Strategic Petroleum Reserve

Final Environmental Impact Statement for

Central Rock Mine

FES 76/77-9

July 1977

Federal Energy Administration
Strategic Petroleum Reserve Office

FEA/S-77/214

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. 20036
(202) 254-8986

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

2. Brief Description of the Proposed Action

   A. The Federal Energy Administration (FEA) proposes 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. In addition, President Carter proposed to the Congress in the National Energy Plan on April 29, 1977, that the SPR be expanded to a total volume of one billion barrels. Petroleum will be stored underground in conventional mines or solution-mined salt cavities, or aboveground in conventional tanks. Details of the Strategic Petroleum Reserve program are discussed in the Strategic Petroleum Reserve Draft Environmental Impact Statement (DES-76-2). The present action is part of the ESR and proposes to store 14 million barrels of oil in an underground limestone mine located in Lexington, Kentucky. The proposed storage of oil at Central Rock Mine would be implemented at an existing underground limestone mine presently owned and operated by the Central Rock 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 Central Rock, Kentucky 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 adverse impacts to the physical environment that could result from the program include: locally significant increases in hydrocarbon emissions during transport of oil from the Gulf of Mexico to the Central Rock Mine; 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 Tates Creek storage tanks; 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 significant sedimentation in a downstream impoundment. 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 estimated credible spill of 2500 barrels could severely pollute a local natural area of up to 80 acres and up to 12.5 miles of local stream channel, but the frequency of occurrence of such a spill, based on historical data, is extremely low. Adverse socioeconomic impacts would be related to the possible dislocation of a substantial number of Central Rock Company employees if the mine were close temporarily.

4. <u>Alternatives Considered</u>

Alternative Storage Sites

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

Nonstructural Alternatives

Structural Alternatives

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

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

Federal:

Department of Agriculture
Department of the Army
Department of Commerce
Department of Health, Education and Welfare
Department of the Treasury
Nuclear Regulatory Commission

State:

Indiana Department of Outdoor Recreation
Indiana Energy Office
Indiana State Board of Health
Kentucky Department of Natural Resources and Environmental Protection
Kentucky Heritage Commission
University of Kentucky

Local:

No comments were received from local government agencies.

Others:

No comments were received.

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 July 1977

TABLE OF CONTENTS

TABLE OF CONTENTS - CONTINUED

TABLE OF CONTENTS - CONTINUED

TABLE OF CONTENTS - CONTINUED

TABLE OF CONTENTS - CONTINUED

TABLE OF CONTENTS - CONTINUED

TABLE OF CONTENTS - CONTINUED

LIST OF TABLES

LIST OF TABLES - CONTINUED

LIST OF TABLES - CONTINUED

LIST OF TABLES - CONTINUED

LIST OF FIGURES

LIST OF FIGURES - CONTINUED

SECTION 1.0

BACKGROUND

This document is a site specific Environmental Impact Statement (EIS) for the proposed storage of crude oil at the Central Rock limestone mine located in Fayette County, Kentucky. 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 suppy 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. In addition, the President proposed to the Congress in the National Energy Plan on April 29, 1977, that the SPR be expanded to a total volume of one (1) billion barrels.

A draft programmatic EIS (DES 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 June 25, 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 draft 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 will 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, 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). Environmental Impact Statements on all five alternative candidate sites (DES 76-4 throught 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 final EISs for these sites were filed with the Council on Environmental Quality and made available to the public in December 1976 and January 1977. Of these sites, West Hackberry, Bayou Choctaw, Bryan Mound, and Weeks Island have been selected for use as storage facilities.

The other three candidate site include the Central Rock limestone mine (Fayette County, Kentucky), the Ironton limestone mine (Lawrence County, Ohio), and the Kleer salt mine (Van Zandt County, Texas). Central Rock and Ironton would both supply the refineries in an area served by the Capline - Ashland pipeline network andare therefore alternatives to each other for that purpose. In addition Cote Blanche site, because of its distribution flexibility, can also serve this inland market. The three (3) sites therefore comprise a group of alternatives. Section 8.3.2 includes a more detailed discussion of the rationale supporting the selection of the seven alternative sites in a brief summary of the impacts associated with each of the other six sites besides the Central Rock mine. The Kleer mine would serve the Texoma pipeline and is therefore not an alternative for the Capline market. The draft EISs for Central Rock, Ironton, and Kleer (DES 76-9,10,and 11, January 1977) have been filed with the Council on Environmental Quality (CEQ) and made available to the public. The Final EIS for Ironton was filed with and made available to the public CEQ in July, 1977. The final EIS was Kleer is in preparation and will be made available prior to any subsequent site selection for the Texoma market.

---

*These criteria are capacity, distribution accessiblity, 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

Central Rock Mine is located in the Bluegrass Region of Kentucky, about 70 miles east of Louisville and 70 miles south of Cincinnati, Ohio. This mine site is within the city limits of Lexington, Kentucky (Figure 2.1-1), in the southwestern part of Fayette County, approximately 7.5 miles east of the Woodford County line. Land use in the surrounding area ranges from urban and suburban to agricultural land. The Central Rock property extends over approximately 165 acres, the majority of which (97 acres) is used for quarry operations; the remaining acreage is either wooded slopes or abandoned pasture and cultivated fields. The highest elevation on the property is about 945 feet above mean sea level (MSL). The shafts for the oil storage cavern would be located at this level (945 feet); the floor of the oil cavern would be between elevations of 645 and 657 feet MSL.

At present, approximately 2000 tons of limestone are mined daily from the subsurface caverns at Central Rock. The FEA is considering purchase of the existing underground caverns, together with sufficient surface area, for conversion of the caverns into a crude oil storage facility, to be part of the SPR Program. The present underground mining activities can be relocated to an area just to the northwest of the existing mine (Figure 2.1-2).

Major construction activities would include: excavating a production and access decline, and drilling a service shaft at the new mine site; sinking six small-diameter pump shafts at the old mine site; installing oil pipelines, pumps, manifolds and metering equipment between the new pump station and the pump shafts; installing an electrical power substation; constructing a pipeline from the Central Rock Mine to the Tates Creek Terminal (a distance of about 13 miles); and constructing terminal facilities (including pumps, meters, control system, and two 120,000-barrel storage tanks) at Ashland's Tates Creek Terminal. No extensive utility corridors would be required under present plans.

Two possible methods are under consideration for developing the oil storage facility. With the first, modification of the existing cavern to receive oil would be delayed to prevent disruption of limestone mining while the new mine is being developed. With the second, modification would be made without delay so as to place oil in storage as soon as possible. This would result in shutting down limestone production for approximately 20 weeks while the new mine is being developed. Both development strategies are addressed in the EIS.

During construction of the project facilities, from 50 to 170 workers would be required. During standby storage, manpower requirements would be limited to perhaps two or three personnel for security and equipment inspection. For planning purposes, the 14 million barrels of crude oil are assumed to be withdrawn approximately once every 5 years, under emergency conditions, in response to an oil supply interruption. The cavern would be filled again as soon thereafter as practical. Approximately 8 to 10 employees would be required during oil transfer. Filling the cavern with oil would require an estimate 71 weeks at 28,000 bbl/day; withdrawal would require 150 days at 93,000 bbl/day.

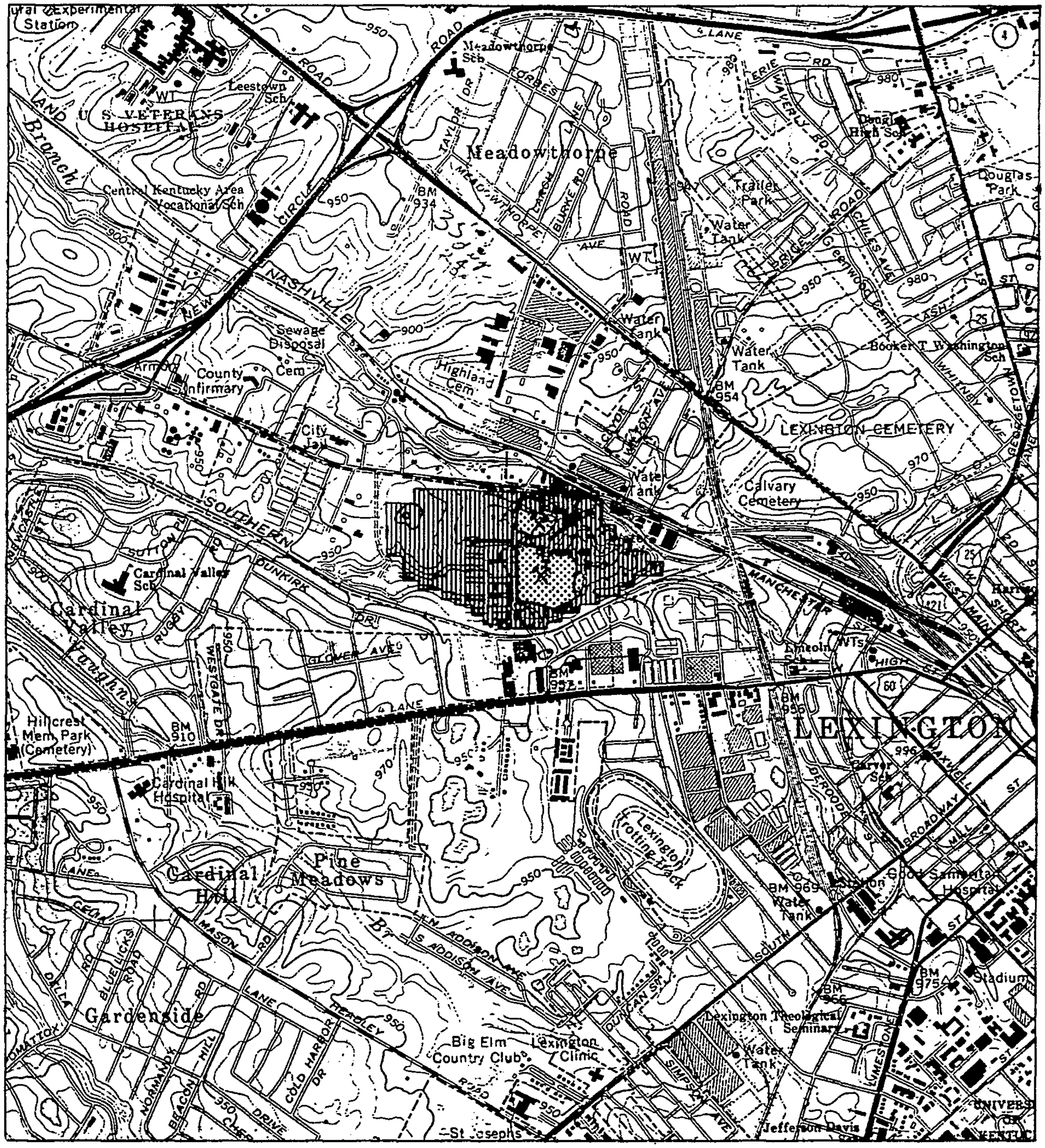
About 9000 man-weeks of labor would be required to develop the Central Rock oil storage facility. This work force would be required for a 59-week period for the temporary mine shutdown option, and for 79 weeks for the no mine shutdown option. Capital costs of constructing the oil storage facility will amount to $6.8 million; total cost of a new limestone mine is $7.6 million. Total project development costs are $14.4 million, or $1.03 per barrel of oil stored.

Waste disposal associated with mine conversion, construction, and operation would consist primarily of overburden and limestone removed in constructing the necessary shafts and decline. All waste limestone materials (totaling about 50,000 cubic yards) would be disposed of inside the existing mine. Other materials excavated would have negligible volume and can be used in site grading. All other construction waste would be removed. Gaseous wastes would be limited to engine exhausts and hydrocarbons vented and flared during cavern filling. Liquid wastes would include sanitary effluent disposed of in a septic tank or routed to the municipal sewage system, and minimal amounts of oily or brine water to be treated and released into a settling pond on the site and subsequently pumped into Town Branch.

The mine conversion and new mine construction would be designed to comply with all MESA and OSHA requirements. The Central Rock limestone mine has been selected in part on the basis of its geologic suitability for both mining and oil storage. The new mine workings would be located 1000 feet to the northwest of the existing mine and would be at least 300 feet from the oil storage cavern, to provide sufficient clearance for safety considerations. Possible accident modes were recognized and accounted for in designing the storage and transportation facilities.

The oil storage and new mine facilities are presently in the preliminary design stage. Future studies would provide detailed information on equipment design, construction methodology, and operational procedures. 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.

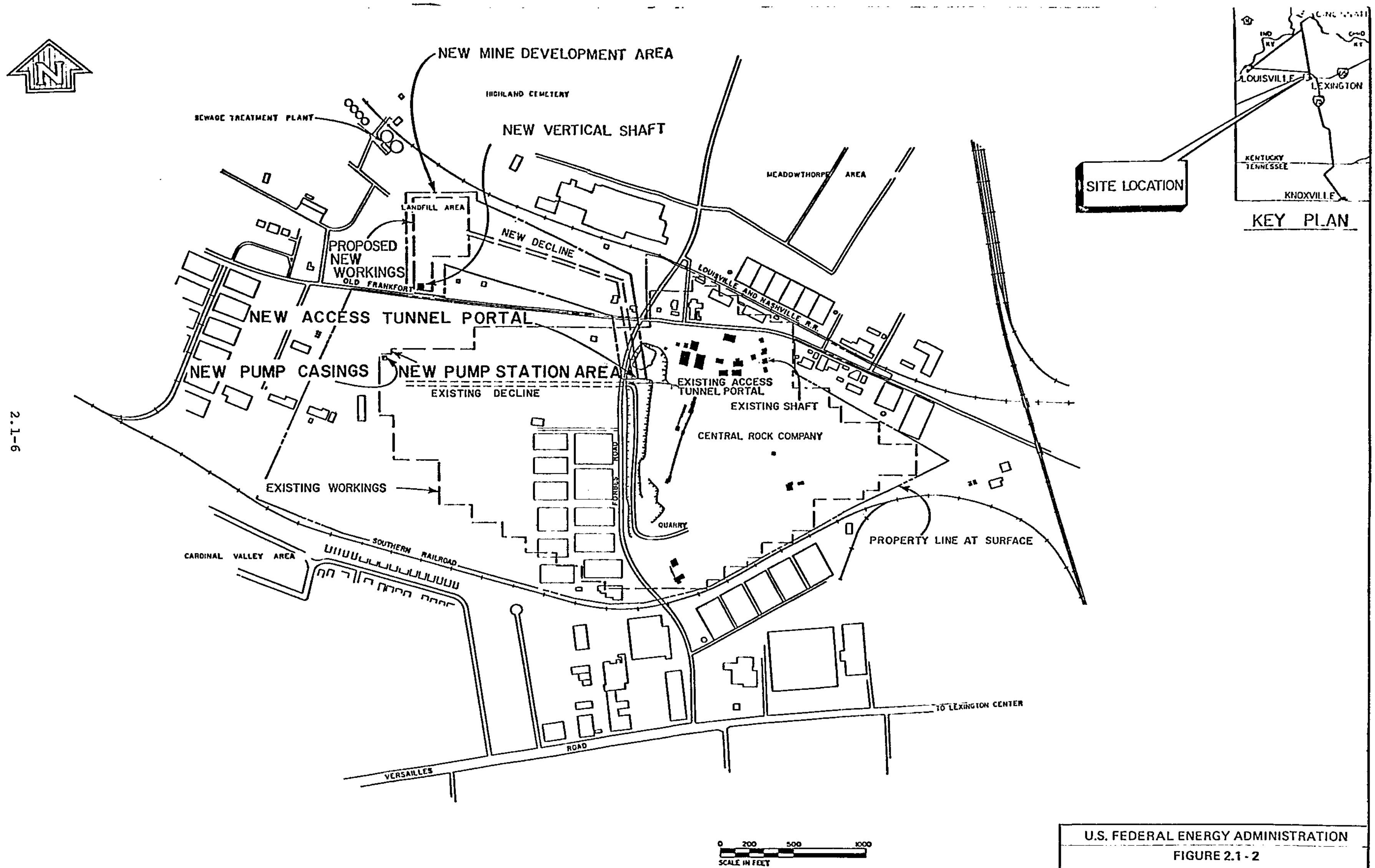
In Kentucky, three state agencies have responsibility for oil pipelines. The Public Services Commission has no fixed requirements, but they recommend that all pipelines be buried; aboveground pipelines are considered undesirable for reasons of public safety and security. The Department of Natural Resources and the Department of Environmental Protection also strongly recommend pipeline burial for reasons of public health and safety. Occasionally permits are granted for temporary surface pipelines. These permits are normally for a maximum of 5 years and are non-renewable. Thus, aboveground pipelines have not been considered as part of the proposed project plan for the Central Rock oil storage facility.



UNDERGROUND WORKINGS, CENTRAL ROCK MINE

QUARRIES, CENTRAL ROCK MINE

FIGURE 2.1-1 Location map of Central Rock Mine in Lexington, Kentucky



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.1 - 2

SITE PLAN - CENTRAL ROCK MINE
LEXINGTON, KENTUCKY

2.2 EXISTING MINE FACILITIES

The Central Rock Mine is owned and operated by Central Rock Company, Inc. The mine is located in a residential-industrial area of west Lexington (Figure 2.2-1). The principal product of the Central Rock Mine is limestone in crushed rock and large aggregate forms. The limestone is used in commercial processes to make concrete, concrete blocks, and an asphalt mix. It is extracted from the mine at a normal operating rate of 2200 tons per average 10-hour day, or about 570,000 tons annually. The maximum production rate is 2500 tons per 10-hour day (650,000 tons annually).

The mine was first operated in 1941 as an open quarry mine. The original topsoil and overburden on the site were removed during these preliminary quarrying operations. At a later date, the operation changed to use of a technology including underground chambers in order to mine high quality limestone. No additional topsoil or overburden removal is anticipated on the property in the near future as a result of mining operations.

The mine surface facilities are located at an elevation of 945 feet above MSL; the existing tunnel portal is located approximately 795 feet above sea level; the floor of the mine is at an elevation of 645 to 651 feet above MSL.

2.2.1 Aboveground Facilities

The total surface area of the property encompasses about 165 acres. Surface facilities at the Central Rock Mine include about 20 buildings that consist of warehouses, a machine shop, office buildings, and other facilities used for repair, refurbishing, and general maintenance (Figure 2.1-2) associated with supporting the mining operation. A new rock crusher is presently being built on the property.

Vehicle access to the property is by paved Forbes Road, which connects Old Frankfort Pike on the north with Versailles Road on the south. Two railroads, the Louisville and Nashville and the Southern Railroad, skirt the property on the north and south, respectively.

The domestic water supply is provided by lines installed by the Lexington Municipal Water Company. These lines supply the human consumption requirements, as well as ancillary washing and cleaning water required periodically on the site. Electric power is supplied by Kentucky Utility to the mine by overhead voltage lines that power the various compressors and crushing operations. The present supply is a 4160-volt, 3-phase, 4-wire, 60-cycle, 1000-ampere service. An underground substation, located in the vicinity of vent hole No. 1, is designed for 4000-horsepower output. Diesel fuel is stored onsite in several small tanks near the machine shop and warehouse area. Sanitary facilities, contained in the mine operating office, are connected to the municipal waste treatment facility. A powder magazine is situated underground in the eastern portion of the mine, away from most of the operational areas and the mine office.

Surface runoff near the site is generally polluted due to extensive use of septic tanks in the area. Surface water entering the mine facility is pumped out to a natural stream (Town Branch) after being held in lagoons at three locations. No further treatment is required to meet local standards.

The volume of solid waste from the mining operation is not large. Those wastes requiring disposal are placed in receptacles and transported offsite by municipal waste removal services. Liquid wastes are not generated by plant operations and occur only when surface effluents are released following rain or snow. This liquid waste is pumped into a settling pond located on the site, from which it is then pumped into Town Branch. Relatively minor amounts of gaseous emissions are produced by equipment associated with mine operation, principally exhaust from diesel trucks, pay loaders, and other equipment.

2.2.2 Underground Facilities

One vertical shaft and one inclined shaft (Figures 2.2-2 and 2.2-3) provide access to Central Rock Mine. The vertical shaft is 15 by 20 feet in cross-section, extends 280 feet deep below the surface, and is lined with concrete along two-thirds of its length. The vertical shaft is no longer used for production; the head frame is presently being dismantled and the shaft would be used for ventilation and emergency exit. The inclined shaft extends on a 10 percent grade from the quarry bottom (140 feet deep) to the mine level (280 feet deep). The shaft is about 30 feet wide, 20 feet high, and 1400 feet long.

The mine was developed at one level by the room and pillar method and encompasses about 115 acres. The average ceiling height of the rooms is 24 feet, except in certain areas where mining by deepening has resulted in room heights up to 50 feet. Approximately 75 percent recovery has been attained through room and pillar extraction. The pillars are approximately 25 feet in both length and width. Hall development is also approximately 25 feet. The caverns provide an estimated potential oil storage capacity of 14 million barrels.

