.

According to the publication <u>Wetlands of the United States</u>, Fish and Wildlife Circular 39, 1956, this marsh is classified as Type 9 wetlands - Inland Saline Flats. The soil is without standing water except after recent rains, but the water table is high and the soils are poorly drained. According to Gaylon Lang, the soils of the marsh are highly unusual. The salinity results from the upwelling of salt bearing ground water through a 200 foot clay deposit which overlies a salt dome. The soils are silty clays, which contain sodium chloride and neutral salts, and have a generally low pH of about 5. Surface waters are not excessively saline, having a salinity value of about 15 parts per thousand. As the surface waters drain and evaporate, exposed mudflats are left with a salt crust deposited over large areas. Precipitation is about 40 to 45 inches annually.

The vegetation of the salt marsh includes such seemingly out of place halophytic species as inland saltgrass, Distichlis spicata var. stricta, and alkalai bulrush, Scirpus maritimus var. paludosus. Several small ponds occur in the area, some of which contain dense growths of a submerged pondweed, Potamogeton pusillus. Cattails, Typha sp., prairie cordgrass, Spartina pectinata, and other typical marsh plants occur in less saline areas adjacent to the salt marsh. Highway 110 South from Grand Saline divides the marsh into two distinct units. The area west of the highway is sparsely vegetated. There are large expanses of exposed mudflats with vegetation scattered in patches of various sizes and shapes. The area east of the highway apparently retains more water and may be less saline. For the most part it is densely covered with vegetation. No detailed floristic studies have been conducted at the marsh.

No unusual terrestrial or aquatic animals have been identified in the marsh thus far. The area does provide good habitat for shore and marsh birds as well as waterfowl when water is present. The salt marsh, even though relatively small in size, makes a valuable contribution to the habitat diversity in this region of the state.

The Grand Saline inland salt marsh is truly a unique area and should be preserved as an example of an uncommon habitat type. The natural value of the marsh is attested by its inclusion in the publication, The Natural Areas of Texas (Preliminary Listing; 1973, compiled by the Texas Natural Area Survey).

There is a need, nation-wide and within the State of Texas, to preserve representative examples of various habitat types in essentially their natural condition. The need is especially great to save small natural areas such as the Grand Saline salt marsh which could be easily destroyed by a single drainage or development project. In the interest of sound land use planning, it is important that the values of unique natural communities be recognized and that measures are taken to protect them. Toward this end, the Texas Legislature enacted the State Scientific Areas Act to protect such areas for the purposes of education, scientific research, and preservation of flora and fauna.

In order to insure the preservation of the Grand Saline salt marsh, we recommend that concerned individuals and agencies arrange a meeting to discuss the ecological values of this marsh with representatives of the Morton Salt Company. There are several possible courses of action. Possibly the company wishes to retain the property and will agree to maintain the area in its present state, free from development or drainage. Another alternative would be for the company to donate or lease the land to the State to be administered by the Texas Parks and Wildlife Department as a scientific area. Still another possibility would be for the Morton Salt Company to donate, lease, or sell the salt marsh to the Nature Conservancy or a similar private organization dedicated to the preservation of natural areas.

At this point, the specifics of how the area should be preserved and who should administer it are secondary. Of primary importance is the need to insure that the area is preserved and managed in the broad public interest. Management of the marsh need not be complex. If left as it is, the marsh will continue to maintain and renew itself.

We appreciate the opportunity to view this marsh and to provide our comments. We would also appreciate receiving specific information on construction and location of the pump house and pipeline when this information becomes available.

Sincerely yours,

W. R. Bridges

ACTING Assistant Regional Director

cc: Field Supervisor, FWS, Ecological Services, Fort Worth, Texas

TEXAS
PARKS AND WILDLIFE DEPARTMENT



CLAYTON T. GARRISON
EXECUTIVE DIRECTOR

JOHN H. REAGAN BUILDING
AUSTIN, TEXAS 78701



May 13, 1976

Mr. Brown Collins
Project Ecologist
Dames and Moore
Suite 200
2020 North Loop West
Houston, Texas 77018

Dear Mr. Collins:

On May 4, 1976, Carl Frentress, Department biologist, met with you, Jon Nickles of the Fish and Wildlife Service, Dr. William Mahler of the SMU Herbarium, and Gayland Lane and Bobby Ward of the Soil Conservation Service to examine an inland salt marsh owned by the Morton Salt Company near Grand Saline. The purpose of this meeting was to bring together a multidisciplinary group that could tour the marsh with a view toward assessing the uniqueness of the site and make appropriate recommendations concerning needs for preservation of the area.

Environmental concern rises from a proposal by the federal government to utilize abandoned chambers in the salt dome as oil storage facilities. Surface impact will be limited to a small pumping station and right-of-way alteration resulting from an underground pipeline.

I understand that the marsh has resulted from an upwelling of ground water carrying dissolved salts from the crown of the salt dome approximately 200 feet below the surface.