The mine floor level slopes to the northwest at about 0.7 percent grade with the highest area at elevation 660 and the lowest at 645 feet above MSL (Figure 2.2-3). The local floor contour is relatively smooth, except for three areas where floor mining operations have deepened rooms 25 feet below the mine floor level. These sublevels are completely isolated below the main level so that drainage from these areas is impossible. The one sublevel near the vertical shaft has some seepage accumulation (seepage from shaft area).

Three 18-inch diameter vertical holes penetrate the mine and are used for ventilation. The locations of these holes are indicated on Figure 2.2-2. At the end of the inclined entry is a 75-foot by 75-foot sump, with a 10 percent grade from the south end.

Removal of seepage water is not a major problem at the Central Rock Mine. Inflow from the vertical and inclined shafts is the only source of water; currently, dewatering of these shafts is accomplished by a single 3-inch pump at the top of the slope shaft.

In terms of ground water movements in the area, it is clear from examination of the open cuts that water does move horizontally on bedding planes within the limestone sequence. However, there is virtually no vertical movement. The total quantity of water involved is extremely small. There is a ground water seal around the mine even though there is virtually no evidence of water inflow to the mine itself.

The equipment used underground consists of a double boom over-under jumbo used for face drilling. Front-end loaders are used to haul the material from the face to diesel trucks, which transport the material to the surface crushing facilities.

2.2.3 Mine Operation

Central Rock, Inc., operates four separate divisions: 1) Lexington quarry; 2) Harrodsburg quarry; 3) asphalt; and 4) concrete. In addition, the company owns controlling stock in Lexington Concrete Products, Inc.

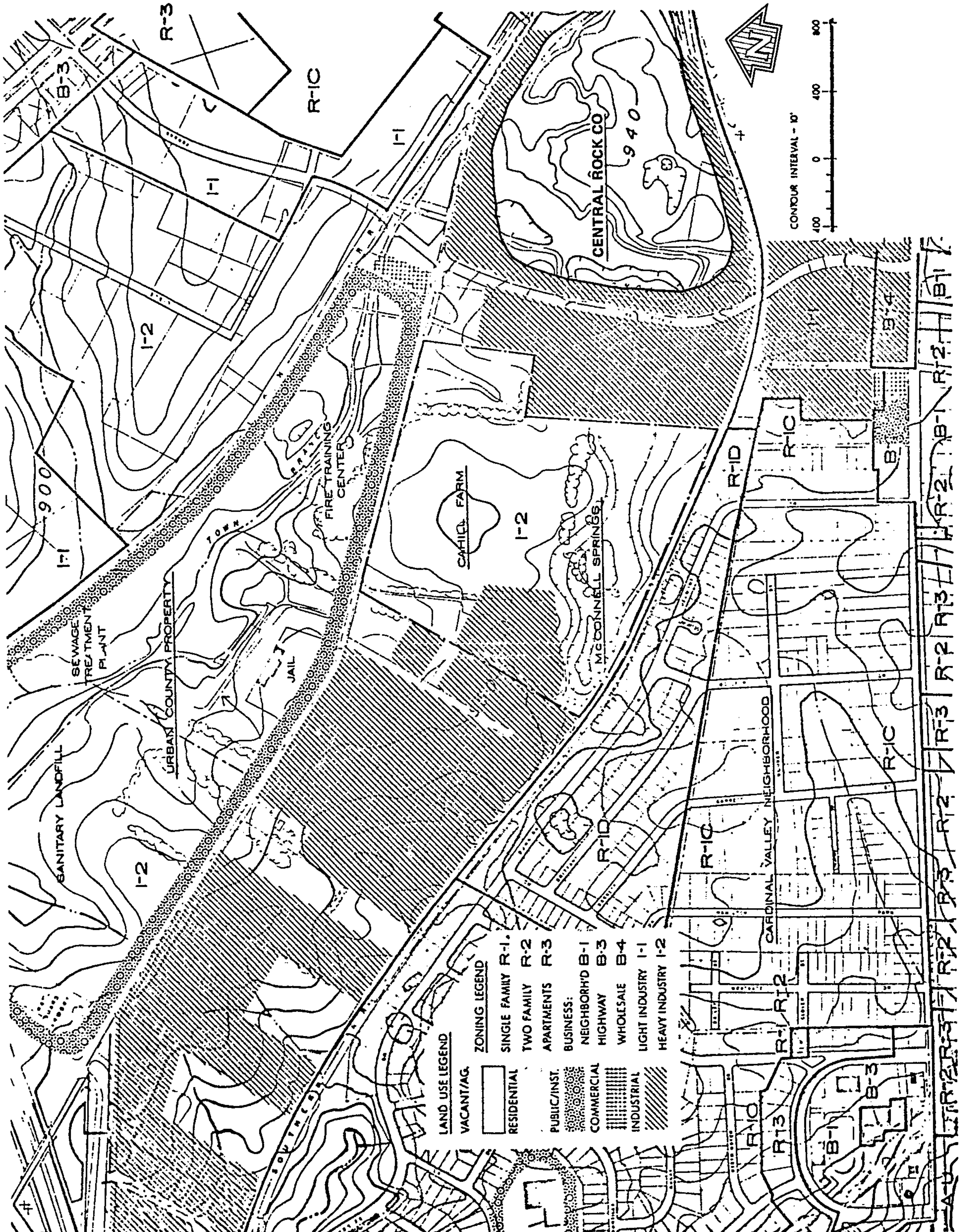
The surface and mining operations employ approximately 180 people. Of these, 25 are employed full time in the Lexington quarry (half in the mine and half on the surface). An additional 60 people are employed by Lexington Concrete Products, about 40 of them at the Lexington Central Rock facility.

Gross income in 1975 for Central Rock, Inc. was approximately $3 million. Assuming that the construction industry re-establishes normal growth trends during 1976 and 1977, this figure could reach as high as $5 million. Lexington Concrete Products, Inc. grossed approximately $3 million in 1975 also.

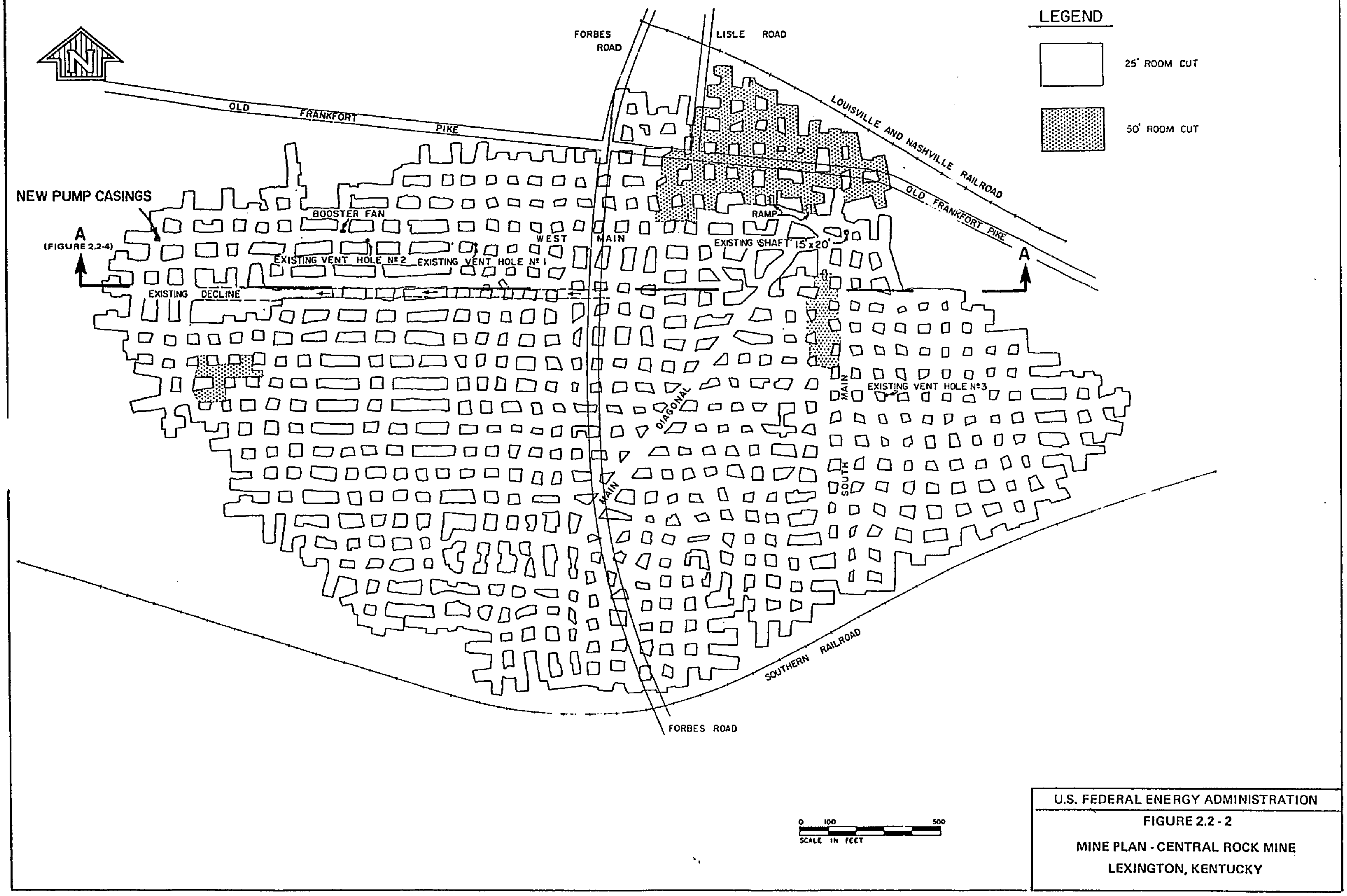
Limestone is extracted from the underground mine at Central Rock and is transported to the surface by diesel truck. Upon reaching the surface, the limestone is deposited in a crushing machine, which consists of a trammel mill and several crushers and conveyors that divide the crushed limestone into various sizes from coarse aggregates to very small fines. These products are then transported either to a concrete plant, asphalt mix plant, concrete block plant, or directly to the consumer by diesel truck.

Normally, limestone is extracted from Central Rock Mine at the rate of 2200 tons per average 10-hour period. Daily production rates of 2500 tons are possible; however, the yearly average extraction rate is 2200 tons.

Currently, limestone mining is nearly complete at the present level and it is planned to move the operations 70 feet lower. At this new level, there is a stratum of good to excellent quality limestone.



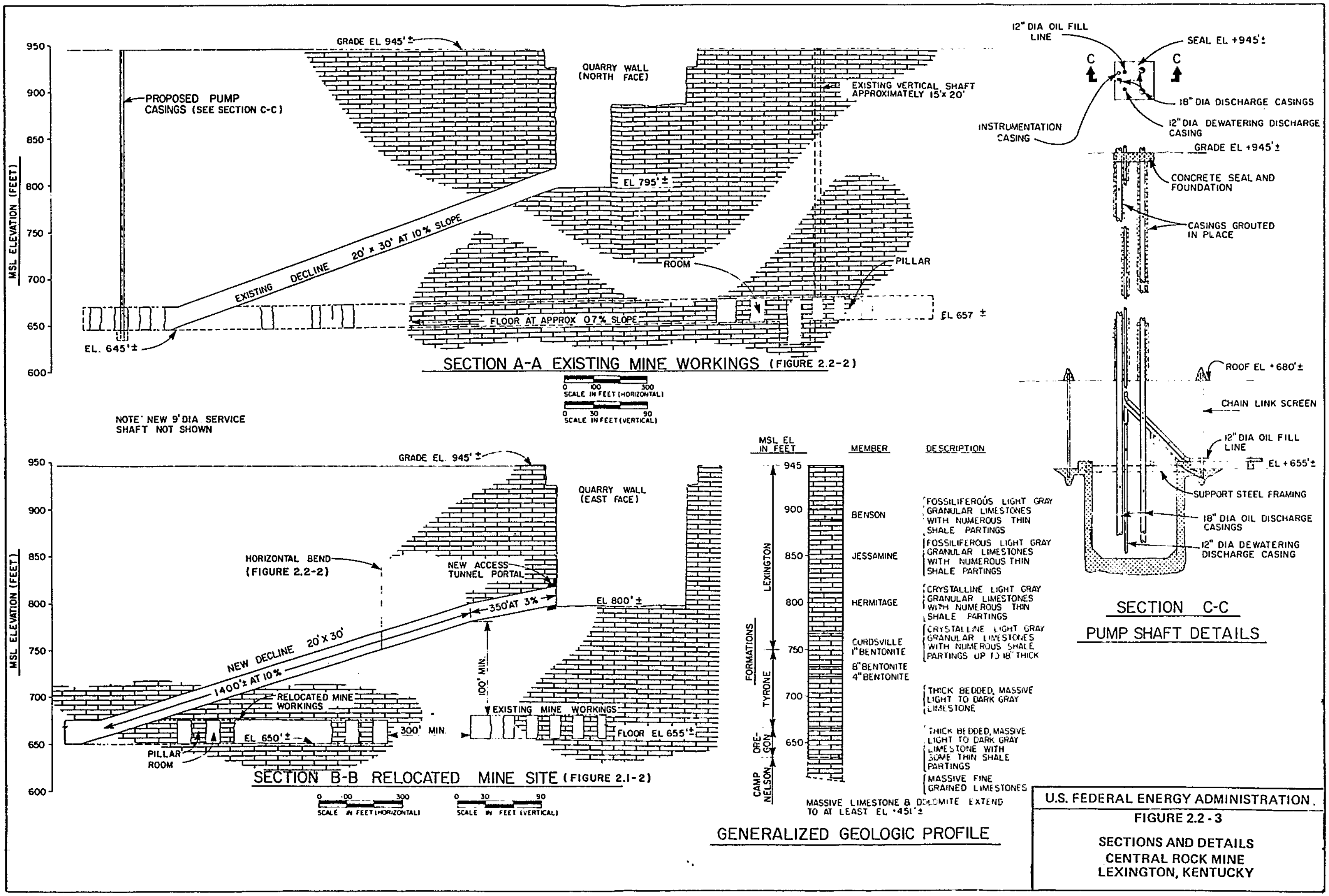
Source: Lexington/Fayette County Historic Commission & Central Rock Company
FIGURE 2.2-1 Central Rock area land use



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.2 - 2

MINE PLAN - CENTRAL ROCK MINE
LEXINGTON, KENTUCKY



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.2-3

SECTIONS AND DETAILS
CENTRAL ROCK MINE
LEXINGTON, KENTUCKY

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, associated with oil migration, to safety and other environmental impacts. 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, and intrusion into the cavern by water or gas. Volume decreases in the stored oil due to barometric, tidal, and 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 can be 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; or 4) the flows can be reduced to such levels 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 saturing 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 flowage exceeds 400 to 700 cubic feet per day per 500,000 barrels of storage space. However, grouting itself is relatively expensive, such that 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 stored 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 Central Rock Mine for crude oil storage primarily involves removing the existing shaft equipment, sinking a new pump shaft, installing oil pumps and casings, sealing the existing production decline and service shaft, and constructing the necessary pipelines and terminal facilities.

One option for developing Central Rock oil storage capacity would avoid or minimize the disruption of mine production activities. For this option, mine conversion would be scheduled to phase smoothly with development of a new limestone mine. The corresponding schedule of construction activities is given on Figure 2.3-1; required manpower is given in Table 2.3-1.

The second option for developing Central Rock oil storage capacity provides the most rapid means of getting oil into storage. For this option, mine conversion is given first priority, requiring shutdown of Central Rock limestone production for a period of approximately 20 weeks, until the new mine can be developed. This option places 4 million barrels more of oil in storage by January 1, 1979 than does the previous option. The corresponding schedule of construction activities is given on Figure 2.3-2; required construction manpower is given in Table 2.3-2.

2.3.1 Underground Conversion

2.3.1.1 Pump System

Central Rock has an existing 20-foot by 30-foot access tunnel. A 15-foot by 20-foot vertical shaft is also located in the mine, but is currently not being used (see Figures 2.2-2 and 2.2-3). Neither the access tunnel nor the shaft is located in the low area of the mine. Since an extensive drainage network would be required to recover the oil from either opening, a new pump shaft would be constructed. The existing shaft and decline would be sealed with concrete bulkheads keyed into the limestone. Above the roof of the cavern, a concrete bulkhead would be constructed to provide support for the lower casings; the bulkhead would be keyed well into the rock to provide a vapor seal. The bulkhead in the decline would be placed between the roof of the mine and the bentonite layer above the limestone.

Rather than excavating a large diameter shaft with a multipump installation, a one-shaft/one-pump arrangement was adopted (Figure 2.2-3). Each pump would be contained in a separate, lined shaft with grouting placed around the outside perimeter of the shaft casings. The mine is shallow (280 feet deep), and no special problems in shaft excavation or sealing are envisioned. However, a geotechnical exploration in the area of the new shafts would be required prior to final design. The 6 shafts (3 for oil withdrawal, 1 for the level gauge and instrumentation, 1 for filling the cavern, and a spare for dewatering or sludge removal), can all be conventionally drilled. A steel-encased metal lining would be inserted in the shaft and grouting placed behind the casing area. A concrete collar and foundation would be installed at the surface to support the pumps and piping. One 18-inch vent hole would be drilled at the higher end of the mine (west side) for ventilation during filling.

2.3.1.2 Mine Caverns

The existing mine cavern has a floor that drains toward the area of the new pump shaft so that construction of drainage channels should be minimal. Three areas in the mine are lower than the surrounding floor elevation but, if these are filled with water, oil losses can be minimized. A sump would be excavated at the base of the pump shaft, lined with a concrete curbing, and a screen placed around it. Rock bolting and wire mesh would be placed above the sump area to contain any minor spalling. All the debris and equipment located in the mine can be hauled from the mine by truck out the access tunnel. No significant quantity of waste rock is stored in the mine.

Two faults with a NNE strike have been identified within the mine. One of these was inspected and indicates up to 18 inches of vertical displacement, but the fault has been largely rehealed with calcite and occasional spalerite inclusions. Large brecciated blocks of the parent limestone were evident within the calcite rehealing material. No water was dripping from the cavity and there was no evidence of any iron or calcite stains which would indicate leakage in the past. Nevertheless, large voids and openings penetrating the rehealing material were observed. One of these openings was seen to be about 8 to 12 feet high and contained crystal growth, which implies past groundwater movement. As a precaution, these openings would be sealed by placing dental concrete in major voids, followed by contact grouting, to further ensure containment of the crude oil within the mine (see section 3.2.6).

2.3.2 Aboveground Conversion

Only a minimal amount of surface grading would be necessary to prepare the aboveground area on the Central Rock property for oil storage. Additional acreage would be required for the construction of a new pump station (Figure 2.3-3) and a pipeline to connect the storage facility with an existing pipeline at Tates Creek Terminal (Figure 2.3-4). Total land usage requirements are estimated to include about 9 acres for Tates Creek Terminal (including storage tanks, Figure 2.3-5), about 2 acres for the pump station located on the mine property, and 65 acres for the pipeline right-of-way between the storage area and the terminal (assuming a 13.5-mile-long, 40-foot-wide pipeline right-of-way).

Electrical power would be provided from an existing transmission line located on the property. Minor modifications to the existing distribution system used by Central Rock and installation of a new 2000 kva electrical substation and transformer would be adequate to provide the necessary power supply for oil transfer and storage operations.

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.

Plans showing the proposed manifolding, meter proving loop, and metering system at the Central Rock and Tates Creek Terminals are presented on Figures 2.3-6 and 2.3-7, respectively. 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 currently being developed.

To meet the proposed 150-day withdrawal schedule, two 300-horsepower electric cavern booster pumps (Figure 2.3-6) would be required. The booster pumps would be used to pump the oil from the mine cavern to the surface facility. In addition, two 350-horsepower mainline pumps would be required to move the oil between the storage site and Tates Creek. Piping and instrument designs were based on 50,000 bbl/day fill and 111,000 bbl/day withdrawal probable maximum flow rates.

The oil distribution system was designed for unattended operation. A supervisory control system would allow the operator to control all normal fill and withdrawal functions from a remote location (perhaps not at the cavern or the terminal site). Automatic safety shutdown controls and pressure relief devices have been included in the system.

A 16-inch pipeline would be constructed and buried between the Central Rock storage facility and the Ashland oil booster station located at Tates Creek Terminal (Figure 2.3-4), a distance of about 13 miles. The pipeline alignment would run from west Lexington to the west and south around the perimeter of the city and eastward to the Tates Creek Terminal No significant elevation differences or hydraulic control points occur between the storage facility and the terminal. Oil would be left in the pipeline system under pressure during standby storage. System conditions would be continuously monitored.

Some problems may be encountered in procuring the pipeline right-of-way. Although the route was selected to avoid populated areas, the area is developed in valuable racehorse pasturelands. Restoration of this land would be a necessity.

2.3.3 Operation

Oil will be delivered to the Tates Creek Terminal by tanker and pipeline from the Gulf of Mexico. Oil would be offloaded from VLCC's to 45,000 deadweight ton (DWT) tankers just south of the Mississippi River. The tankers would transport the oil through Southwest Pass 170 miles upriver to St. James, Louisiana. Oil would be pumped into temporary storage at the St. James Terminal, then into Capline to Patoka, Illinois. From Patoka the oil would be pumped through the Ashland pipeline to Tates Creek. 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 Tates Creek Terminal to refineries would be via the Ashland 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 Tates Creek.

The Central Rock storage facility is planned to be filled by pipeline through the Tates Creek Terminal (Figure 2.3-4) at a minimum rate of 28,000 BPD. At this rate, full storage of 14 million barrels of oil will require 71 weeks. Withdrawal during an oil supply interruption would utilize the same pipeline system, delivering approximately 93,000 BPD to the Ashland Pipeline over a 150-day period.

A modern supervisory control system would allow the dispatches to observe the status of operations at the pump station and terminal, and to shut down the flow in the system should any potentially dangerous deviation in normal operating conditions occur. One function of the supervisory system would be to serve as an accurate leak detection system 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's utilizing the supervisory control system or by automatic 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

The oil storage facility is assumed to be emptied and refilled once every 5 years to meet national emergency conditions. Oil stored at Central Rock has unlimited storage life.

To maintain a state of operational readiness, it would be necessary to maintain a trained crew available to carry out oil transfer activities. A total of 8 to 10 men should be sufficient; only 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 limestone mine work force or from Ashland's Tates Creek Terminal and might be used during cavern filling as well.

During standby storage periods, a total of 2 or 3 men would sufficient to man the storage facilities. Duties would include security routine maintenance, and equipment monitoring.

A temporary flare system would be used during fill periods for combusion of hydrocarbon and hydrogen sulfide vapors vented from the cavern. The venting would also prevent excessive buildup of vapor pressures in the cavern. Approximately 42 pounds per day of hydrocarbons would be emitted during this period; flaring is a standard method of reducing concentrations of combustible gases and SO_2 in the mine vicinity. 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 be monitored and should not exceed 1.5 atmospheres.

Only during fill and withdrawal would significant numbers of workers be present. Minimal ground water seepage occurs in the existing mine. Should small amounts of ground water gradually accumulate in the cavern, the water could be periodically pumped to the surface and treated at the pump station or transported via tanktruck or tankcar to suitable facilities for removal of oil, gas, and salts.

Oil spillage is the only significant potential source of pollution at the storage facility. An oil spill contingency plan is described in Section 4.3.8.6.

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 or at Ashland's Tates Creek Terminal.

Water supply for domestic purposes would be taken from the existing Lexington municipal water system. No other significant quantities of water would be required.

2.3.4 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 Central Rock. 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.

2.3.5 Costs

Cost estimates have been generated for mine conversion excluding acquisition and abandonment of the mine site and purchase of oil. Capital costs, expressed in 1976 dollars, regionally adjusted, and not including interest or escalation during construction, are given in Table 2.3-3. Costs are unaffected by the selection of the mine development option since a new pump shaft would be constructed in either case. Operating costs, including labor required for inspection of the mine shafts and all oil distribution facilities, maintenance of equipment, instrumentation and shafts, taxes (if applicable), insurance, and power, are estimated to be $184,400 per year for static storage, plus an additional $6,500 per month for filling, and $18,400 per month for withdrawal. "These costs do not include transport of oil by tanker to St. James Terminal or by pipeline to Tates Creek.

TABLE 2.3-1 Estimate of employment and earnings, mine conversion and replacement mine construction for no mine shutdown, Central Rock site

Week	Average No. of Workers per Week		Average Annual Wage	Total Earnings	Number of Workers by Place of Permanent Residence: Within Commuting District	Number of Workers by Place of Permanent Residence: Beyond Commuting District	Earnings by Place of Permanent Residence: Within Commuting District	Earnings by Place of Permanent Residence: Beyond Commuting District
42-93	Specialists (25%)	38	$ 22,000	$ 820,000	--	(100%) 38	--	$ 820,000
(51	Skilled (35%)	52	18,000	920,000	(80%) 42	(20%) 10	$ 736,000	184,000
weeks)	Nonskilled (40%)	60	12,000	710,000	(100%) 60	--	710,000	--
	Total	150		$2,450,000	102	48	$1,446,000	$1,004,000
93-121	Specialists	13		$ 155,000	--	(100%) 13	--	$ 155,000
(28	Skilled	17		165,000	(80%) 14	(20%) 3	$ 132,000	33,000
weeks)	Nonskilled	20		130,000	(100%) 20	--	130,000	--
	Total	50		$ 450,000	34	16	$ 262,000	$ 188,000
	Project Total			$2,900,000			$1,708,000	$1,192,000

TABLE 2.3-2 Estimate of employment and earnings-mine conversion and replacement mine construction for temporary mine shutdown, Central Rock site

					Number of Workers by Place of Permanent Residence		Earnings by Place of Permanent Residence	
Week	Average No. of Workers per Week		Average Annual Wage	Total Earnings	Within Commuting District	Beyond Commuting District	Within Commuting District	Beyond Commuting District
42-89 (47 weeks)	Specialists (25%)	43	$22,000	$ 855,000	--	(100%) 43	--	$ 855,000
	Skilled (35%)	59	18,000	960,000	(100%) 59	--	$ 960,000	--
	Nonskilled (40%)	68	12,000	738,000	(100%) 68	--	738,000	--
	Total	170		$2,553,000	127	43	$1,698,000	$ 855,000
89-101 (12 weeks)	Specialists	23		$ 117,000	--	(100%) 23	--	$ 117,000
	Skilled	31		129,000	(100%) 31	--	$ 129,000	--
	Nonskilled	36		100,000	(100%) 36	--	100,000	--
	Total	90		$ 346,000	67	23	$ 229,000	$ 117,000
	Project Total			$2,899,000			$1,927,000	$ 972,000

TABLE 2.3-3 Cost summary for Central Rock Mine project

Construction Costs[a]

Mine Conversion	$ 803,000	($0.057/bbl)
New Mine Development	7,553,000	($0.54/bbl)
Oil Handling and Distribution Facilities	6,007,000	($0.43/bbl)
Total Construction Costs	$14,363,000	($1.03/bbl)

Operation and Maintenance Costs

Annual Storage[b]		Monthly During Filling	Monthly During Withdrawal
$184,400	(1.32 cents/bbl)	(16.4 months)	(5 months)
		$ 6,500	$ 18,400
		(0.05 cents/bbl)	(0.13 cents/bbl)

---

a Excludes acquisition and abandonment of mine site and purchase of oil. Costs are not affected by development option

b Static storage costs do not include costs of new mine operation. They do include $84,700 in storage facility ad valorem taxes applicable only if the facility is privately owned and operated

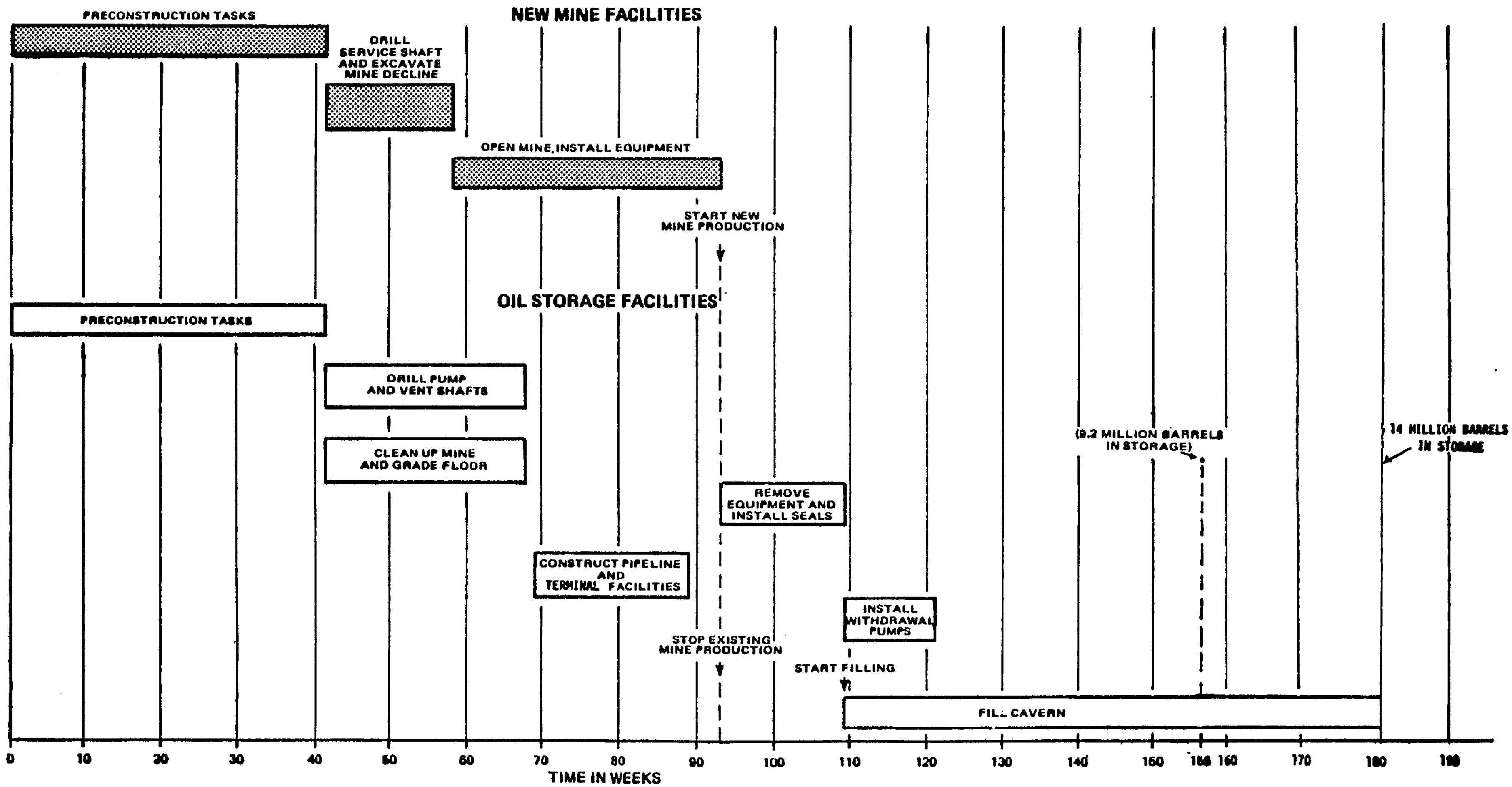


FIGURE 2.3-1 Construction schedule for oil storage project development without limestone mine shutdown, Central Rock site

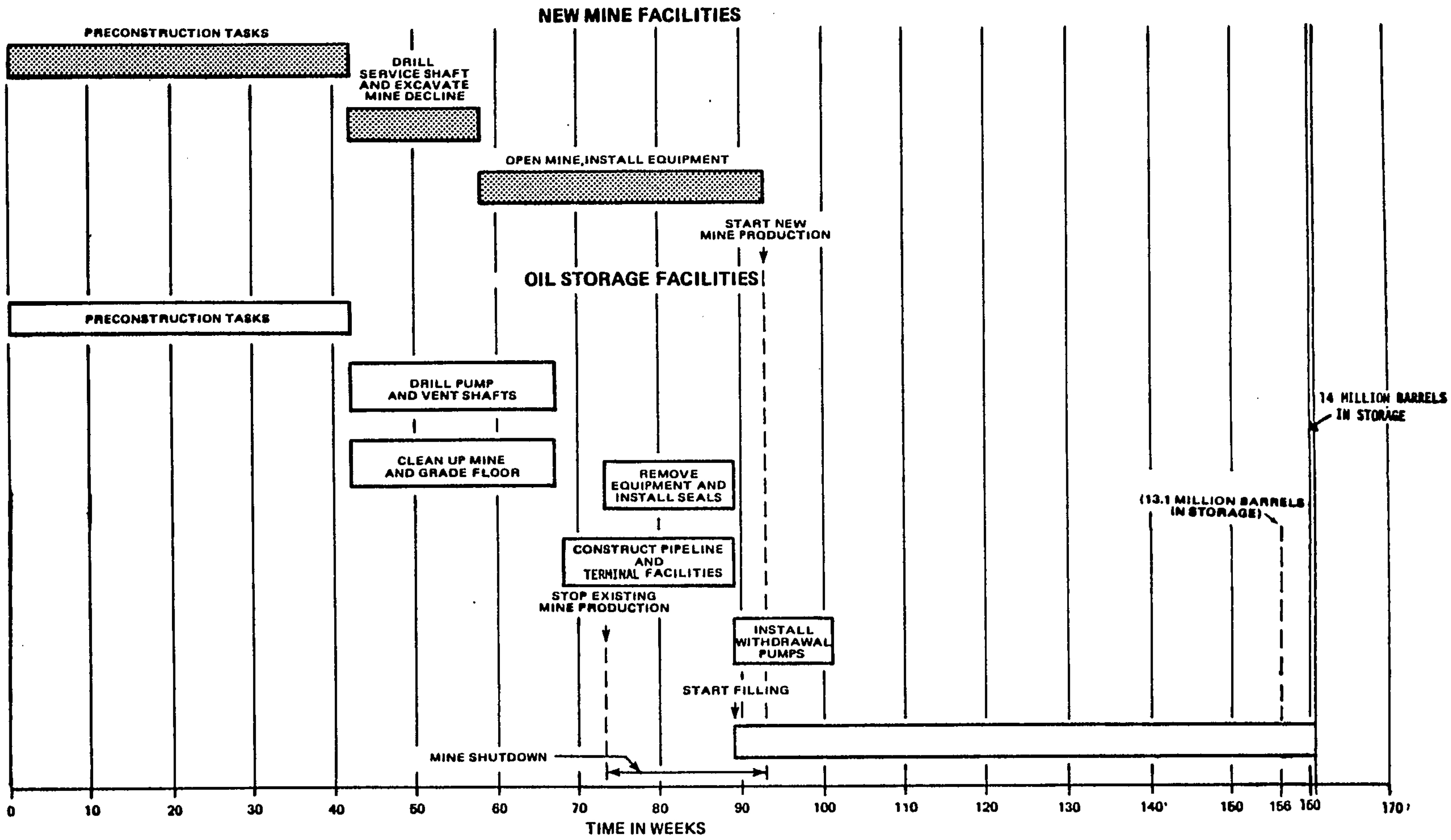
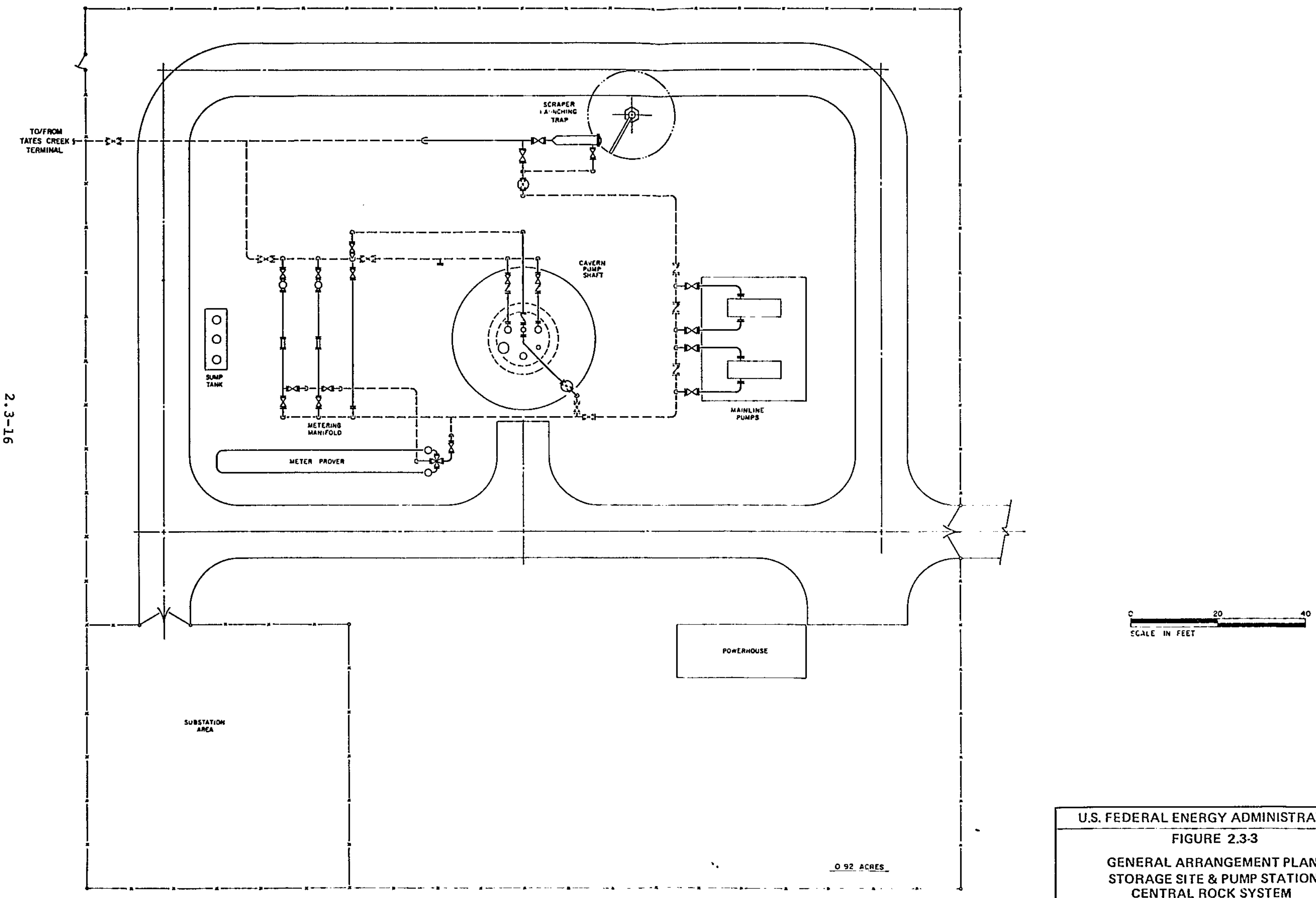


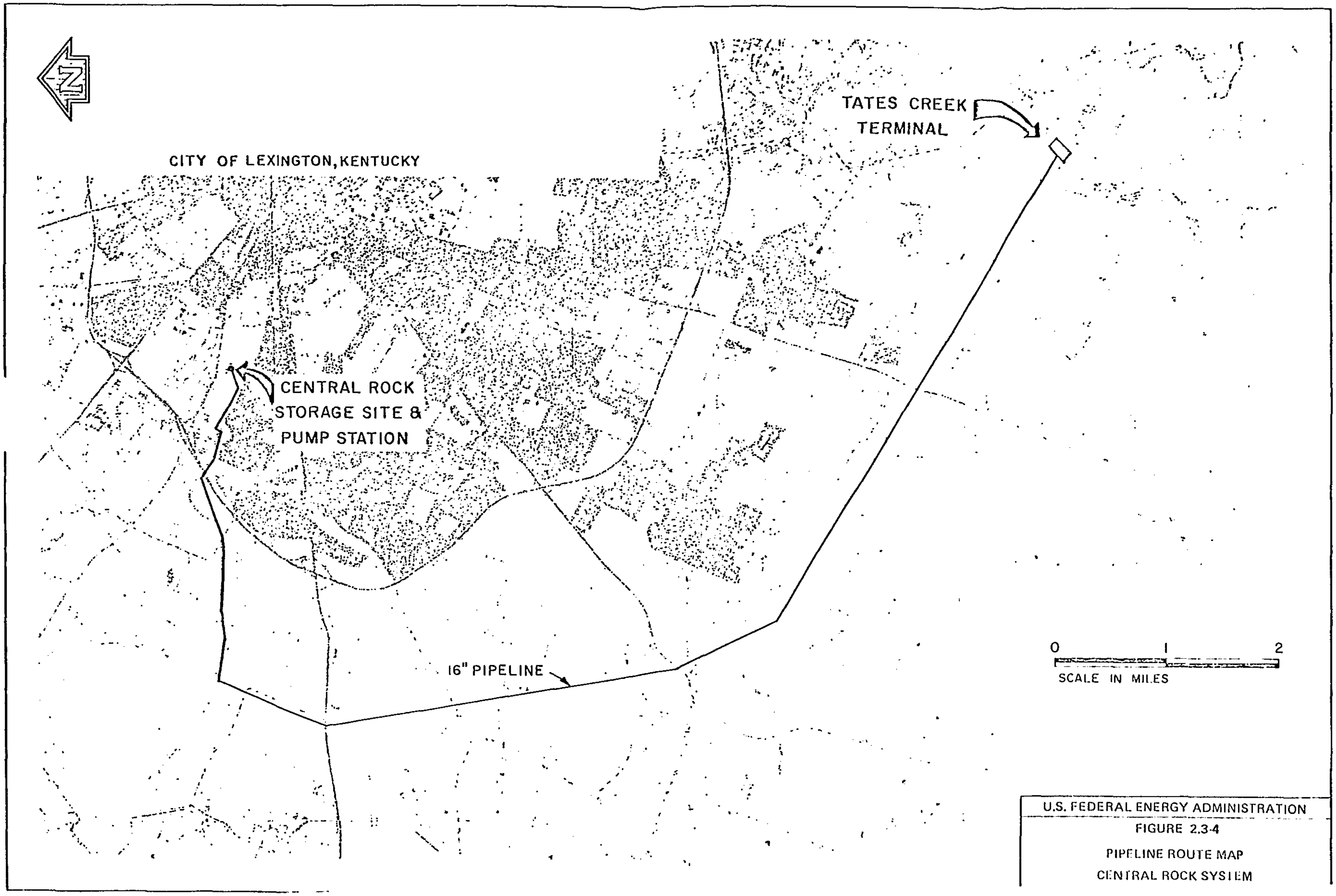
FIGURE 2.3-2 Construction schedule for oil storage project development with temporary limestone mine shutdown, Central Rock site