Mr. Frentress reports the marsh is definitely unique in this section of East Texas characterized by post oak-red oak-hickory forest. The most dominant marsh species is inland saltgrass (Distichlis spicata var. stricta). Mats of this species occur extensively over the marsh flats. Extensive stands of Scirpus maritima (a "three-square" bulrush) occur in the eastern end of the marsh. Several shallow ponds have dense stands of Potamogeton spp. or a Najas spp. Other ponds are barren except for blue-green algae. A small isolated stand of Spartina pectinata is present along Grand Saline Creek. Cattails (Typha spp.) are present in the more permanent ponds in the eastern end. Large unvegetated flats with a salty surface crust occur along the southern and central portion.

The area contributes to the diversity of wildlife habitat in this locale. Within one-quarter mile one can stroll from fox squirrel habitat to the haunts of shorebirds and water-fowl. The area is most important as habitat for various species of shorebirds. Four pairs of rarely seen Wilson's phalarope (Steganopus tricolor) were observed. Mr. Frentress also tentatively identified stilt sandpipers (Micropalama himantopus), long-billed dowitchers (Limnodromus scolopaceus), lesser yellow-legs (Totanus flavipes), solitary sandpipers (Tringa solitaria), and pectoral sandpipers (Erolia melanotos), a sora rail (Porzana carolina) and twelve blue-winged teal (Anas discors).

I concur with Mr. Frentress in that attempts to preserve or enhance this area would be well justified. The uniqueness of a naturally occurring saltmarsh in East Texas seems cause enough for preservation. Perhaps acreage-wise the loss of the Grand Saline salt marsh would not be particularly significant, but certainly the qualitative character of the East Texas environment would be seriously degraded by loss of another of the diverse habitats of the region.

Sincerely,

Ted L. Clark

TED L. CLARK
Director, Wildlife Division

TLC:CF:js



cc: Mr. Jon Nickles, U. S. Fish and Wildlife Service
Dr. William F. Mahler, Southern Methodist University

RICE UNIVERSITY
HOUSTON, TEXAS
77001

DEPARTMENT OF BIOLOGY

May 18, 1976

Mr. Brown Collins
Dames & Moore
Suite 200, 2020 No. Loop West
Houston, Texas 77018

Dear Brown:

The marsh at Grand Saline which you showed me is certainly a rare, if not unique, plant assemblage, and as such, I strongly recommend that it be preserved. Such an area is valuable as a study area for plant taxonomists, geographers, and ecologists, since the vegetation is so distinct from that of surrounding areas. I gather, too, that it serves as habitat for a unique bird community.

To protect the value of the marsh, development needs to be prevented; further crossings by roads, railroad spurs, pipelines or pipelines should also be prevented. In addition, I would like to see grazing pressure reduced, and some effort made to insure that natural freshwater drainage from the watershed is not disrupted.

At present, the marsh is in poor condition, probably because of past human activities. The fact that the marsh is disturbed does not alter its uniqueness, nor does it decrease the desirability of preserving it. It does mean, however, that the natural value of the marsh could be greatly enhanced with some management.

Thanks again for giving me the chance to see the marsh.