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-3

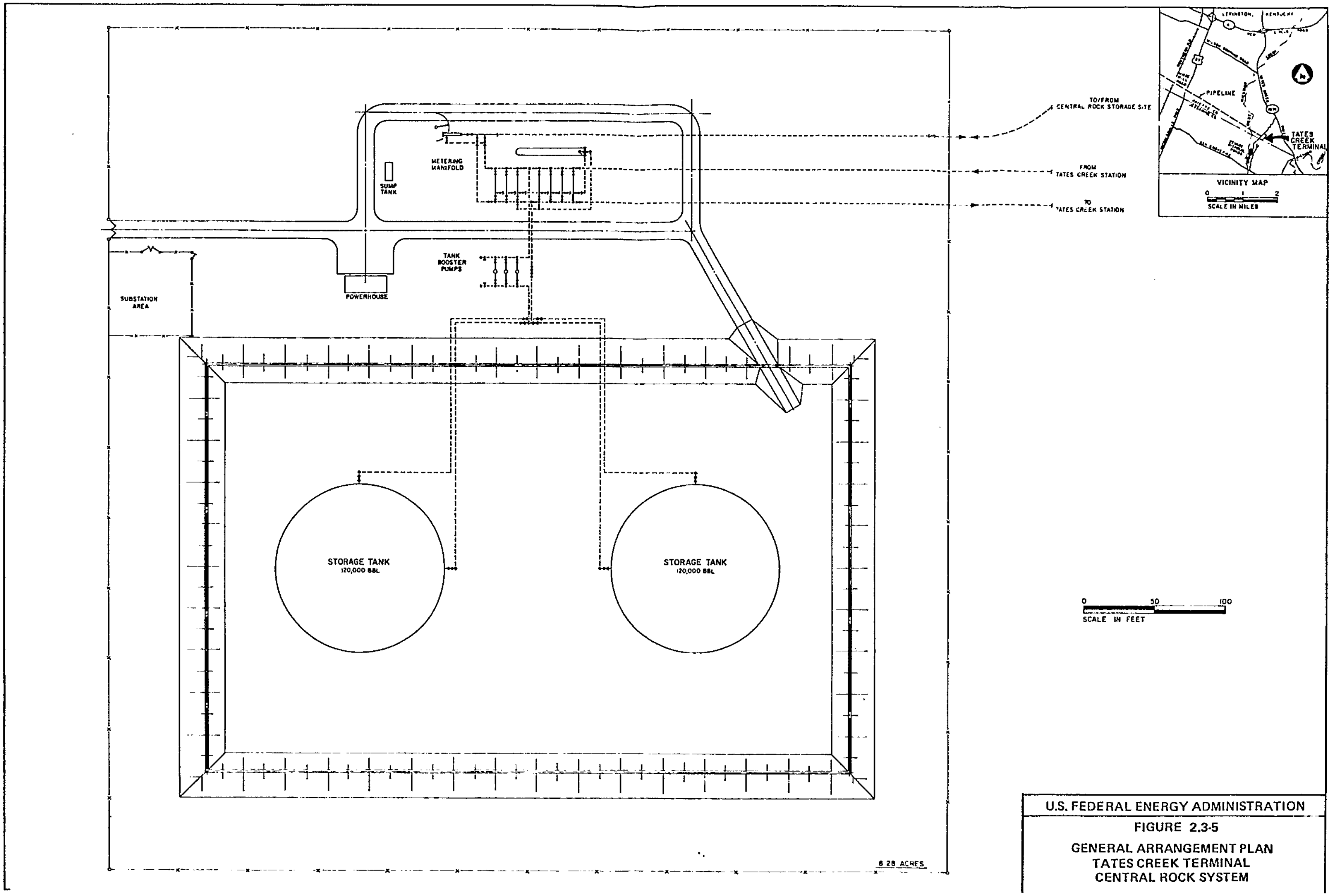
GENERAL ARRANGEMENT PLAN
STORAGE SITE & PUMP STATION
CENTRAL ROCK SYSTEM



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-4

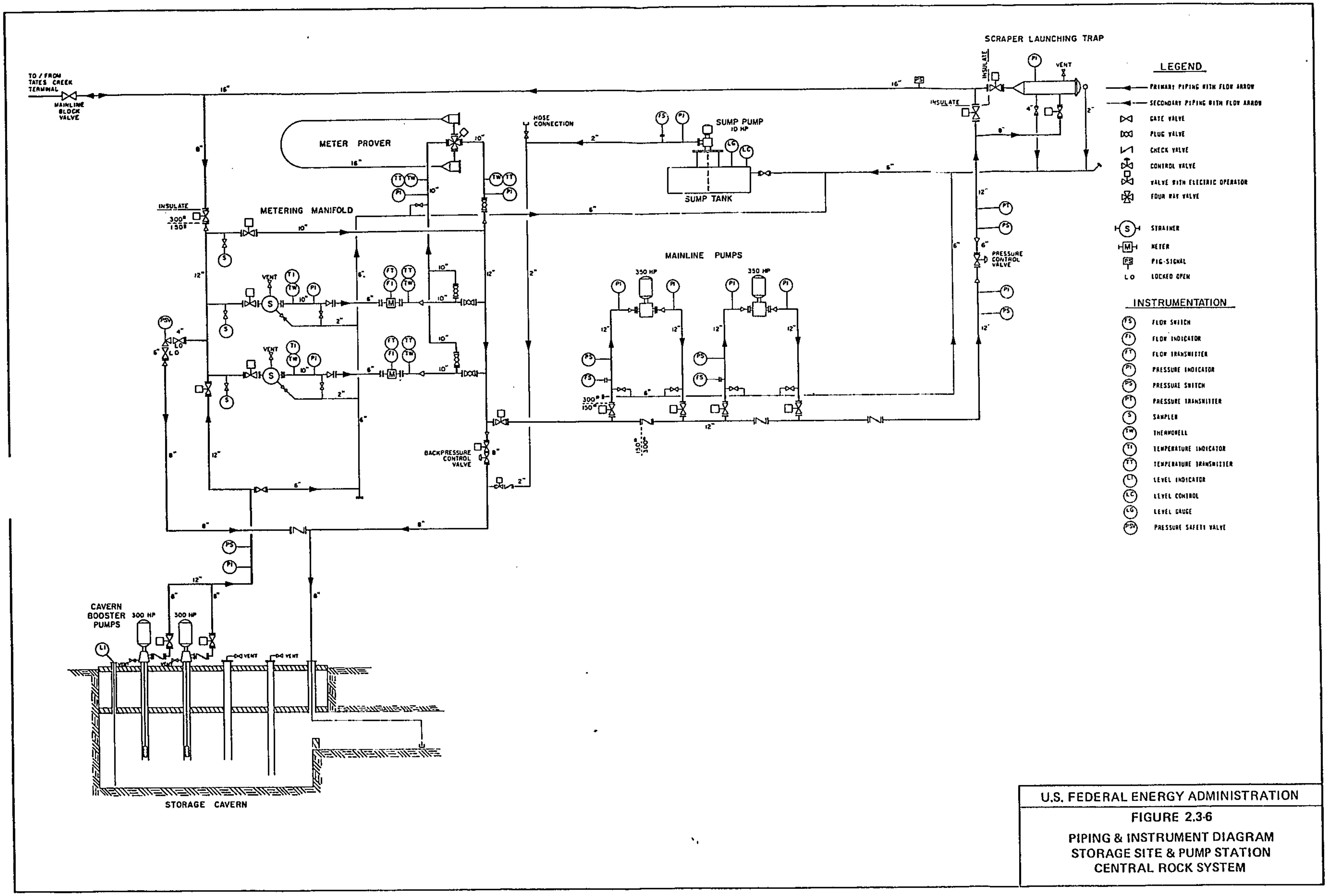
PIPELINE ROUTE MAP
CENTRAL ROCK SYSTEM



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-5

GENERAL ARRANGEMENT PLAN
TATES CREEK TERMINAL
CENTRAL ROCK SYSTEM

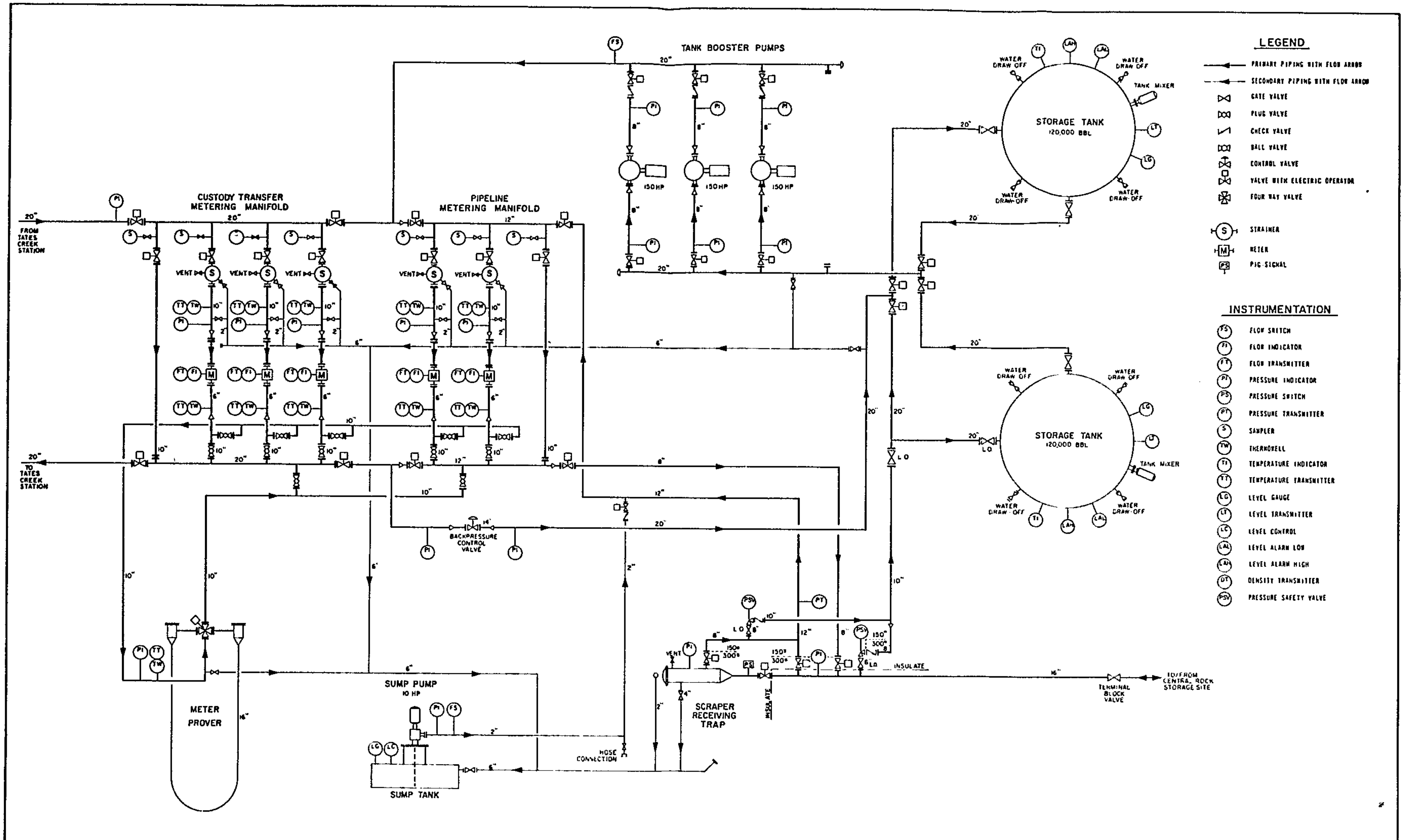


2.3-19

U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-6

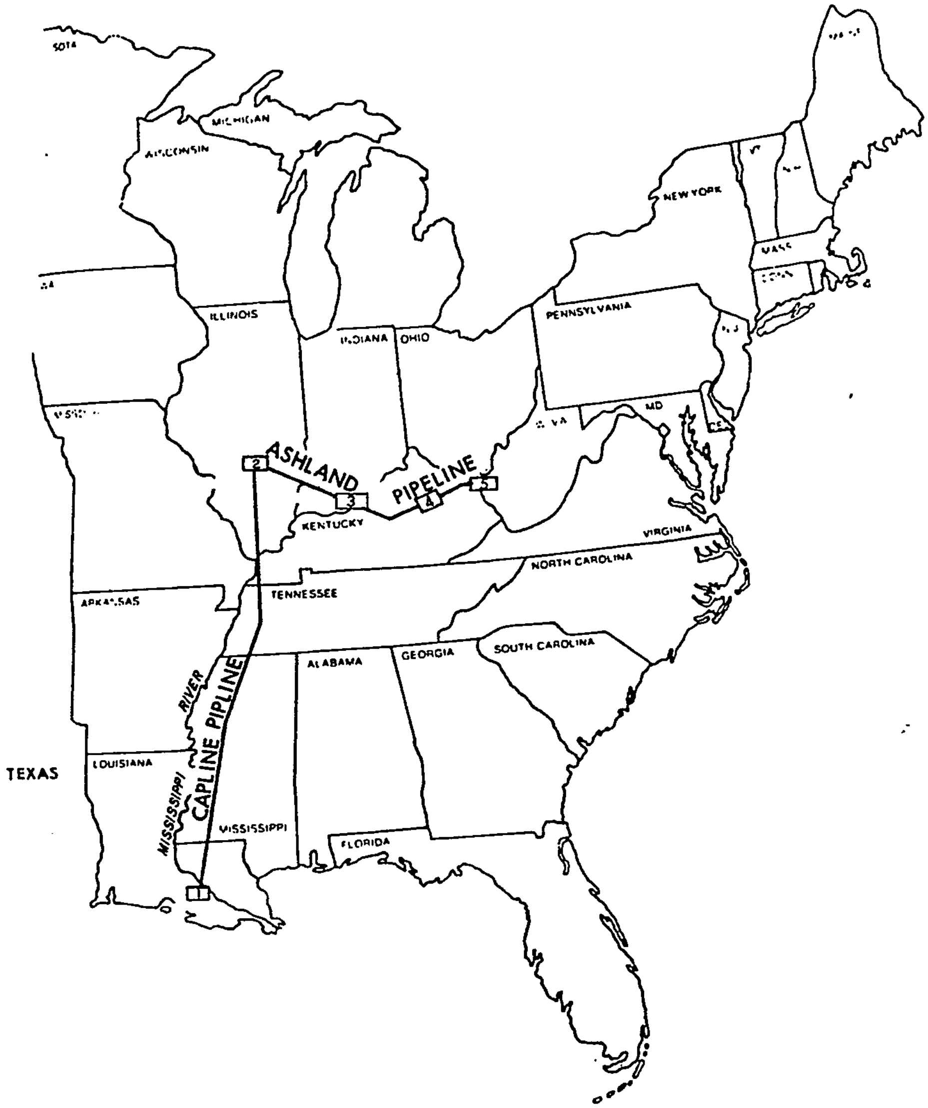
PIPING & INSTRUMENT DIAGRAM
STORAGE SITE & PUMP STATION
CENTRAL ROCK SYSTEM



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-7

PIPING & INSTRUMENT DIAGRAM
TATES CREEK TERMINAL
CENTRAL ROCK SYSTEM



TERMINALS

1 ST. JAMES
2 PATOKA
3 OWENSBORO
4 TATES CREEK
5 CATLETTSBURG

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

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 exists ample space near Central Rock Mine to relocate the current mining operations, and it is assumed that the owner would 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 undecided 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. One plan allows the completion of the new mine prior to closing the existing mine (Figure 2.3-1). This would avoid any disruption of limestone production, but would require a delay of 20 weeks in converting the existing mine. Such a delay could reduce the storage capability of the facility within the time frame of the ESR from 13.1 million barrels to about 9.2 million barrels. The second plan provides for conversion of the existing mine in the most expeditious manner possible, including closing production operations at a point in time that would not delay the conversion effort (Figure 2.3-2). Although new mine construction could occur concurrently with conversion activities, this plan would result in a suspension of limestone production for about 20 weeks. This could impact significantly upon the socioeconomic 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 Tables 2.3-1 and 2.3-2. Since only the timing of activities is changed, both options require approximately the same labor input.

The decision to construct the new mine and the final design and construction activity itself would be the responsibility of the Central Rock Company. However, a new mine design is presented in this section for purposes of impact analysis. The design concept for the new mine provides equivalent facilities suitable for the current production capacity and work force. Existing aboveground facilities would be retained to the extent practical.

The minimum distance between the new mine caverns 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 mineral structure at Central Rock compared to that in most coal mines, this is considered to be a conservative design.

In selecting the space requirements for the new mine, the production rate, the mining cycle, and the owner's requirements were used to determine the number of working faces needed. Additional space was also provided for the storage of limestone appropriate to mine requirements, for shop areas, and for haulways. Material handling and production equipment would be located at the surface as in the existing mine.

2.4.1 Underground

A 20-foot by 30-foot access tunnel or decline extending 650 feet north and 1100 feet west of the existing mine site would be provided for the new mine (Figure 2.2-3). The portal of the new tunnel would be situated directly over a row of pillars in the mine at a minimum separation distance of 100 feet. A greater separation distance between the decline and the oil storage caverns can only be achieved by excavating the decline from ground level instead of from the existing quarry. The new decline would go under a road (the old Frankfort Pike before turning northward into the new mined area. An 8-foot-diameter shaft would also be drilled to be used for a service and access shaft. The new mine level would be at elevation 650 feet above MSL which is approximately 300 feet below ground level (Figure 2.2-3).

Opening a new mine in the limestone would be somewhat the same as the current operation of limestone extraction described in section 2.2.3.

The operation can be done in four phases:

<u>Phase 1</u> - Excavation of the decline to the new area. Excavation of the shaft can begin at this time.

<u>Phase 2</u> - Initial excavation around the bottom of the decline to begin forming the rooms and working faces.

<u>Phase 3</u> - Excavation of the 500-foot tunnel between the shaft and the decline. Excavation of the rooms started in Phase 2 would be completed in this phase. It is anticipated that most of the excavated material can be used in processing.

<u>Phase 4</u> - The excavation required to open storage areas, shop areas, and sufficient working faces for normal operation would be done in this phase, as would the transfer to the new mine.

2.4.2 Aboveground

All the aboveground material handling equipment (i.e., crushers and conveyors) at the Central Rock Mine are situated on the surface; no new equipment would be needed. Some minor modifications to the surface facilities may be required as part of the relocation. Hoisting and head frame equipment would not be provided at the new shat because the owner does not have this equipment at the existing shaft (the access tunnel is used for production operations). The remainder of the surface equipment and office facilities would be unaffected by the project.

2.4.3 Operation

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

2.4.4 Costs

Construction costs (Table 2.3-3) for developing the new mine (including sinking the access tunnel in the new mine area) are estimated to be $0.54 per barrel storage capacity, or $7.6 million. Total project development costs are, thus, $14.4 million, or $1.03 per barrel of stored oil, including mine conversion and new mine costs, but excluding site acquisition, abandonment, and oil purchase costs.

2.5 REFERENCES

The following is a list of references relating to underground storage:

Ayers, D.L. and Hoover, D.Q., 1974, Gas turbine system using underground compressed air storage: American Power Conference (May).

Dames & Moore, 1975, Underground gas storage, Utilization of the subsurface environment: Dames & Moore, Park Ridge, Illinois.

Federal Power Commission, 1973, Guidelines for environmental reports, Order no. 485, Docket no. R-473, Implementation of the National Environmental Policy Act of 1969, Order amending Part 2 of the General Rules to provide environmental reports: FPC, Washington, D.C.

_____, 1974, Final environmental impact statement: Bureau of Natural Gas, Northern Natural Gas Company, Dallas Center Underground Storage Project, Docket no. CP72-251 (June).

Harboe, Henrick, 1971, Economical aspects of air storage power: American Power Conference (April).

Illinois Environmental Protection Act, 1972, Those amendments by the General Assembly which became law on or before July 1, 1972: Ill. EPA.

Katz, D.L. and others, 1959, Handbook of natural gas engineering: McGraw Hill, New York.

Katz, D.L. and Coats, K.H., 1973, Underground storage of fluids: Ulrick's Bookstore, Ann Arbor, Michigan.

Katz, D.L., 1975, Pumped-air storage in northern Illinois (a confidential study).

Kavernen Bau and Betriebsgesellschaft, 1974, Underground storage brochure.

Mace, Charles, 1975, Deepest combustion project proceeding successfully: Oil and Gas Journal, vol. 73, no. 46 (November).

Quarles, John, 1974, Subsurface emplacement of fluids: Administrator's decision statement no. 5: Federal Register, vol. 39, no. 69 (April).

Rogers, F.C. and Larson, W.E., 1974, Underground energy storage: The American Power Conference 36th Annual Meeting (May).

Sherlock, Phillip and others, undated, Environmental studies for a pumped storage - nuclear station power complex: International Conference on Pumped Storage Development and its Environmental Effects, University of Wisconsin, Milwaukee, and American Water Resources Association.

Stal-Laval Technical Information Letter, 1968, Air storage power: Stal-Laval, TG, KTh 4/68, 15.6.68.

Stys, Z. Stanley, 1975, New energy-storage concept sold: Electrical World (June 15).

Tek, M.R. and others, 1966, New concepts in underground storage of natural gas: American Gas Association Monographs, New York (March).

U.S. Nuclear Regulatory Commission, 1975, Regulatory guide 4.7 - General site suitability - criteria for nuclear power stations: U.S. NRC, Office of Standards Development, Washington, D.C.

Winar, Richard M., 1975, Possibilities for increased underground gas storage along the Atlantic Seaboard: Paper presented to the Transmission Conference, American Gas Association (May).

SECTION 3.0

DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1 INTRODUCTION AND SUMMARY

3.1.1 Existing Site Environment

Central Rock Mine has been proposed as a potential crude oil storage facility suitable for the SPR Program. This section summarizes the existing physical, biological, and human environment surrounding the mine site. Detailed site information for Central Rock Mine, Tates Creek 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 Tates Creek are provided in Section 3.10.

Central Rock Mine is located in the Bluegrass Region of Kentucky. The 165-acre site lies within the city limits of Lexington, in Fayette County (Figure 2.1-1). The mine is an underground limestone operation that began in 1941. The extracted limestone is used to make concrete and concrete blocks, and is also used in an asphalt mix. These operations support a work force of approximately 70 men (in two shifts) and an overall employment of approximately 180 people. Central Rock Company has mineral and surface rights for the 165 acres, with the exception of the surface rights for one tobacco warehouse complex along Forbes Road. General land use in the area within 5 miles of the site ranges from urban and suburban to agricultural and industrial uses.

The climate in the area is classified as temperate and characteristically continental: warm, humid summers and cool winters. The area has long growing seasons and abundant rainfall. Air quality is generally good because of the absence of large concentrations of heavy industry and also because of the relatively low population densities. However, short-term local air quality problems may occur as a result of hydrocarbon emissions due to automobile and other vehicular traffic.

The Bluegrass Region of Kentucky supports an abundant and wide variety of wildlife that helps to support a large sport hunting and fishing activity. Commercial fishing in the area is very limited. Because of its urban location, only small mammals such as red fox, opossum, rabbits, squirrels and raccoons, rodents (such as moles), rats and mice, and several species of birds are likely to be found on the mine property. There is no suitable habitat at the mine site for waterbirds, herons or shorebirds.

Fayette County has an area of about 283 square miles (179,200 acres). Agriculture has been important in the county since early settlement of the region; tobacco and livestock are the major agricultural products. Two-thirds of the farmland in the county is pastureland. Of the 165 acres on the Central Rock site, 59 percent is used for quarry operations, 29 percent is oldfield-pasture, and 12 percent is wooded slopes. An old farmstead and several tobacco warehouses are also located on the property.

Lexington is a service and distribution center for the Bluegrass Region. The local economy is more dependent on wholesale and retail trade, medical centers and universities, horsebreeding, and the tobacco industry than on mining activities. The fastest growing sectors of the local economy are finance, insurance, real estate, and government. Agricultural economy has dropped in growth during the past 10 years.

3.1.2 Future Conditions in the Area Without the Proposed Action

The Lexington-Fayette County area is expected to continue significant development during the next 10 to 20 years. Of the 283 square miles in Fayette County, only 40 square miles were urbanized in 1972. By 1990, it is estimated that another 20 square miles will be urbanized. Population will increase from 174,000 (1970) to 263,000 in 1990. Although urbanization has not brought air pollution problems to the region, the area is faced with challenges in soil erosion, water supply, water pollution and water disposal. Employment is expected to increase 67 percent, but agricultural jobs are expected to decrease 67 percent. The greatest increase is estimated to be in nonmanufacturing jobs, which will increase by 40 percent. The fastest growing nonagricultural areas will be services, local and state government and finance, insurance, and real estate.

At Central Rock Mine, it is unlikely that any significant change from current conditions will occur. Future limestone operations will depend on market conditions. However, there is a large volume of easily accessible, high quality mineral to sustain current production levels for several decades. Other mining levels similar to that proposed for the SPR Program could be developed in the near vicinity of the present activities.

If the SPR Program were not implemented at the Central Rock Mine site, the present extraction method would continue for the foreseeable future. Approximately the same work force would be employed. Current production averages 2200 tons per day, and would probably continue at the same rate. It is planned to move the current mining operation to a new level, 70 feet deeper than the current production level. The plans include eventual installation of an underground primary crusher and conveyor system to transport the limestone from the mine up the 1400-foot incline shaft to the rock-crushing treatment system on the surface.

Due to the locally unique character of Central Rock Mine, certain sections could be sold and developed for residential or other uses. However, there is no apparent reason for such an action to take place in the near future, particularly since the mine is an economically successful operation and the owner is in the midst of substantial expansion and improvement of facilities. Therefore, future conditions at the mine site without the project are projected to change little from present conditions. Air and water quality, noise levels, land use, and the character of nearby communities should remain substantially the same as they are now.

3.1.3 Organization of the Section

The following sections present details of the existing environment in the region around and at Central Rock Mine. The sections have been developed to include the various physical, chemical, biological, and socioeconomic factors important to the development of Central Rock Mine as an SPR site. An attempt has been made to describe all factors as completely as possible, especially with regard to the important parts of the existing environment that could be affected by a major oil spill.

3.2 GEOLOGIC CHARACTERIZATION OF THE REGION AND MINE SITE

3.2.1 Regional Physiography

Kentucky may be subdivided into several physiographic provinces, depending on varying geologic conditions. Lexington lies in the Bluegrass Region, which comprises a large, roughly circular portion of north central Kentucky. As a part of the much larger Interior Low Plateau of the central United States, the Bluegrass Region is a central lowland area mostly developed on Paleozoic limestone. The Bluegrass Region is divided into the Inner Bluegrass, the Eden Shale Belt, and the Outer Bluegrass Subprovinces (Figure 3.2-1).

Typically, the Inner Bluegrass terrain, including the vicinity of Central Rock Mine, is gently undulating and dissected with well-developed karst features including numerous sinks, springs, and occasional underground streams. Elevations typically range from 900 to 1000 feet. Northwest of downtown Lexington, slopes typically vary from 0 to 6 percent; southeast of the city, slopes are somewhat steeper, locally up to 20 percent. The Kentucky River is the sole major drainage feature, skirting nearly the entire southern half of the subprovince perimeter, 10 to 20 miles distant from Lexington. Unlike other local drainages, the Kentucky River is sharply incised up to 400 feet or more into the undulatory surface of the rest of the subprovince. Along its margins, tributaries are also deeply incised; nearby topography is mature and rough.

The Outer Bluegrass terrain is essentially identical to the Inner Bluegrass. Between these regions the Eden Shale Belt shows a more dissected topography with a fine dendritic drainage pattern and slopes ranging from 6 to more than 50 percent along small narrow tributary valleys. The Highland Rim section (or "Knobs") is a narrow belt of hills encircling the Bluegrass Region. The topography is typically that of conical hills separated by broad, relatively flat stream valleys. Summits and flood plains are relatively flat; side slopes typically range from 12 to 20 percent.

3.2.2 Regional Stratigraphy

The Central Rock site is located within the Interior Lowlands Province, situated on the outer part of the Central Stable Region of North America. Since Precambrian times, this region has had a relatively gentle tectonic history and, as a result, Paleozoic and younger sediments that overlie the Precambrian basement are flat-lying or gently dipping.

The strata (Figure 3.2-2) exposed in the Bluegrass Region range in age from Middle Ordovician to Middle Mississippian on the geologic time scale (Table 3.2-1). The generalized local stratigraphic column is shown on Figure 3.2-3. Deep units include a basal Cambrian sandstone resting on Precambrian basement, overlain respectively by the thick lower Cambrian Knox Dolomite, and the Ordovician St. Peter Sandstone. Collectively, in central Kentucky, these strata are about 5000 feet thick. Strata of the early Middle Ordovician High Bridge Group are the oldest exposed rocks of the Lexington area and consist mostly of dolomitic limestones. Formations (in ascending order) composing the group are the Camp Nelson, Oregon and Tyrone limestones. The Central Rock Mine workings are excavated from the latter two formations. The High Bridge Group is directly overlain by Lexington limestone, a heterogeneous succession of bioclastic carbonate rocks of the Middle Ordovician age, approximately 310 feet thick near Lexington. In the vicinity of Central Rock Mine, the Lexington is the youngest exposed rock unit, but elsewhere in the Lexington area it is overlain respectively by the Eden Shale and the fossiliferous limestones, and shales of the uppermost Maysville and Richmond Formations of Ordovician age.

Silurian strata outcrop in a narrow band on the eastern and western margin of the Bluegrass, overlapped on their southern margin by mid-Devonian units. Silurian rocks are predominately limestones and dolomites, with lesser amounts of interbedded calcareous shale. Devonian strata are comprised of limestone with interbedded shales and siltstones.

Lower and Middle Mississippian strata outcrop in the Knobs and the vicinity, and consist of shales alternating with thinner sandstone and siltstone units. Recent alluvial deposits comprised of silt, clay, sand,

and gravel commonly occur in the beds of primary and secondary streams of the area, and occasional high-level terrace deposits are found along the Kentucky River.

Soils that overlay the bedrock (Figure 3.2-4) in the vicinity of Lexington belong to the so-called Maury-McAfee Association. The topography of this association is characterized by undulating ridges and short, steeper slopes around sinkholes and drainageways. Caverns and other solution features are common. Maury soils are deep, well-drained, and fertile, and are found on broad ridgetops and on some side slopes. McAfee soils are well-drained or somewhat excessively drained, are less than 3 feet deep over bedrock, and occur on steep slopes around drainageways and sinkholes.

3.2.3 Regional Structure

The most prominent structural features of the region include the Cincinnati Arch, and the Rough Creek and Kentucky River Fault Zones (Figure 3.2-5). The Cincinnati Arch is one of several structural highs determining the distribution of outcrops in the central interior of the United States. The axis of the arch trends northeast-southwest from central Tennessee across Kentucky. Developed along the axis near Lexington is the Jessamine Dome, with outward dips typically ranging from 10 to 40 feet per mile. Superimposed on the regional dip are numerous minor flexures. Uplift of the Jessamine Dome occurred initially in the pre-mid-Devonian, and again at the end of the Paleozoic Era during the Appalachian Revolution. As shown by the structural contours (Figure 3.2-5), the eastern margin of the dome is marked by the Eastern Kentucky "Geosyncline" (McFarlan, 1943).

The east-west trending Rough Creek Fault Zone, or uplift, has been alternately interpreted as a series of anticlines, accompanied by reverse en-echelon faulting, a thrust fault, and a wrench fault. Uplift ranges up to 1500 and 2500 feet or more.

The major fault systems of the Bluegrass Region are the Kentucky River Fault Zone and the Lexington-Maysville Fault Zone. The Kentucky River Fault, located 12 to 13 miles to the southeast of the Central Rock

Mine site, is a zone of en-echelon normal faults. It trends N80°E and may be traced from the vicinity of Mt. Sterling in Montgomery County southwest to Lincoln County. The fault sharply separates the Inner Bluegrass from the other portions of the Bluegrass and forms a boundary between the Knobs and Bluegrass. The fault acts as a structural control over the course of the Kentucky River, which enters the Bluegrass from the southeast, veers sharply to the southwest, and follows the fault zone for several miles before resuming its normal course to the north. The fault may have experienced movement during the late Tertiary uplift, as suggested by an injected sandstone dike of that age at Clays Ferry in Madison County.

The Lexington-Maysville Fault trends northeast-southwest and passes about 30 miles southeast of Central Rock Mine. This fault is structurally similar to the Kentucky River Fault and extends as a single fault to Maysville on the Ohio River; the southern half of the Lexington-Maysville Fault is a graben.

3.2.4 Regional Seismicity

Historic earthquake activity in Kentucky has been relatively mild (Figure 3.2-6). The earliest recorded earthquake in the area occurred in 1779; the most recent in 1968. During the period in between, 16 other earthquakes were recorded in southwestern Kentucky (Jackson Purchase area), primarily along the Ohio and Mississippi Rivers. Only three quakes have been recorded within 100 miles of the site, only one of which exceeded Intensity VI (see the modified Mercalli intensity (MMI) scale, Table 3.2-2). The closest recorded earthquake to Central Rock Mine was 56 miles away, at Maysville, Kentucky (May 28, 1933). Its intensity was V. All significant shocks (Intensity V and greater) recorded in the state are given in Table 3.2-3.

Epicenters of all significant shocks (Intensity V and greater) within approximately 200 miles of the site are shown on Figure 3.2-7.

The closest major recorded activity to Central Rock Mine was three earthquakes near New Madrid, Missouri (270 miles to the southwest), which occurred in 1811-1812. These three earthquakes were the largest ever recorded in the central and eastern United States. Reportedly, these shocks (about Intensity XI) were felt over a 2 million-square-mile area and changed the surficial topography of about 30,000 to 50,000 square miles. Although the shocks were also recorded throughout Kentucky, their strength was reported to be less than Intensity V in the vicinity of Central Rock Mine.

The one other zone of relevant seismic activity is more than 150 miles east of the site in the Central Appalachians. With the exception of the Charleston, South Carolina earthquake, this region has had a moderate amount of low-level earthquake activity.

The maximum earthquake expected at the mine site would be similar to the effects recorded from the 1811-1812 New Madrid event; site intensity generated by such an event probably would not exceed Intensity VII. In addition, the site could have small ground motion (Intensity III and less) from time to time in response to distant Intensity IV-VI earthquakes.

3.2.5 Mineral Resources

The most commercially valuable mineral resource in Kentucky is coal, with oil and gas the next most important. All three of these resources are produced in both eastern and western Kentucky, beyond the limits of the Bluegrass Region. Minerals produced in the Bluegrass Region are limited mostly to limestone and clay, although other minerals of potential economic importance occur locally.

The primary mineral resource of the Inner Bluegrass is limestone, quarried and mined for use as crushed stone. There are 62 abandoned and 3 operational limestone quarries in Fayette County. One of the most well known is Central Rock Mine. Begun as a surface quarry, the operation shifted to a mine-type endeavor when horizontal expansion became limited. The mine produces road material, agricultural lime, and shaly or cherty materials as aggregate. Other local mines include an open-face quarry located in the southeast corner of the county (Lambert Brothers Stone Company/Vulcan Materials Company), and an operation presently using both open-face and pit mining, located 4 miles north of Central Rock Mine.

In addition to limestone and clay, vein material deposits are also an important mineral resource of the Inner Bluegrass, although they have not been commercially exploited in Fayette County since the 1920's. The chief vein material is barite. Veins range in thickness from 2 to 3 inches to a maximum of 24 feet. A majority of the veins occur in fissures that have developed through faulting or jointing. Generally, barite veins are characteristic of the strata of the High Bridge Group. The majority of the veins strike north-south and are primarily vertical to dipping slightly less than 60^{0}.

Phosphates from some of the more phosphatic varieties of limestone are another potential mineral resource. Phosphate rock is derived from leaching of calcium carbonate, mainly from units of the Lexington limestone. Such rocks occur widely throughout the Bluegrass Region, but none are currently mined for that purpose in Fayette County.

3.2.6 Mine Geology

The eastern half of the Central Rock property (Figure 2.1-2) has been extensively quarried to variable depths. However, the surface of the western half of the property is essentially natural, dominated by an irregular, elongate, east-west trending sinkhold about 30 to 40 feet deep. Beyond the sinkhole, the ground surface is undulating, with a relief of 20 to 30 feet. Where undisturbed, bedrock is overlain by 5 to 8 feet of soil.

The floor elevations of the underground workings (Figure 2.2-3) are mostly near elevation 655, about 250 feet below natural ground level, and more than 100 feet below the deepest extent of surface quarrying. Workings are about 25 feet high, and the natural rock cover throughout the workings (excluding the inclined access) is 75 feet or more.

The underground workings are confined primarily to the lower 25 feet of the Tyrone Formation and the upper part of the Oregon Formation. In a few small areas, the floor has been deepened to include up to 100 feet of the underlying Camp Nelson limestone. All three formations belong to the Ordovician High Bridge Group. The Tyrone limestone is of pure quality, locally lithographic, and shows scattered inclusions of coarsely crystalline calcite. The member contains several bentonite beds ranging from a few inches to a few feet thick. The Oregon limestone is granular to finely crystalline magnesian limestone about 30 feet thick.

The Camp Nelson Formation is a relatively impure limestone that exhibits irregular patches of finely-crystalline magnesian limestone similar to the Oregon Formation. However, the Nelson Formation is in a matrix of dense, locally lithographic limestone, with scattered small calcite crystals in layers of a few inches to a few feet thick.

The rock column above the workings is comprised of the remaining 60 feet or so of the Tyrone Formation and the overlying Lexington limestone. All surface quarries are excavated from the latter.

The Lexington limestone shows well-developed karst features near the surface, as well as well-developed right-angle vertical jointing, visible in the quarry faces. Associated with other karst features (including the large sinkhole mentioned earlier) is a well-developed secondary solution effect that occurs along the bedding planes and joints. This effect provides a significant secondary porosity to the depth of active ground water movement (about 90 to 100 feet below ground level). Below this depth, solution effects are not apparent, joints are tight, and the remainder of the Lexington limestone and the underlying Tyrone, which together form the remainder of the cover above the workings, appear essentially impermeable.

Three faults have been documented within the mine, the most notable of which is located in the eastern part of the workings. This fault trends roughly north-northeast, with a vertical displacement of about 1 foot. The fault in the walls and roof of the mine is 2 to 3 feet wide and is filled with calcite, occasional sphalerite inclusions, and large brecciated blocks of the parent limestone. Large voids and openings, however, appear within the calcite filling. One fault opening is 8 to 12 feet high and lined with calcite crystals. Another cavity in the mine roof is 5 feet long, 2 feet wide, and 3 to 5 feet deep. No moisture was found around the cavity, nor was there any evidence of past ground water inflow from the cavity. While these cavities are very minor and few in number , the fault itself transects the entire mine. A long linear depression found at the surface of the mine probably is a surface expression of the subterranean fault.

Jointing within the mine is generally vertical to subvertical and strikes north-northeast. The joints exhibit considerable continuity along the roof of the mine. Along strike, these joints commonly feather out and reappear a little further on. All observed joints were filled tightly with calcite, and appear to be vertically restricted to the lithological unit in which they appear.

3.2.6.1 Stability

The mine pillars (Figures 2.2-2 and 2.2-3) are on approximately 80-foot centers; spacing between pillars is about 40 feet. The actual size of the pillars is quite variable. The pillars have been made longer in an east-west direction, along the strike of the north-northeast trending fault, for greater stability.