Sincerely,

Paul

P. A. Harcombe
Assistant Professor

PAH:rnp

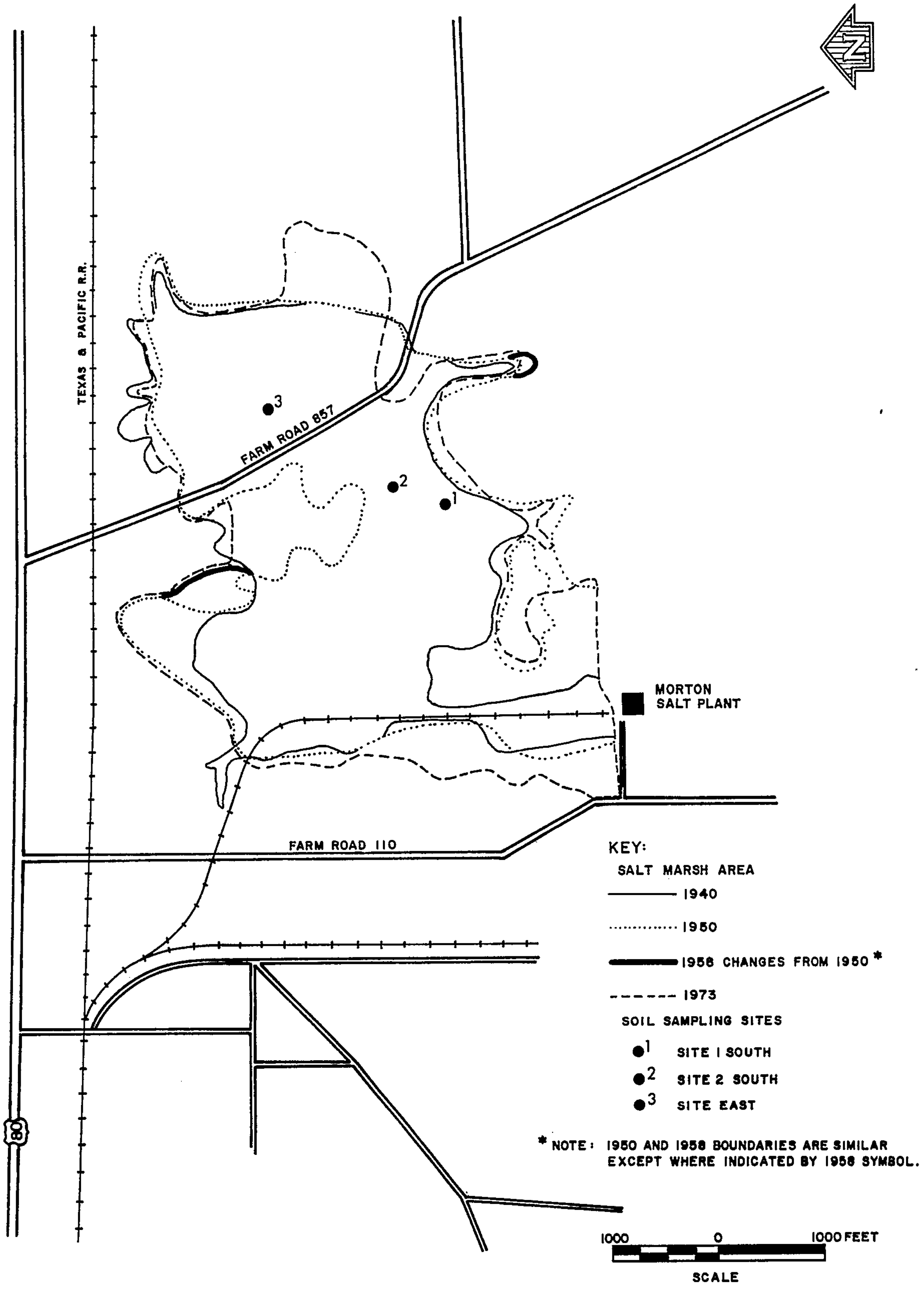
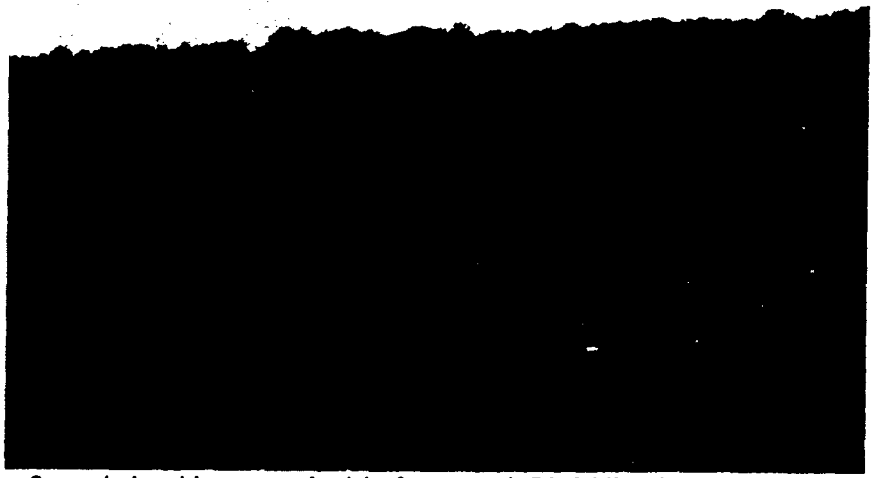



FIGURE I-1 Location of Morton Salt Company surface facilities, Grand Saline marsh, and soil sampling sites.



*Spergularia echinosperma* in right foreground, *Distichlis spicata* var. *stricta* in remainder of foreground. *Scirpus maritimus* var. *paludosus* is in near background. *Ulmus* (elm) *Quercus* (oak) forest is in extreme background.

Interface of *Distichlis* marsh and unvegetated area.
Note Morton plant in background and driftwood in foreground.

FIGURE I-2 Landscape of Grand Saline salt marsh

# APPENDIX J - COMMENTS RECEIVED

Advisory Council on
Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

February 16, 1977

Mr. Michael E. Carosella
Associate Assistant Administrator
Special Programs
Executive Communications, Room 3309
Federal Energy Administration
Washington, D. C. 20461

Dear Mr. Carosella:

This is in response to your request of January 21, 1977 for comments on the draft environmental statement for the Kleer Mine, Van Zandt County, Texas. Pursuant to its responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969, the Advisory Council on Historic Preservation has determined that while you have discussed the historical, architectural, and archeological aspects related to the undertaking, the Council needs additional information to adequately evaluate the effects on these cultural resources. Please furnish additional data indicating:

I. Compliance with Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f, as amended, 90 Stat. 1320). The Council must have evidence that the most recent listing of the National Register of Historic Places has been consulted (see Federal Register, February 10, 1976 and monthly supplements each first Tuesday thereafter) and that either of the following conditions is satisfied:

A. If no property included in or eligible for inclusion in the National Register is affected by the project, a section detailing this determination must appear in the statement.

B. If a property included in or eligible for inclusion in the National Register is affected by the project, the statement must contain an account of steps taken in compliance with Section 106, as amended, and a comprehensive discussion of the contemplated effects on the property. (Procedures for compliance with Section 106 are detailed in the Federal Register of January 25, 1974.)

II. <u>Contact with the State Historic Preservation Officer</u>.

The procedures for compliance with Section 106, as amended, of the National Historic Preservation Act of 1966 require the Federal agency to demonstrate consultation with the appropriate State Historic Preservation Officer. The State Historic Preservation Officer for Texas is Truett Latimer, Executive Director, Texas Historical Commission, P.O. Box 12276, Capitol Station, Austin, Texas 78711.