The limestone of the mine is massive, but bedding planes are very indistinct. Less than 50 percent of the mine has roof bolts; these are spaced on 6-by-6-foot centers. Except in the upper half of the inclined shaft, the bolts reportedly are precautionary rather than essential. The walls and pillars of the mine are massive, stable, and show no evidence of spalling. The mine rock is generally hard and competent. Despite factors such as a relatively high ratio of recovery, the massiveness of the limestone and relatively shallow mine depth (less than 230 to 280 feet), the pillars do not appear to be overstressed. This is supported by the fact that in the oldest part of the mine, excavated 20 years ago, no roof collapse or pillar deterioration has been reported or observed.

TABLE 3.2-1 Geologic time scale

	Geologic Time Units	Beginning of Period (in millions of years)*	Time-Stratigraphic Units
CENOZOIC ERA	Quaternary Period	1	Quaternary System
	Tertiary Period	63	Tertiary System
	Cretaceous Period	135	Cretaceous System
MESOZOIC ERA	Jurassic Period	181	Jurassic System
	Triassic Period	230	Triassic System
	Permian Period	280	Permian System
	Pennsylvanian Period	320	Pennsylvanian System
	Mississippian Period	345	Mississippian System
PALEOZOIC ERA	Devonian Period	405	Devonian System
	Silurian Period	425	Silurian System
	Ordovician Period	500	Ordovician System
	Cambrian Period	600 (approx.)	Cambrian System
		Precambrian	

* Time-scale in millions of years after Kulp, 1961

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 noticeably 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 fiver bands 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.

TABLE 3.2-3 Earthquakes with epicenter within Kentucky, Intensity V or greater

Date	Location	Latitude	Longitude	Intensity
1779	Northern Kentucky	-	-	-
1791, 1792 (?)	Northern and eastern Kentucky	-	-	-
1834, Nov. 20	Northern Kentucky	-	-	V
1841, Dec. 27	Hickman, Kentucky	-	-	V
1878, Mar. 12	Columbus, Kentucky	36.8	89.2	V
1915, Oct. 26	Mayfield, Kentucky	36.7	88.6	V
1915, Dec. 7	Near mouth of Ohio River	36.7	89.1	V-VI
1916, Dec. 18	Hickman, Kentucky	36.6	89.3	VI-VII
1922, Mar. 23	Western Kentucky	-	-	V
1924, Mar. 2	Kentucky	36.9	89.1	V
1925, May 13	Kentucky	36.7	88.6	V
1925, Sept. 2	Kentucky	37.8	87.6	V-VI
1933, May 28	Maysville, Kentucky	38.7	83.7	V
1954, Jan. 1	Middlesboro, Kentucky	36.6	83.7	VI
1957, Mar. 26	Paducah, Kentucky	37.0	88.4	V
1958, Jan. 27	Illinois-Missouri-Kentucky border	37.0	89.0	V
1963, Aug. 2	Illinois-Kentucky border	37.0	88.8	V
1968, Dec. 11	Louisville, Kentucky	38.3	85.7	V

Source: U.S. Department of Commerce, 1973.

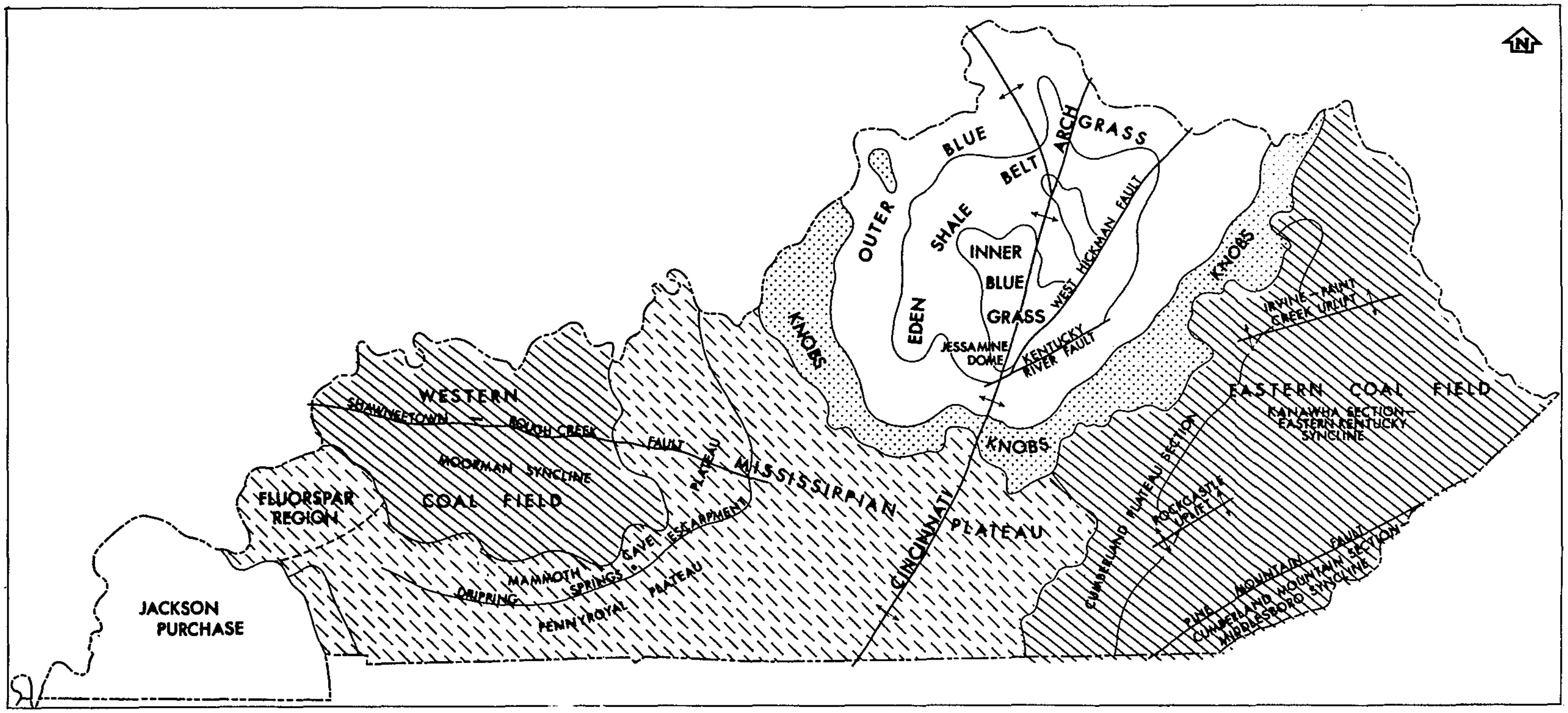


FIGURE 3.2-1 Physiographic regions and major structural features of Kentucky

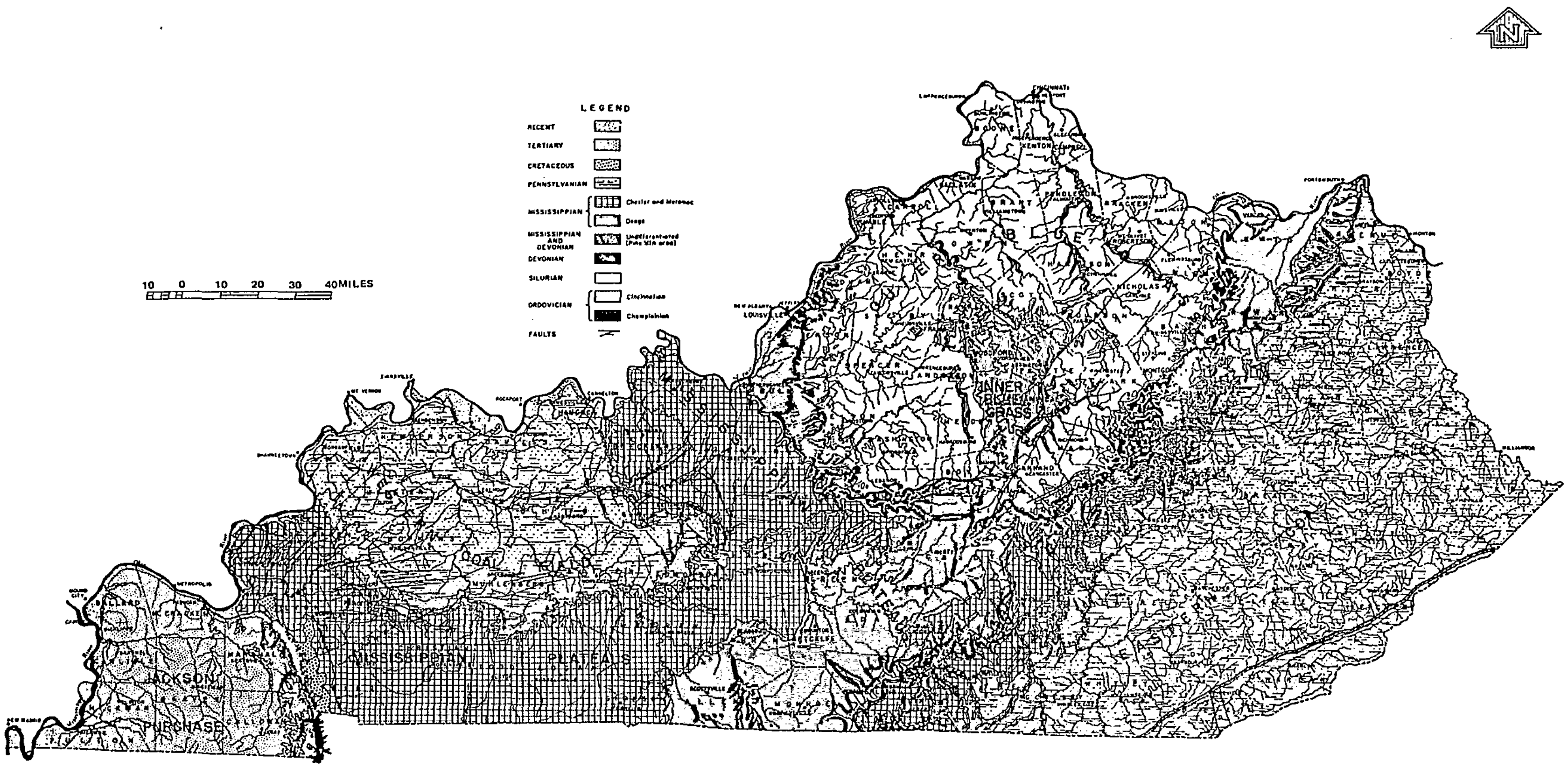


FIGURE 3.2-2 Geologic map of Kentucky

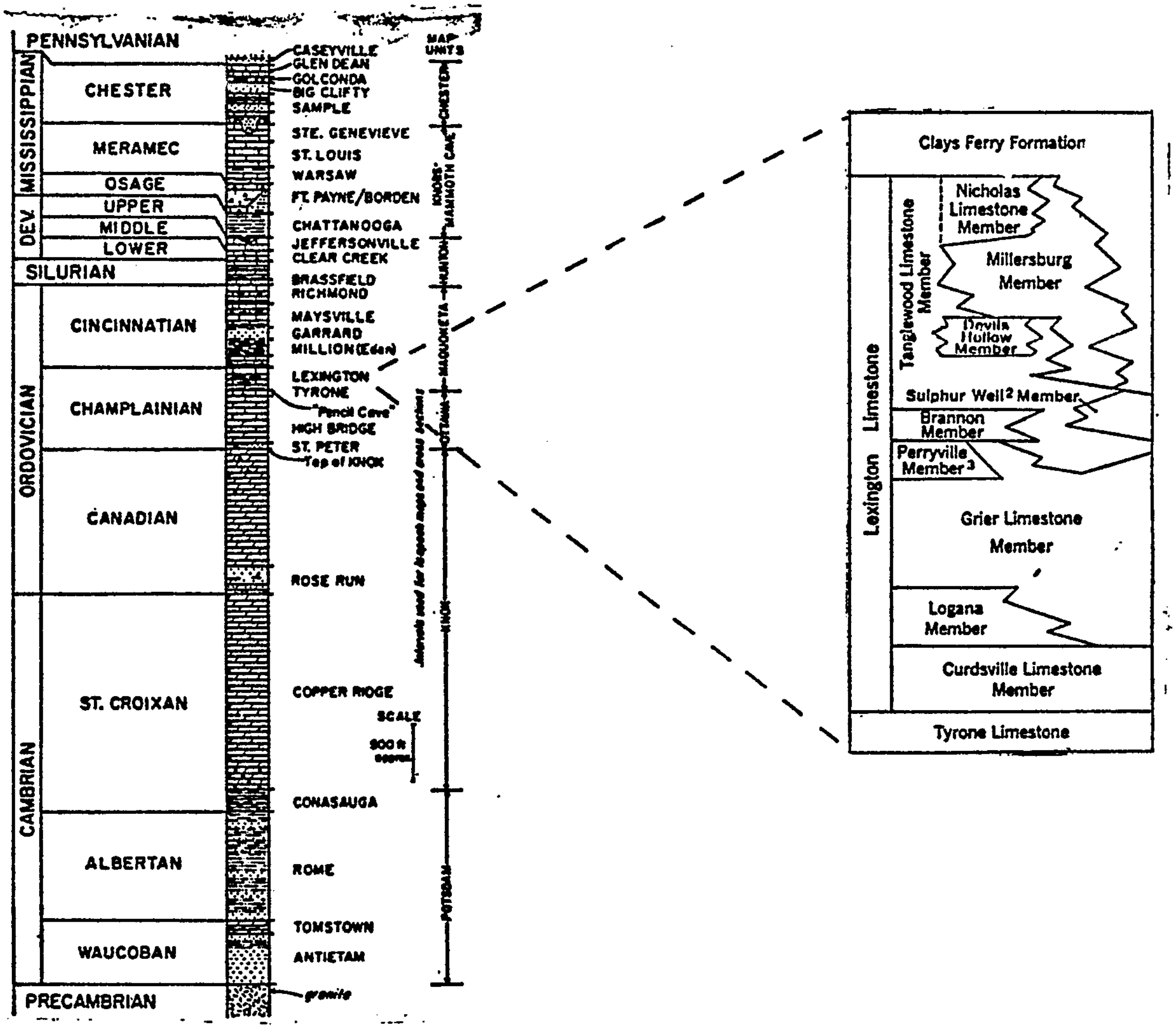


FIGURE 3.2-3 Generalized geologic column

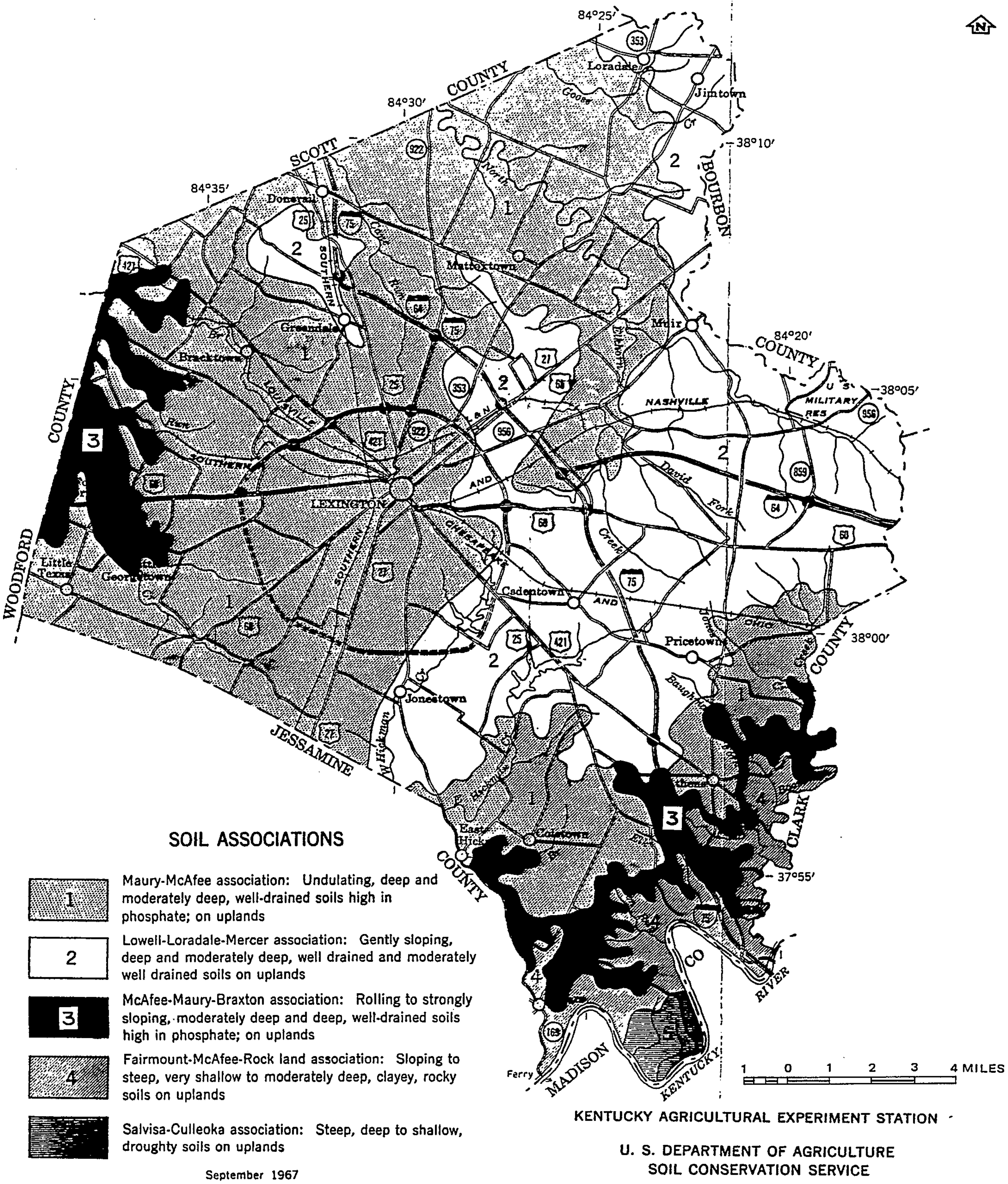


FIGURE 3.2-4 General soil map, Fayette County, Kentucky

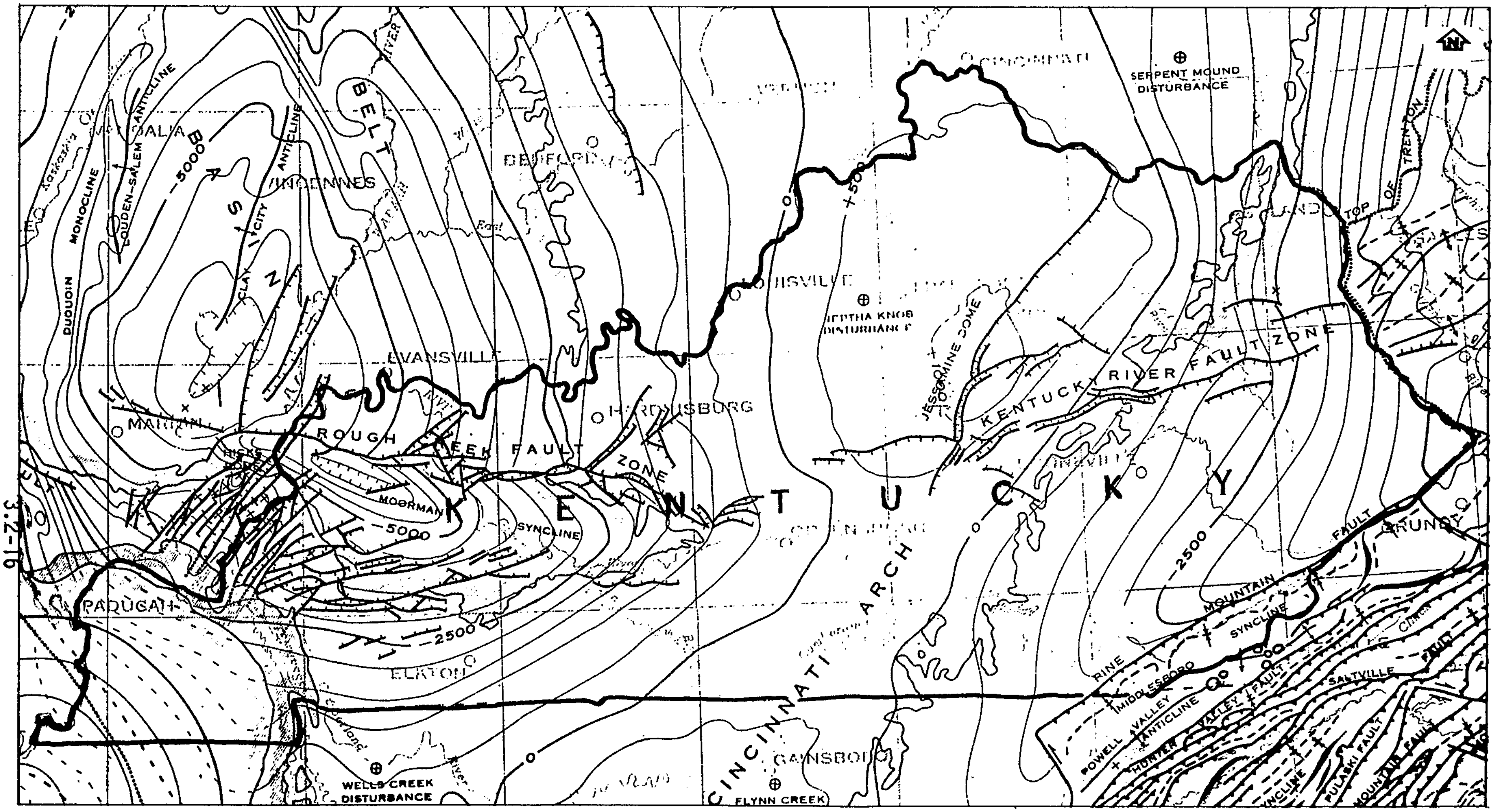
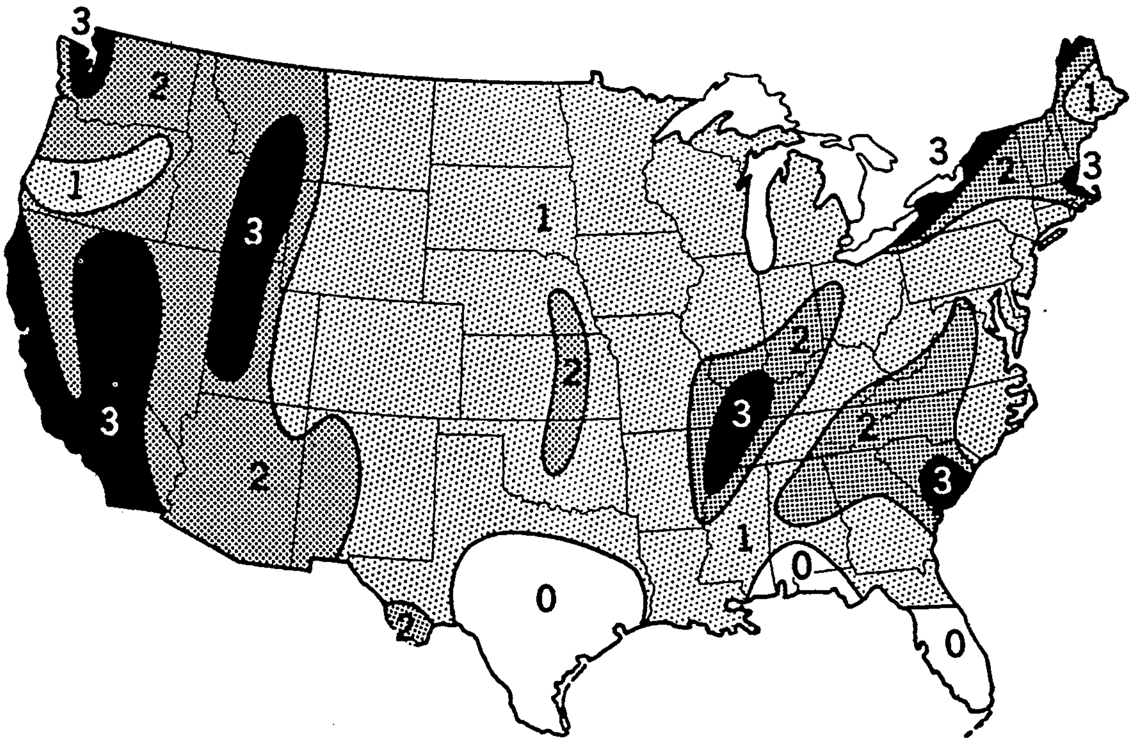


FIGURE 3.2-5 Regional tectonic features of Kentucky



ZONE 0: Areas with no reasonable expectancy of earthquake damage

ZONE 1: Expected minor earthquake damage

ZONE 2: Expected moderate earthquake damage

ZONE 3: Major destructive earthquakes may occur

Source: Algermission, 1969

FIGURE 3.2-6 Seismic risk map of the United States

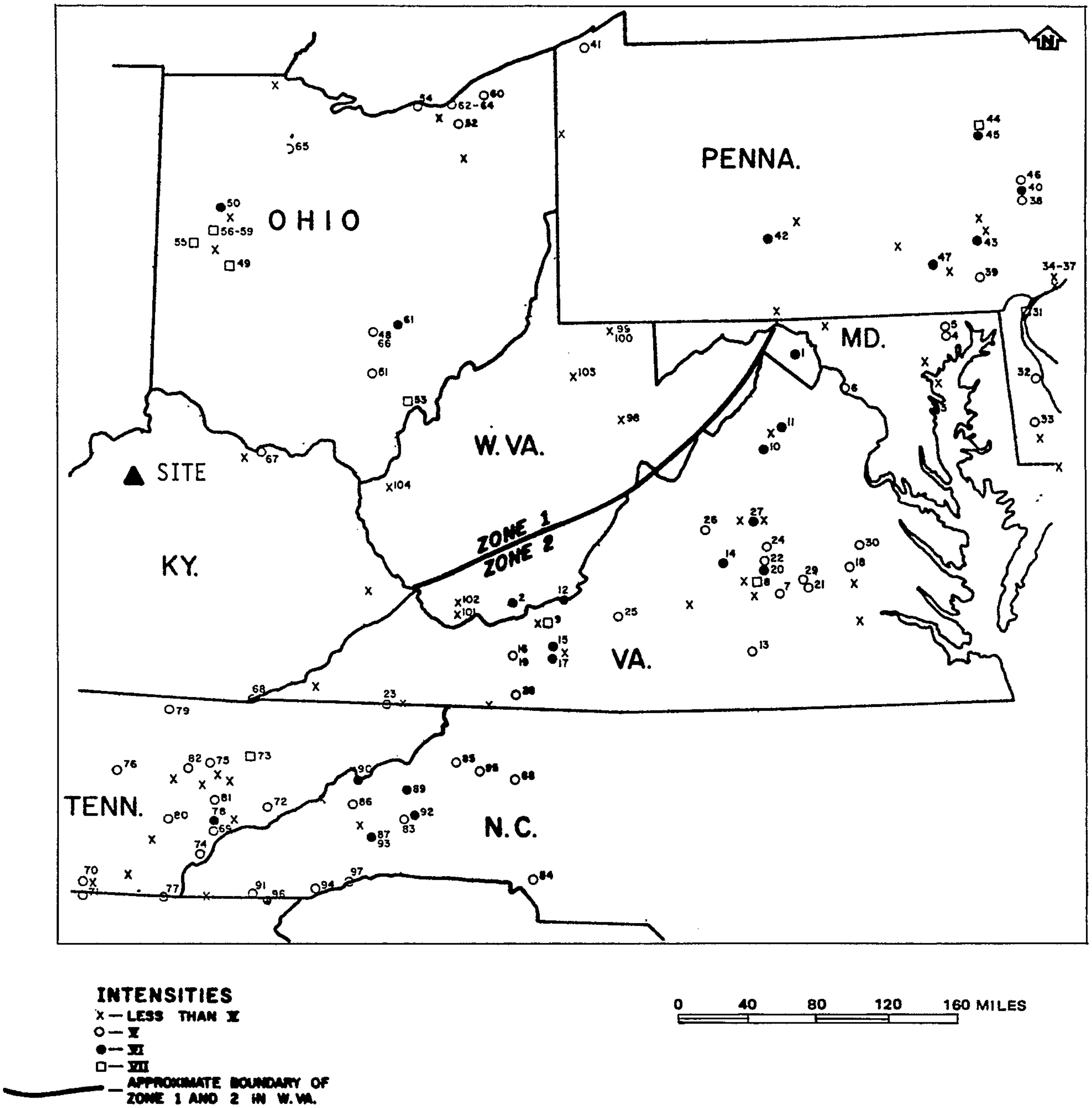


FIGURE 3.2-7 Earthquakes of the central Appalachians from 1758 to 1970

3.3 HYDROLOGY

3.3.1 Surface Water

3.3.1.1 Watershed Descriptions

Hydrologically, Central Rock Mine is located within the Kentucky River Watershed, which in turn is a subbasin of the Ohio River Basin (Figure 3.3-1). The Central Rock Mine region's average annual runoff of 17 inches varies little within the drainage area. The nearest tributary to the mine (0.25 mile north) is Town Branch, which begins as an intermittent stream in western Lexington and flows to the northwest, where it joins South Elkhorn Creek. None of the tributaries of the Kentucky River will be affected by construction of the oil storage cavern at Central Rock.

Construction of the proposed 13.5 mile pipeline corridor between the mine site and Tates Creek Terminal would directly affect the seven watersheds listed below (Figure 3.3-2). These watersheds (and possibly downstream waters such as the Kentucky River) could also be affected during operation of the facility should a major oil spill occur from the pipeline. Town Branch, Wolf Run, Steeles Run, Manchester Branch, and Cave Creek are all tributaries to South Elkhorn Creek which in turn feeds Elkhorn Creek and finally the Kentucky River. West Hickman Creek is a tributary to Hickman Creek, which also flows into the Kentucky River. The listing below indicates the linear distance within each of the seven watersheds crossed by the pipeline.

Town Branch	0.30 mile
Wolf Run	2.03 miles
Steeles Run	1.52 miles
Manchester Branch	0.61 mile
Cave Creek	1.88 miles
South Elkhorn Creek	4.32 miles
West Hickman Creek	2.84 miles

Town Branch - Town Branch (Watershed 1 on Figure 3.3-2) flows through Fayette, Scott, and Woodford Counties. The branch arises in the downtown Lexington area and flows northwest to its confluence with South Elkhorn Creek. Storm sewers and ground water constitute the initial flow of the branch. It emerges on the surface in the railroad yards just north of Manchester Street in a commercial-industrial part of the city. The first 2 miles of surface flow are through heavily developed areas with numerous businesses and industries located along the banks. Downstream from this area to its confluence with South Elkhorn Creek, Town Branch flows through a rural area composed mostly of horse farms. The banks of the creek are intermittently wooded with scrub trees and woody undergrowth; in places, pasture extends down to the water. The stream contains long pools broken by short riffles; the stream bed is mostly gravel and a few large rocks. Siltation in the pools is heavy. The upper end of the stream is laden with trash and debris and its banks have become a common dumping area.

The stream meanders on a narrow flood plain that in places is only a few feet below the adjoining farm land. High water frequently overflows the main channel in the lower reaches; however, most damage from flooding occurs in the headwaters where small tributaries drain the highly urbanized areas of Lexington. About one-half of this sub-watershed is within the Lexington urban area.

Wolf Run - Wolf Run (No. 2 on Figure 3.3-2) is the major tributary of Town Branch, and drains the west and part of the south end of Lexington. Except for the downstream 1.5 miles, the run flows through residential and commercial areas. Thus, about 80 percent of this basin is urbanized. The downstream area is rural and the banks are wooded. The portion of the run that flows through the city is sparsely wooded, and in some places the banks have been cleared and covered with rock to prevent erosion. Stream alterations coupled with the paved areas in the basin have caused flooding problems.

Steeles Run - Steeles Run (No. 3 on Figure 3.3-2) is a small run east of the pipeline route which flows northwest until it converges with South Elkhorn Creek.

Manchester Branch - Manchester Branch (No. 4 on Figure 3.3-2) rises near U.S. Highway 60 at a point about 2 miles east of Fort Spring. The branch flows in a northwesterly direction and closely parallels Steeles Run. The branch discharges into South Elkhorn Creek at a point about 2 miles north of Fort Spring.

Cave Creek - Cave Creek (No. 5 on Figure 3.3-2) rises near the intersection of New Circle Road and U.S. Highway 68, and flows in a westerly direction, where it empties into South Elkhorn Creek at a point about 1.5 miles southeast of Fort Spring. The creek flows in a small channel only a few feet below the adjoining farmland, and does not have the well-defined flood plain typical of larger streams in the area.

Elkhorn Creek and South Elkhorn Creek - Elkhorn Creek drains the entire western portion of Fayette County. The confluence of North and South Elkhorn Creeks forms the main stem of Elkhorn Creek, which flows in a northwesterly direction until it converges with the Kentucky River at River Mile 52.0 (upstream of Lock No. 3).

South Elkhorn Creek (Nos. 6 and 6A on Figure 3.3-2) arises at the southern end of Lexington near Fayette Mall and R.J. Reynolds Warehouses. The creek flows through Monticello Subdivision where it turns in a northeasterly direction and meanders 46.5 miles through rural Fayette, Woodford and Franklin Counties to its junction with North Elkhorn Creek at Forks of Elkhorn. South Elkhorn is made up of long, slow-moving pools broken by riffles. The stream bottom is mostly small- to medium-sized limestone slabs and some sands and gravels. Siltation does not appear to be a major problem since most of the rural land is in pasture instead of farmland. Most of this stream is wooded with second- and third-growth timber, except for the extreme upper section.

About 75 percent of the drainage area is within Fayette County, and about 25 percent within Jessamine County. The major towns in the watershed are Fort Spring, Little Georgetown, South Elkhorn, and an urban area of Lexington consisting of Indian Hills, Stonewall Estates, and Monticello.

Hickman Creek - Hickman Creek (Nos. 7, 8, and 9 on Figure 3.3-2) drains parts of the southern and eastern sections of Lexington. This creek has two main forks: West Hickman Creek and East Hickman Creek, both of which flow in a southerly direction. These two creeks converge at a point about 1.25 miles northeast of the small town of Union Mills. The main stem continues in a southerly direction until it empties into the Kentucky River at River Mile 135.5, upstream of Lock and Dam No. 7.

East Hickman Creek (No. 8 on Figure 3.3-2) originates from the Lexington Water Reservoir No. 4 just southeast of the city. The creek flows through rural land for about 10 miles in a southwesterly direction, then combines with West Hickman Creek to form Main Hickman Creek, which empties into the Kentucky River. Shelby Branch, a major tributary, enters East Hickman from the east about 7.5 miles downstream from the reservoir and flows through rural land.

West Hickman Creek (No. 7 on Figure 3.3-2) begins in the area of the Idle Hour Subdivision in southeast Lexington and flows southwest. A short distance downstream from its origin it is impounded, forming reservoirs 1, 2, and 3, which are used for Lexington's water supply. The lakes behind each of these dams have the effect of a single but segmented reservoir.

After it emerges from No. 3 reservoir, West Hickman Creek flows through the Gainesway-Southeastern Hills Subdivision, picking up a south-flowing tributary from the Lands down area. The stream turns due south and picks up a southeasterly flowing creek from the Brigadoon-Stoneybrook-Blueberry Hill-Baralto Subdivisions. Downstream from this point, West Hickman Creek flows through rural lands until it converges with East Hickman Creek to form the main stem of Hickman Creek.

East, West and Main Hickman Creeks, including tributaries, are charactéristic of Inner Bluegrass streams. They are composed of long, moderately shallow pools broken by short riffles. The creek bed ranges from small gravel to large limestone slabs. Siltation is more pronounced in West Hickman Creek due to erosion of the banks and flood problems. Along most of the stream only a thin line of trees and undergrowth remain since most of the land is used for pasture. Much of Hickman Creek is bordered by steep slopes, and these areas are more wooded than the upstream sections.

Floods

Floods of the Kentucky River or its tributaries should not impact on or be affected by the Central Rock storage cavern or the pipeline corridor. The maximum historical (1937) flood elevation recorded at the Hickman Creek-Kentucky River confluence was 559 feet MSL. The elevation of the mine shaft and pump shaft is 945 feet; the pipeline has a lowest elevation of about 900 feet MSL. Along the upper reaches of West Hickman Creek, the area between and adjacent to the banks of the stream but lower than the 890-foot contour interval is subject to periodic flooding due to local storm water runoff.

Water Uses

Within the area of Central Rock Mine, 14 water rights have been registered with the Kentucky Division of Water Resources for withdrawal of water from the Kentucky River. All of these rights are located downstream of Lock and Dam No. 11 (Figure 3.3-2). These rights are distributed among 8 water companies, 54 distilleries and 1 construction company. In Franklin County, water is also withdrawn by a distillery that has water rights on Elkhorn Creek for plant use.

Water Quality

Kentucky has set forth water quality standards, stream use classifications, and minimum conditions for all of the waters in the Commonwealth (see Appendix A).

Minimum values for water quality parameters may be summarized as follows:

Water Quality Parameter	Violation If Parameter Is:*
Temperature	> 89^{o}F (32^{o}C)
Dissolved oxygen	< 5.0 mg/l
pH	< 6.0 or > 9.0
Total coliform	> 1000/100 ml
Fecal coliform	> 200/100 ml
Ammonia nitrogen	> 2.0 mg/l
Conductivity	> 800 micromhos/cm
Dissolved solids	> 750 mg/l

* > = greater than
< = less than

Major water quality control problems exist in the Elkhorn Creek area and some of the small Kentucky River tributaries that receive treated municipal wastes from package plants. Lexington discharges most of its treated wastes into the South Fork of Elkhorn Creek. During periods of low flow, the stream is anaerobic. There are a few tributaries of the Kentucky River where effluents from treatment plants constitute nearly all the flow in the stream during low flow periods. In Hickman Creek below Lexington, flows ranging from 4 to 15 cubic feet per second are needed to assimilate residual wastes. Sufficient storage for streamflow regulation is not available; intensive treatment is needed.

The general water quality of each main stream that could be impacted by the proposed pipeline construction and operation is as follows:

Kentucky River - Surface waters in the Kentucky River Basin contain concentrations of dissolved solids averaging about 200 mg/l and are moderately hard waters (averaging about 90 mg/l). Generally, dissolved solids and hardness increase with lower sustained flows.

In addition to natural variations occurring in the water, changes in quality are often the result of domestic and industrial wastes, especially in the Elkhorn Creek drainage area. High chloride concentrations are caused by oil well operations and severe mine acid drainage problems occur in the headwater region, especially in the North Fork area.

Town Branch - In several areas, Town Branch is deficient in dissolved oxygen and contains excessive concentrations of fecal coliforms, to which urban runoff contributes. There are several point sources along the branch which contribute to the oxygen deficiency; immediately downstream of these discharge points are excessive biochemical oxygen demand (BOD) values.

A primary source of pollution in Town Branch is Lexington's municipal sewage treatment plant, about a mile downstream of the Central Rock Mine site. Because of low dilution, stream degradation occurs as far as 41 miles downstream of this outfall. The most noticeable evidence of sewage plant effluent is scum, benthic deposits, suspended sewage solids as well as relative high concentrations of dissolved solids, hardness, phosphate, and chloride. Land owners bordering

Town Branch have frequently complained about fish kills, detergent foaming, and unpleasant odors (especially during periods of low flow). Complaints have also been made by residents along South Elkhorn Creek several miles below Town Branch.

Wolf Run - The water quality of this run is characterized as good, but excessive fecal coliform concentrations occur that are attributed to runoff.

Steeles Run - The water quality of this run is classified as good; none of the key water quality parameters are in violation of state standards. However, detergents have been detected in the water.

Manchester Branch - The wastewater treatment plant that serves the Keeneland Race Course is the only point source of pollutants entering this branch. Fecal coliform values are high (872 counts per 100 ml). State standards set an upper limit of 200 per 100 ml for recreational waters.

Cave Creek - No sewage treatment plants exist along this creek. However, there is some indication of pollution by detergents, possibly due to septic tanks. None of the state water quality criteria are violated.

South Elkhorn Creek - The water quality of this creek has been categorized as good. Total and fecal coliform readings tend to be high and are related to storm water runoff. Biochemical oxygen demand readings indicate a measurable effect on the creek attributed to several sewage treatment plants above the creek. Dissolved oxygen concentrations are sometimes low; excessive ammonium nitrate values occur along certain reaches of the stream.

West Hickman Creek - The water quality of this creek has been categorized as good. The only parameters that are violated are total and fecal coliform, and ammonium nitrate. Urban runoff is a major cause of excessive coliform concentration. Two sewage treatment plants are in the West Hickman Creek Watershed. The BOD values just below each treatment plant are high but are reduced further downstream of each outfall.

3.3.2 Ground Water

3.3.2.1 Regional Aquifers

Eight general aquifer types have been identified in Kentucky, each roughly corresponding to the physiographic provinces of the state. These aquifer systems include unconsolidated deposits consisting of sand and gravel, and consolidated aquifers consisting of limestone, sandstone, and siltstone (Figure 3.3-3). Regional aquifers occurring within 50 miles of the project area lie within the limestone, and limestone and shale regions of the Bluegrass Province. Thick-bedded limestones and thin-bedded shales underlie the Inner Bluegrass. Surface and subsurface solution openings (sinkholes) are common in these rocks. These sinkholes produce the characteristic karst topography of the Bluegrass Region. Yields of wells in this system range from 1 to 200 gpm (gallons per minute). Encircling the area is the Eden Shale Belt, a series of shales within interbedded thin limestone layers. Here solution openings are not common, reflecting the impermeable nature of the shale. Average yields in the Eden Shale are 0.1 to 10 gpm. Encircling the Eden Shale Belt is the Outer Bluegrass area underlain by Silurian (limestone with interbedded shale) and Devonian (shale and limestone with interbedded siltstone) rocks.