Should you have any questions or require any additional assistance, please contact Michael H. Bureman of the Council's Denver staff at P.O. Box 25085, Denver, Colorado 80225, or (303) 234-4946, an FTS number.

Sincerely yours,

Louis S. Wall
Assistant Director, Office
of Review and Compliance

**UNITED STATES DEPARTMENT OF AGRICULTURE**

**SOIL CONSERVATION SERVICE**

P. O. Box 648
Temple, Texas 76501

March 1, 1977

Mr. Michael E. Carosella
Associate Assistant Administrator
Special Programs
Federal Energy Administration
Washington, D. C. 20461

Dear Mr. Carosella:

We have reviewed the draft environmental impact statement (EIS) for the Kleer Mine in northeast Texas and have no comments.

We feel the draft environmental impact statement as written clearly reflects the impacts that this project will have on the soil, water, and plant resources.

We appreciate the opportunity of reviewing this draft environmental impact statement.

Sincerely,

C. Budd Fountain

George C. Marks
State Conservationist

DEPARTMENT OF THE ARMY
SOUTHWESTERN DIVISION, CORPS OF ENGINEERS
MAIN TOWER BUILDING, 1200 MAIN STREET
DALLAS, TEXAS 75202

SWDPL-R

17 [illegible] 1977

Mr. Michael E. Carosella
Associate Assistant Administrator,
Special Programs
Federal Energy Administration
Washington, DC 20461

Dear Mr. Carosella:

This office has reviewed the draft EIS for Kleer Mine, Van Zandt County, Texas, furnished to the Office, Chief of Engineers. The results of our review are as follows:

a. The petroleum reserve storage is located in Grand Saline Creek watershed in the Sabine River Basin. The northeastern portion of the pipeline and Winnsboro Terminal are located in the Cypress Creek watershed (Red River Basin - New Orleans District).

b. Existing Lake of the Pines is located on Big Cypress Creek (Red River Basin) downstream from the Winnsboro Terminal and authorized Carl L. Estes Lake is located upstream and near the storage area. Big Sandy Lake, an authorized C-E project, is located just downstream from the pipeline crossing of Big Sandy Creek. Any significant spill or break in pipeline or storage would mean serious problems in the downstream reservoirs and stream reaches.

c. Based on present criteria, the permit under Section 404 of Public Law 92-500, the amendments of the Federal Water Pollution Control Act, will be required when the pipeline crosses Big Sandy Creek, Lake Fork Creek, Grand Saline Creek, and the Sabine River.

Thank you for the opportunity to review the statement.

Sincerely,

HARRY G. ROUGHT, P.E.
Chief, Planning Division

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Form FHWA 121 (Rev. 5-73)

UNITED STATES GOVERNMEN.

DEPA...MENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

# *Memorandum*

DATE: March 8, 1977

In reply refer to: 06-48.10A

SUBJECT: Other Agency Statements
Strategic Petroleum Reserve Sites
Kleer Mine, Grand Saline, Texas

FROM : John J. Conrado, Division Administrator
Austin, Texas

TO : Executive Communications, Room 3309
TES-72 Federal Energy Administration
Washington, D. C. 20461

We have reviewed the subject Draft Environmental Impact Statement. We have no comments at this time.

George H. Nelson
George H. Nelson
District Engineer

KT

U.S. DEPARTMENT OF TRANSPORTATION

REGIONAL REPRESENTATIVE OF THE SECRETARY
9-C-18 FEDERAL CENTER
1100 COMMERCE STREET
DALLAS, TEXAS 75202

00003

MEMORANDUM

To: Executive Communications, Room 3309
Federal Energy Administration
Washington, D. C. 20461

From: Environmental Impact Statement Coordinator
Secretarial Representative, Region VI, Dallas, Texas

Date: March 24, 1977

Subject: Strategic Petroleum Reserve Sites, Kleer Mine, Grand Saline, Texas

We are forwarding comments we received from the Coast Guard concerning the Draft Environmental Impact Statement. The Federal Highway Administration previously provided a negative response on March 8, 1977.

Thank you for the opportunity to provide input on this important project.

James D. Ragsdale
Acting Senior Staff Assistant

(G-WS/73)
(202) 426-2262

15 MAR 1977

Mr. Ed Foreman
DOT Secretarial Representative
9-C-18 Federal Center
1100 Commerce Street
Dallas, Texas 75242

Dear Mr. Foreman:

Enclosed are Coast Guard comments on the draft environmental impact statement for Federal Energy Administration's Strategic Petroleum Storage Project at Kleer Mine, Grand Saline, Texas.

The comments are sent to you for inclusion in a consolidated Departmental response.

Sincerely,

F. P. Schubert
Captain, U. S. Coast Guard
Deputy Chief, Office of Marine Environment and Systems
By direction of the Commandant

Enclosure

ERNMENT

randum

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

G-WEP-7/73
16476/7.b.254

DATE: 03 MAR 1977

SUBJECT: DEIS for FEA Strategic Petroleum Reserve Storage Project at Kleer Mine, Grand Saline, Texas

FROM : G-WEP

TO : G-WS

1. The subject DEIS has been circulated for review and comment by the concerned Coast Guard staff and operating elements. Comments received were as follows:

a. Page 3.2-10 - Collapses of surface ground in the vicinity of the proposed project are mentioned and a recent collapse is attributed to "abandoned shallow salt caverns." No details regarding such abandoned caverns, their numbers, locations, former uses, etc., are offered. A relevant question might be whether such caverns pose a hazard to surface or subsurface operations or structures, also whether there might be some historical significance associated with such caverns.

b. Page 3.4-8 - It may be useful to identify the Air Quality Control Regions (AQCR) for both the storage site and coastal area affected. In addition, there should be discussion of the coastal area AQCR present loadings and pollutant priority classifications.

c. Page 3.7-1 - The Morton Salt Mine is identified as a site of "nationally registered historic significance." However, impact discussions on pages 4.2-15 (§4.2.6) and 4.3-15 (§4.3.6) do not mention possible effects on the Morton Salt Mine in this regard.

d. Page 3.9-10 - In section 3.9.1.6 the question as to ownership of the proposed facility is raised. On page 4.3-17 (§4.3.7.5) the same question is raised again. However, on page 2.1-1 the statement is made that FEA would "purchase" the requisite site from Morton. Some explanation regarding ownership is in order.

e. Page 4.3-20 - Oil spills with respect to two alternative modes of pipeline operation are discussed, viz., keeping oil within the pipeline or displacing the oil with water containing inhibitors. It is reasonable to infer that if crude oil is left for long periods of time in this 42-mile long pipeline, some measures will have to be taken to ensure the pipeline is not plugged by waxing or solidifying of portions of the crude. Will "pigs" be used in this pipeline? Also, the alternative of internal coating of the pipeline should be considered with respect to corrosion prevention and the issue of the use of inhibited water for displacement of the oil in the line.

DEPT. OF TRANSP., USCG, CG-4914 (3-73)

Subj: DEIS for FEA Strategic Petroleum Reserve Storage Project at Kleer Mine, Grand Saline, Texas

f. Page 4.3-21 and Appendix G (Oil Spill Risk Analysis Methodology) - In the discussions of oil spill risk from vessels it is not made clear how the "FEA incremental" or "induced" traffic is viewed with respect to the oil spill data base used. The 30 million barrels required to fill the mine represents about sixteen 250M dwt VLCC's. The number of lightering tank vessels would be many more. This represents additional tank vessel traffic which would not otherwise occur in that region of the Gulf and along the Sabine Lake-Neches River route.

g. Page 10-9 - Reference to the "1976 Draft Environmental Impact (4f) Statement, Seadock Deepwater Port License Application" is probably actually the LOOP Draft EI/4(f) Statement. (Note: Both LOOP and Seadock FEIS's were made available on 17 December 1976.)

h. The fact that oil handling by vessels is governed by the Coast Guard under the Oil Pollution Prevention Regulations should be considered by FEA in its EIS's for strategic storage projects.

J. R. KIRKLAND

# DEPARTMENT OF THE TREASURY
WASHINGTON, D.C. 20220

March 7, 1977

Dear Mr. Carosella:

This is in response to your letters of January 12 and 21 requesting comments regarding the draft environmental impact statements on the proposed Central Rock, Ironton, and Kleer mines candidate sites for petroleum storage facilities for the Early Storage Reserve. The impact statements appear to be objectively directed towards their stated purposes and the Department has no comments beyond those provided on July 29 and November 1, 1976 concerning the draft statements for the Strategic Petroleum Reserve and the first five proposed candidate sites for petroleum storage.

Sincerely,

Anthony V. DiSilvestre
Assistant Director (Environmental Programs)
Office of Administrative Programs

Mr. Michael E. Carosella
Associate Assistant Administrator
for Special Programs
Federal Energy Administration
Washington, D.C. 20461

cc: Mr. Perry

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

FIRST INTERNATIONAL BUILDING
1201 ELM STREET
DALLAS, TEXAS 75270

March 22, 1977

Mr. Michael E. Carosella
Associate Assistant Administrator
Special Programs
Federal Energy Administration
Executive Communications, Room 3309
Washington, D.C. 20461

Dear Mr. Carosella:

We have reviewed the Draft Environmental Impact Statement for Kleer Mine, a candidate site for the Early Storage Reserve Program under the Strategic Petroleum Reserve. If Kleer Mine is selected, 30 million barrels of oil would be stored in this conventional salt mine located in Grand Saline, Van Zandt County, Texas. Major construction activities include the following: renovation of the existing underground salt mine; expansion of facilities at Winnsboro Terminal for transfer of oil to and from the Texoma pipeline; and installation of a 42-mile long pipeline between Kleer Mine and Winnsboro Terminal.

Oil would be delivered to Winnsboro Terminal by tanker and pipeline from the Gulf of Mexico. In the Gulf of Mexico, oil would be off-loaded from VLCC's (Very Large Crude Carrier) to 30,000 deadweight ton (DWT) tankers to be transported through Sabine Lake to Nederland, Texas, a distance of approximately 95 miles. After temporary storage at Texoma Terminal, the oil would be pumped into the Texoma pipeline for transport to Winnsboro Terminal.

The following comments are for your consideration in the preparation of the final statement:

1. Potential construction impacts on water quality include sedimentation and infiltration and decreased water quality (page 4.2-3). Estimates of additional sediments to be received in area reservoirs are given on page 4.2-4. The increased sediment accumulation estimates are less than 0.1 percent of the total original storage capacity of each of the reservoirs; however, the final statement should discuss the possible effects the increased sediment accumulation could have on the expected project life of each reservoir. Quitman Reservoir appears to be the reservoir most affected, since it is expected to receive 83 percent of the present annual sediment accumulation due to the project. In addition, the final statement should also indicate if erosion control measures were included in estimating the sediment accumulation due to project construction.

2. On page 4.2-14, it is stated that the proposed surface facilities "could alter freshwater flow to the marsh from the drainage area to the west." Since the marsh is considered to be unique, the final statement should describe the measures to be used to protect the marsh during construction and operation of the proposed facility.

3. Liquid construction wastes (i.e., oily and briny water) from the project are proposed to be treated by a commercial disposal company (page 2.1-2). However, on page 5.2-2 it is stated that this waste water could be taken by tank truck to be treated in the municipal sewage system. If this alternative is chosen, the final statement should indicate that the municipal system is capable of treating this oily and briny waste water.

4. Background noise levels were estimated for the project site and three other areas. It would strengthen the statement if an area land use map were included with the locations of the sites given. On page 3.5-1 it is stated that there are a number of residences within 1000 feet of the route and terminal locations. Noise levels and locations for these residences should be estimated and included in the final statement. This information would be helpful in assessing the potential effect of increased noise levels from the project on area residents.

Section 4.2.4 discusses the noise impacts of the proposed action. While it is indicated that there should be no increase in ambient noise levels in areas beyond one-half mile of the site, the final statement should discuss the noise levels to be experienced by residents less than 2000 feet away from construction sites, as well as the number that would be affected. It is indicated that construction activities at the site would be continuous (i.e., 24 hours a day). The final statement should indicate if the Ln and Ldn values given in Table 4.2-9 for construction activities include a 10dB penalty for night-time activities. Noise events become more intrusive at night, and a weighting factor is applied to night-time noise levels to increase the levels commensurate with their severity. If noise from the construction activities will annoy area residents, consideration should be given to limiting blasting to daylight hours. Other construction activities which could be annoying to area residents could be scheduled so the work at night would be less intruding and disturbing to sleep.

5. Assurances should be given in the final statement that possible mitigative measures discussed in Section 5.2 would be implemented, where feasible, if Kleer Mine is selected as a storage site.

6. We would like to point out that EPA has issued guidelines for noise levels to protect public health and welfare, as stated in Appendix C, and the levels should not be interpreted as regulatory requirements. Therefore, the statement on page 4.2-12 that these guidelines were "promulgated" should be clarified.

7. On pages 4.3-8 and 4.3-9, class "F" stability air should be described as stable rather than unstable. On page 4.3-11, it is stated that at West Orange the high value recorded for ozone in the first six months of 1976 is 1.68 parts per million (ppm). Since the standard is 0.08 ppm, this value appears to be too high. The value should read 0.168 ppm.

8. It would strengthen the statement if additional air quality data for southeast Texas were included. EPA proposed hydrocarbon/photochemical oxidant strategy on November 11, 1976, (41 Federal Register 49840) using 1973 as the base line year for southeast Texas. Included below are additional ozone data which would help to support the statement on page 4.3-11 that there is a consistent occurrence of very high concentrations of photochemical oxidants in southeast Texas. For comparison, the standard concentration of 160 $ug/m^3$ (micrograms per cubic meter) is equivalent to 0.08 ppm.

West Orange, Texas

| | high ($ug/m^3$) | second high ($ug/m^3$) |
|---|---|---|
| 1974 | 406 | 382 |
| 1975 | 370 | 368 |
| 1976 | 332 | 288 |

Nederland, Texas

| | high ($ug/m^3$) | second high ($ug/m^3$) |
|---|---|---|
| 1972 | 623 | 612 |
| 1973 | 745 | 637 |
| 1974 | 368 | 341 |
| 1975 | 380 | 347 |
| 1976 | 366 | 356 |

The final statement should recognize that southeast Texas is a non-attainment area for photochemical oxidants because the national standard has not been achieved.

9. Assurances should be given in the final statement that the data given in the statement was obtained either by using accepted methodology or from an agency that used accepted methodology.

These comments classify your Draft Environmental Impact Statement as LO-2. Specifically, we have no objections to your project as proposed in the statement. However, we are requesting additional information on the environmental impacts of the proposed project in order to evaluate the project more fully.

The classification and the date of our comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on proposed Federal actions, under Section 309 of the Clean Air Act.

Definitions of the categories are provided on the attachment. Our procedure is to categorize our comments on both the environmental consequences of the proposed action and on the adequacy of the impact statement at the draft stage, whenever possible.

We appreciate the opportunity to review the Draft Environmental Impact Statement, and we would be happy to discuss our comments with you. Please send us two copies of the Final Environmental Impact Statement at the same time it is sent to the Council on Environmental Quality.

Sincerely yours,

John C. White
Regional Administrator

Enclosure

## ENVIRONMENTAL IMPACT OF THE ACTION

### LO - Lack of Objections

EPA has no objections to the proposed action as described in the draft impact statement; or suggests only minor changes in the proposed action.

### ER - Environmental Reservations

EPA has reservations concerning the environmental effects of certain aspects of the proposed action. EPA believes that further study of suggested alternatives or modifications is required and has asked the originating Federal agency to re-assess these aspects.

### EU - Environmentally Unsatisfactory

EPA believes that the proposed action is unsatisfactory because of its potentially harmful effect on the environment. Furthermore, the Agency believes that the potential safeguards which might be utilized may not adequately protect the environment from hazards arising from this action. The Agency recommends that alternatives to the action be analyzed further (including the possibility of no action at all).

## ADEQUACY OF THE IMPACT STATEMENT

### Category 1 - Adequate

The draft impact statement adequately sets forth the environmental impact of the proposed project or action as well as alternatives reasonably available to the project or action.

### Category 2 - Insufficient Information

EPA believes the draft impact statement does not contain sufficient information to assess fully the environmental impact of the proposed project or action. However, from the information submitted, the Agency is able to make a preliminary determination of the impact on the environment. EPA has requested that the originator provide the information that was not included in the draft statement.

### Category 3 - Inadequate

EPA believes that the draft impact statement does not adequately assess the environmental impact of the proposed project or action, or that the statement inadequately analyzes reasonably available alternatives. The Agency has requested more information and analysis concerning the potential environmental hazards and has asked that substantial revision be made to the impact statement. If a draft statement is assigned a Category 3, no rating will be made of the project or action, since a basis does not generally exist on which to make such a determination.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 10 1977

Mr. Michael E. Carosella
Associate Assistant Administrator
Special Programs
Federal Energy Administration
Washington, D. C. 20461

Dear Mr. Carosella:

This is in response to your letter of January 21, 1977 inviting our comments on the Draft Environmental Impact Statement concerning the proposed use of Kleer Mine as a petroleum storage facility in the initial phase of the Strategic Petroleum Reserve.

We have reviewed the statement and determined that the proposed action has neither radiological health and safety impacts nor will it adversely affect any activities subject to regulation by the Nuclear Regulatory Commission. Accordingly, we have no comments or suggestions to offer.

Thank you for providing us with the opportunity to review this Draft Environmental Impact Statement.

Sincerely,

Voss A. Moore

Voss A. Moore, Assistant Director
for Environmental Projects
Division of Site Safety
Environmental Analysis

cc: CEQ (5 copies)

A GOVERNMENTAL AGENCY OF THE State of Texas

SABINE RIVER AUTHORITY of Texas

P. O. BOX 579
ORANGE TEXAS
77630

March 11, 1977

Michael E. Carosella
Associate Assistant Administrator
Special Programs
Federal Energy Commission
Washington, D. C. 20461

Dear Mr. Carosella:

As per your request for comments, we have received the draft environmental impact statement (EIS) for the Kleer Mine, a candidate site proposed for possible use as a petroleum storage facility for the Early Storage Reserve. We understand that creation of the Reserve is mandated by Title I, Part B, of the Energy Policy and Conservation Act of 1975 (P.L. 94-163).

Our principal concern relative to this storage facility and the pipeline route is the probability of oil spills. Our concern is for oil spills in the drainages of the Sabine River and Lake Fork Creek and the effect on water uses in these streams.

The Sabine River Authority of Texas is at this time constructing Lake Fork Reservoir just upstream from the proposed pipeline route. This reservoir will be supplying water downstream to water intake facilities for Texas Utilities Services, Inc. and the City of Longview. It is this reach of the Sabine River and of Lake Fork Creek that would be most severely effected if, as calculated in the report, the maximum Estimated credible spill of 5000 barrels were to occur.

Additionally, we are concerned as to the effects on water quality in Toledo Bend Reservoir. As noted on page 4.3-34 of the impact statement, the 5000 barrel maximum spill hypothesized to occur at flood stage could reach Toledo Bend Reservoir which is approximately 200 miles downstream within 92 hours, with an estimated 400 to 800 wide or more and 38 mile long slick in the reservoir. Such a possiblity is certainly cause for concern and could be severely damaging to the aquatic habitat in the reservoir and to the water uses.

We understand that the possibility of such a spill is remote as based on the data for projecting pipeline oil spills. Further, we have noted the preventive measures and environmental safeguards that could be used to reduce the oil spill risks. However, we are familiar with and know the Sabine River as a stream that frequently flows at flood stage, as a stream that has long reaches that are inaccessible, and a stream on which it would be extremely difficult to lessen detrimental impacts in the event of a major crude oil spill.

SABINE RIVER AUTHORITY of Texas



In closing, we would urge that, if the project is undertaken, every effort should be made to include safeguards against spills and that it should be explicitly spelled out ahead of time which governmental agencies and private industry would be responsible for the "strike-force" crews and the contingency plan to be used for corrective action in the event of a spill.

We thank you for this opportunity to provide our comments.

Sincerely

SABINE RIVER AUTHORITY OF TEXAS
John W. Simmons
Executive Vice President
and General Manager

By Jack W. Tatum

Jack W. Tatum
Technical Department Supervisor

JWT/pna

Texas Water Quality Board
1700 North Congress
Stephen F. Austin Building
Box 13246 Capitol Station
Austin, Texas 78711 Phone (512) 475-2651



February 25, 1977

Re: Draft Environmental Impact Statement for Kleer Mine, Strategic Petroleum Reserve Program, Federal Energy Administration

Mr. Charles D. Travis, Director
Governor's Division of Budget
and Planning
411 West 13th Street
Austin, Texas 78701

Dear Mr. Travis:

The staff of the Texas Water Quality Board has reviewed the draft environmental impact statement for Kleer Mine under the Strategic Petroleum Reserve Program of the Federal Energy Administration and has determined that no lasting harmful effects on water quality will result from the project, provided reasonable precautions are taken during construction. We recommend that adequate erosion control measures be employed during pipeline construction, and that pipeline routes be renegotated after construction in order to prevent excessive erosion.

We appreciate the opportunity to review and furnish comments on this proposed activity. If we can be of further assistance, please let us know.

Very truly yours,

Emory G. Long

Emory G. Long
Director

Enclosure

cc: Mr. Michael E. Carosella

SOUTHERN METHODIST UNIVERSITY

ARCHAEOLOGY RESEARCH PROGRAM
Department of Anthropology
DALLAS, TEXAS 75275

February 17, 1977

kI

281001

Executive Communications, Room 3309
Federal Energy Administration
Washington, D.C. 20461

Dear Sirs:

The Archaeology Research Program is a part of the Department of Anthropology at Southern Methodist University. The purpose of our program is to provide expertise in the location, assessment, and management of archaeological resources impacted by land modification activities. We conducted the archaeological reconnaissance of the proposed pipeline route for the Draft Environmental Impact Statement for Kleer Mine (DES 77-2). With regard to the archaeological parts of the Draft Statement, we offer the following comments.

Section 3.7, "Archaeological and Historical Resources", is an accurate synthesis of our field reconnaissance and assessment. One factual error is that pottery was generally absent during the Archaic period.

Section 4.2.6, dealing with the impact upon the archaeological and historical resources needs clarification. We recommend that an intensive survey be undertaken to inventory the total scope of affected archaeological resources prior to commencement of construction but after the field location of the right-of-way is marked. Further, we recommend that testing be undertaken at potentially significant sites and that sites determined to be significant be nominated to the National Register of Historic Places. Any historic or prehistoric sites which are discovered and cannot be avoided by pipeline relocation will need to be thoroughly investigated to minimize adverse impact on the archaeological and historical resources affected by pipeline construction.

Sincerely,

James E. Bruseth
Research Archaeologist
Archaeology Research Program

S. Alan Skinner, Director
Archaeology Research Program

JEB/SAS:jg

HERBARIUM
SOUTHERN METHODIST UNIVERSITY
DALLAS, TEXAS 75222

281002

23 February 1977

Executive Communications
Rm. 3309, Federal Energy Administration
Washington, D.C. 20461

Dear Sir:

In response to your request for a review on the "Draft Environmental Impact Statement for Kleer Mine, Strategic Petroleum Reserve," I am submitting the following comments.

On pages 3.6-12 and 10-5, Robert Kral's name was misspelled (as Karl) and on page 316-13, last paragraph, the word drosera was also misspelled twice (as dorsera).

In the section on "Rare and Endangered Species," pp. 3.6-18, 3.6-19, the latest list of Endangered and Threatened Wildlife and Plants (September 26, 1975, Federal Register) was said to have been used to identify endangered and threatened species in the project area. The latest Federal List was published in 1976, 6 mos. prior to the date of the statement (Jan. 1977). Rubus duplaris Shinners is in both of the Federal Lists and is known from Freestone and Henderson counties. This plant species is in the same vegetation zone - oak-savannah - as Kral's study (Freestone County) that was used to describe Seeps, on pages 3.6-12 and 3.6-13. The presence of Rubus duplaris Shinners in the proposed 42 mile pipeline route is within the realm of possibility (similar habitats within same zone.)

If as much attention could be focused on the biology of the proposed pipeline route (not literature surveys) as was conducted on the Grand Saline Marsh and the rest of the report, the presence (or absence) of this species could have been elucidated.

Sincerely,

Wm. F. Mahler

Wm. F. Mahler, Ph.D.
Curator, SMU Herbarium



☆ U. S. GOVERNMENT PRINTING OFFICE : 1977 O - 245-890

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

There are presently no official plans, policies, or controls established by Federal agencies in Van Zandt County or elsewhere in the project region. Furthermore, lands under consideration for use in developing the Strategic Petroleum Reserve facility at Kleer Mine are presently devoted to industrial uses. This includes the 1 to 2 acres of land required for facilities at the Winnsboro Terminal. Half of the pipeline route to be used for transport of the oil between Kleer Mine and Winnsboro Terminal is presently accessible to the Mobil Pipeline Company; thus, about 21 miles, or 300 acres, of river flood plain, oak-savannah, and tame pasture must be temporarily disturbed by pipeline construction. Most present uses can be continued during the project lifetime.

The East Texas Council of Governments keeps historical records but to date has set no policy on land-use priorities (section 3.9). There are no zoning ordinances which apply to lands affected by the proposed action.