3.3.2.2 Local Aquifers

For Fayette County, ground water occurs in two distinct environments. The primary environment, or source of most of the ground water in this area, is that of the consolidated bedrock, which underlies the entire region; the other source includes the unconsolidated deposits of sand and gravel occurring in the valleys of the Kentucky River and larger tributaries.

Shallow aquifers are developed in the lower part of the Lexington limestone. In Fayette County, this formation is approximately 350 feet thick and is comprised of limestone and interbedded shale. The hydrologically significant members of the Lexington include the Curdsville, Grier, Brannon, and Tanglewood limestones.

The Curdsville consists of 20 to 30 feet of fossiliferous limestone. It contains little shale and yields more than 500 gpd (gallons per day) in places where it is exposed at or below stream level. The Grier is a fine-to-coarse-grained, thin-bedded fossiliferous limestone about 135 feet thick. It is soluble, giving rise to karst-sinkhole surfaces. Water movement is along joints and bedding planes enlarged by natural solution processes. Most wells drilled in the upper Grier (=Benson) yield more than 130 gpd and as many as 500 gpd where exposed at and below stream level. Wells drilled into the lower part of the Grier (= Jessamine, Logana) yield little water due to the higher shale content. The Brannon, overlying the Grier in the western and southern parts of the county, is about 30 feet thick and consists of interbedded limestone and shale. Yields range from 100 to 500 gpd from drilled wells in valley bottoms and along streams.

The Tanglewood overlies the Grier and makes up most of the upper Lexington limestone in Fayette County. The unit is about 80 feet thick, with uniform beds of limestone 3 to 12 inches thick separated by thin beds of shale. Vertical jointing is common in the Tanglewood, and many joints are enlarged by solution; the joints permit water to move through this member with ease.

Well yields in shallow aquifers range from less than 5 to more than 150 gpm. The differences in yield are due in part to the influence of rock structures and the location of the well in relation to the stream. Higher yielding wells are located in structurally low areas or in proximity to major streams.

The deep aquifers of the Fayette County area include the Knox dolomite and the St. Peter sandstone, lying from 800 to 1000 feet below the land surface. The upper part of the Knox dolomite attains a thickness of 2000 feet in the Lexington area. Sustained yields of wells from the upper part of the Knox would probably be less than 15 gpm. The St. Peter sandstone, immediately overlying the Knox dolomite, is about 15 feet thick in the eastern part of the county and may be absent west of Lexington. The St. Peter sandstone consists of a fine-to-coarse-grained sand that may show a calcareous cement. Water is present in intergranular openings and joints; sustained yields, however, would probably be less than 10 gpm. Availability of ground water in the Lexington and Central Rock Mine vicinity is shown on Figure 3.3-4.

3.3.2.3 Local Ground Water Levels

The overall direction of ground water movement within the shallow aquifers in the Inner Bluegrass Region is controlled by the structure of the underlying rocks and by the incised valleys of the major streams. Water levels in Lexington proper, the highest area in Fayette County, reflect the relationship between structure and ground water movement. For example, the elevation of a well (owned by Papania Fruit Company) on Vine Street is 934 feet MSL and 8 feet below ground level. To the north, south, and west of Lexington, water levels are lower than 925 feet MSL, indicating a slope of the piezometric surface away from Lexington and reflecting the dip of the rocks. A well located along Leestown Road (approximately 0.4 mile southeast of the interchange of Leestown and New Circle Roads) shows a depth of 35 feet and a static water level of 24 feet. To the east of Lexington, where the regional dip of the rocks has been altered by faulting, the water levels are at about the same altitude as the water levels at the Papania Fruit Company well. The water level in an observation well on the Madden Farm, about 3.5 miles east of Lexington, is 931 feet MSL.

Ground water levels are also influenced by local surface streams. Altitudes of the water levels in wells within drainage basins are lowest along the streams, increasing in altitude toward the drainage divide along any line perpendicular to the valley. This reflects movement of ground water toward the stream and shows that all the major stream channels in the area are ground water discharge areas.

There is an abundance of small-diameter domestic wells in the Lexington-Georgetown area that tap shallow aquifers. Ground water levels are found to range from 5 to 25 feet below ground surface, or deeper, but usually average 12 to 18 feet below ground level.

3.3.2.4 Local Ground Water Use

Within the Bluegrass Region of central Kentucky, surface water supplies 79 percent of public and industrial needs and ground water supplies only 21 percent (Kentucky Geological Survey, 1971). In the Lexington area, however, ground water is presently utilized as the primary water supply for most rural areas. Sustained yields to limestone wells are less than 15 gpm.

3.3.2.5 Local Ground Water Quality

The quality of ground water in the Bluegrass Region varies considerably from place to place and is usually determined by its geologic source. The U.S. Public Health Service recommends an upper range of total dissolved solids in a water supply not to exceed 500 ppm (parts per million); if water of this quality is not available, however, water having more than 500 but less than 1000 ppm may be used.

The ground water in shallow aquifers of the Fayette County area is of a calcium-magnesium-bicarbonate type with low mineralization and is suitable for most uses. However, sodium chloride waters with relatively high mineralization may be found at depths greater than 75 feet east of the Lexington area. The two most common constituents that make water in the Bluegrass Region objectionable for domestic use are sodium chloride and hydrogen sulfide, the latter of which is found in about one-fifth of all drilled wells. Salt occurs in about one-eighth of the wells.

A comparison of the chemical characteristics of ground water in bedrock aquifers of the Inner Bluegrass Region is given in Table 3.3-1. Ranges of chemical constituents as elements in parts per million for representative wells and springs of the bedrock aquifer units of the Bluegrass Region are given in Table 3.3-2.

Saline waters occur in many parts of the Inner Bluegrass Region and underlie the zone of active ground water circulation everywhere in the area. Saline waters are classified as those having a total dissolved solids concentration of 1000 ppm or more; those having less than 1000 ppm are considered to be fresh. In Fayette County, the base of fresh ground water ranges from less than 50 to more than 350 feet below the land surface. Saline water is found from depths of 50 to more than 2000 feet below the surface. As a rule, the change in quality from fresh to saline is gradual and may occur through an interval of 100 to 500 feet. As this change occurs, the water becomes more sodic (sodium bicarbonate or sodium chloride in type). This saline-freshwater interface is shown in Figure 3.3-5 for Fayette County and vicinity as the altitude of this interface above MSL. The altitude in the vicinity of Central Rock Mine is between 940 and 950 feet MSL; therefore, the depth to the saline-freshwater interface is approximately 150 to 200 feet below ground surface (rim of quarry).

Standard tests for coliform bacteria have been performed by the Fayette County Health Department. The presence of coliform bacteria indicates pollution from fecal wastes that may originate from farm livestock or man. Large areas in Lexington are still unsewered. In addition, ground water pollution can occur due to leakage from city sewers or the large land area used for livestock grazing. Fifteen percent of wells sampled after periods of heavy rainfall (in the spring) were found to show bacterial contamination. The increase in coliform content probably reflects the increased amount of water moving overland; this water picks up bacteria from animal excrement and carries these organisms into local ground water.

Wells obtaining water from deeper aquifers may also be contaminated in much the same way. Many sewer lines in Lexington are laid within the upper few feet of bedrock, and leakage from these lines can enter the adjacent aquifer water body almost immediately. Substantial leakage into the bedrock from sanitary sewers is reported to occur after heavy rains (Hopkins, 1966); thus, bacteria-laden water can mix with the natural ground water.

3.3.2.6 Ground Water of the Mine Site

The underground mine workings are at a depth of about 300 feet (Figure 2.2-3) in and under an Ordovician limestone sequence. The upper formation of the sequence is Lexington limestone. On the eastern half of the mine property, this unit is deeply exposed in extensive surface quarries. The natural surface is essentially undisturbed on the western half of the property; here the Lexington is covered with 5 to 8 feet of clayey residual soil.

In the quarry faces, well-developed solutioning along bedding planes and joints is highly evident. Numerous springs emanate from these openings and attest to their lateral hydrologic continuity. The large elongated sink along the southern edge of the mine property clearly indicates that this solutioning has been locally developed to cavernous proportions. Similar sinks and karst features are widely evident throughout much of the Lexington area. Although locally depressed by the presence of the quarries, the ground water observed in wells in the mine vicinity previously ranged from 5 to 18 feet deep. There are no public groundwater supplies within 1/2 mile of the mine. However, there may be a number of private wells (probably horse ranches) that sell water to tenants (Marsh, 1976).

As evidenced in the exposure of the surface and subsurface workings, the solutioning and associated ground water movement extends to a depth of about 90 to 100 feet, typical of the entire Lexington vicinity (Hamilton, 1950). Below that, Lexington limestone and the formations underlying it are tight, essentially impermeable, and dry.

According to mine management, only about 1000 gallons per week are pumped from the workings. Observations indicate that virtually all of this minor inflow is artificially introduced from the surface, either for drilling purposes or as minor seeps down the mine openings. During inspection no inflows were observed from the roof or walls of the mine, including the areas where the porous fault zones are exposed.

No iron stains or other indications of postseepage were observed. Although joints are well developed and horizontally continuous, they are well healed with calcite and appear to be vertically restricted to the lithologic unit in which they appear. No open joints were observed in the mine.

TABLE 3.3-1 Comparison of chemical characteristics of ground water in bedrock aquifers of the Inner Bluegrass Region

Chemical Character	Formation		
	High Bridge	Lexington	Cynthiana
General Water Type	Calcium - magnesium - bicarbonate	Calcium - magnesium - bicarbonate	Dilute waters are calcium - magnesium - bicarbonate; concentrated waters are sodium chloride
Degree of Mineralization	Low; increases with depth and increased mineralization	Low; increases with depth and increased mineralization	Relatively high
Ca - Mg Ratio	Low; increases with depth and increased mineralization	Higher than High Bridge	Higher than Lexington and High Ridge
K - Na Ratio	High; decreases with depth and increased mineralization	High; decreases with depth and increased mineralization	Low; increases with depth and increased mineralization
Ca - Na Ratio	High; decreases with depth and increased mineralization	Lower than High Bridge	
Cl - H_2CO_3 Ratio	Low; increases with depth and increased mineralization	Higher than High Bridge	Higher than Lexington and High Bridge and increases with increased mineralization
Cl - S Ratio	Low; increases with depth and increased mineralization	Higher than High Bridge	Higher than Lexington and High Bridge and increases with increased mineralization
COMMENTS:	Water from dug wells and springs is not highly mineralized (dilute)		Water from dug wells and springs is highly mineralized; dissolved solids range upwards of 11,500 ppm

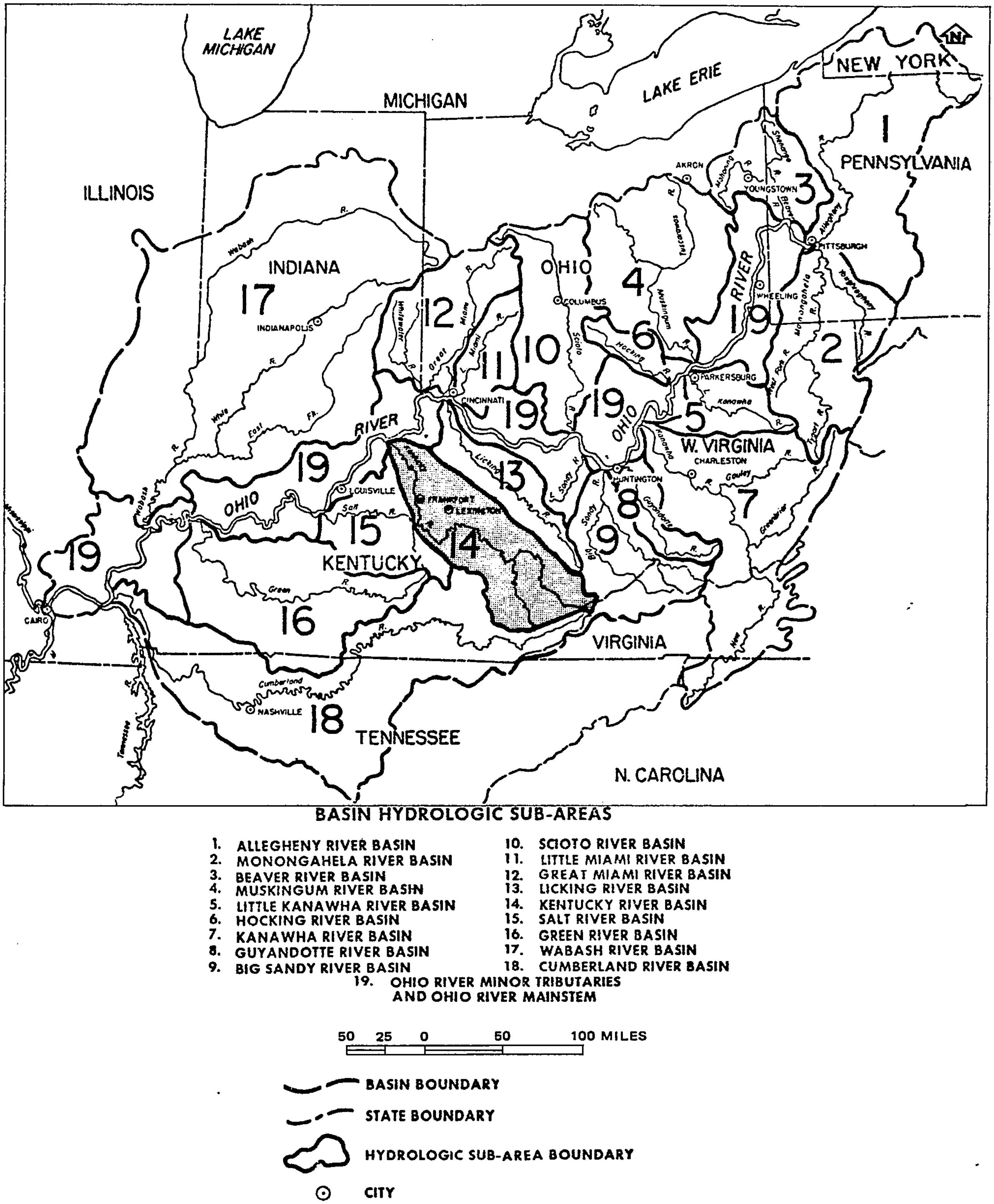
TABLE 3.3-2 Range of chemical constituents in ground water from major aquifers of the Bluegrass Region

Element	High Bridge Range (ppm) Springs	High Bridge Range (ppm) Wells	Lexington Range (ppm) Springs	Lexington Range (ppm) Wells	Cynthiana Range (ppm) Springs	Cynthiana Range (ppm) Wells
SiO_2	7.8-11	4.4-11	4.1-16	4.9-14	7.7-29	8.1-14
Al	-	-	-	-	-	-
Fe	0.24-1.3	0.17-10	0.08-0.69	0.03-2.9	0.02-0.96	0.0-7.6
Mn	0.0-0.19	0.0-0.36	0.0-0.15	0.0-0.48	0.0-0.86	0.0-0.42
Ca	61-121	82-86	55-103	46-141	63-467	52-124
Mg	4.3-8.7	12-14	2.4-9.1	4.7-55	4.9-216	7.3-36
Na	1.8-2.7	5.3-15	1.6-16	2.0-341	3.3-3,580	19-784
K	0.6-1.2	2.1-2.2	0.5-4.8	0.5-82	0.9-98	3.4-19
Li	-	-	0.0	0.0-0.2	-	0-15
HCO_3	174-342	222-306	143-304	154-364	154-475	240-795
CO_3	0.0	0.0	0.0-8.0	0.0	0.0	0.0
SO_4	14-38	26-75	9.9-47	13-112	28-692	7.2-8.5
Cl	2.5-3.5	9.0-26	2.6-32	4.0-848	6.6-6,350	16-1,020
F	0.2	0.2	0.0-5.3	0.0-1.0	0.2-2.5	0.2-3.0
NO_3	11-25	1.0-5.0	0.5-40	0.0-18	3.3-18	0.1-43
PO_4	0.0-0.09	0.0	0.0-0.25	0.0	0.0	0.0
Dissolved Solids	199-375	307-347	192-380	183-1,720	210-11,500	361-2,340
Hardness						
Ca, Mg	170-338	262-264	159-294	154-578	177-2,050	257-396
Noncarbonate	22-57	13-80	23-98	0.0-389	51-1,700	0.0-81
Specific Conductance (mhos at 25°C)	328-618	507-560	312-628	307-3,010	348-19,300	582-4,110

TABLE 3.3-2 Continued

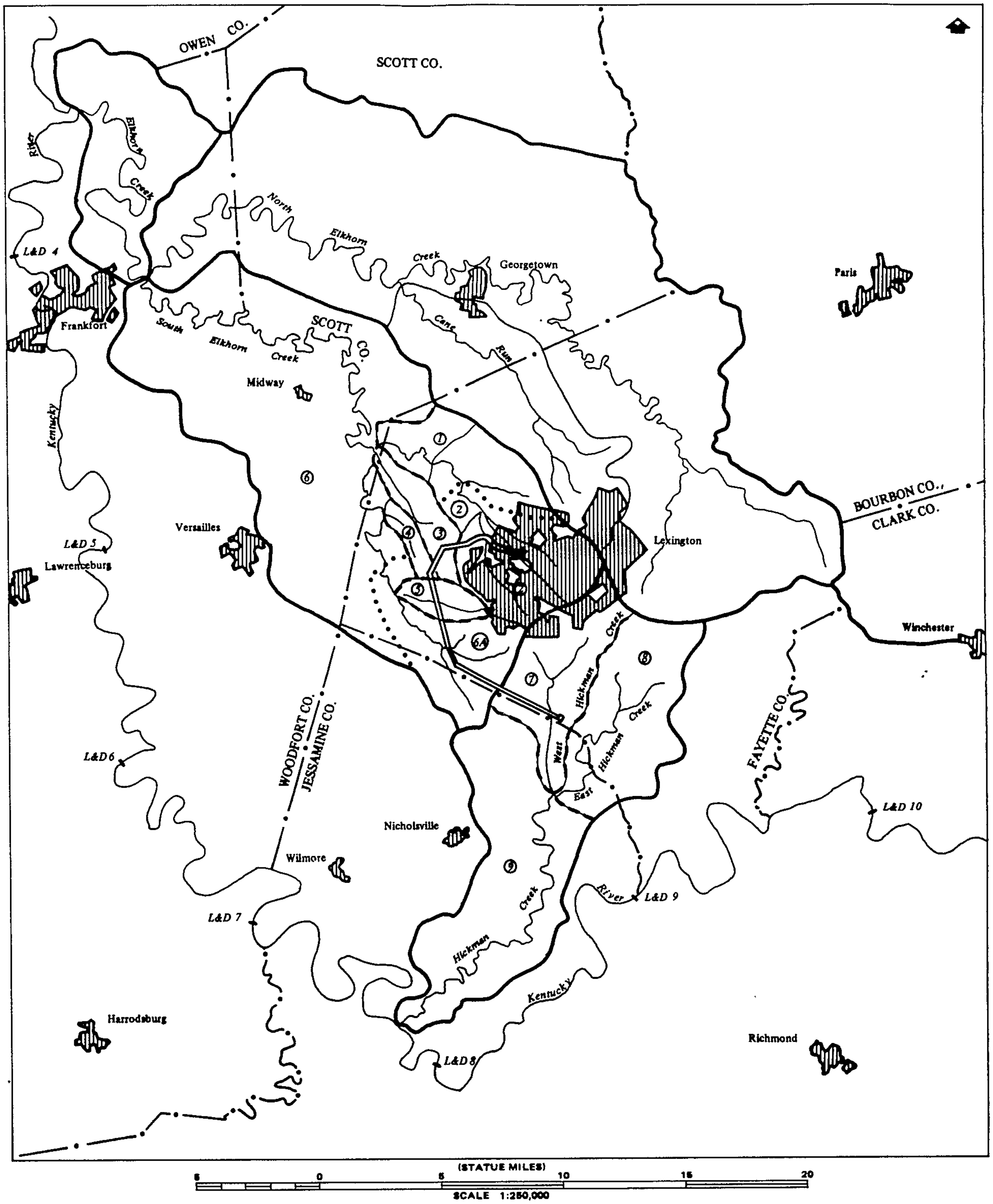
Elements	High Bridge Range (ppm) Springs	High Bridge Range (ppm) Wells	Lexington Range (ppm) Springs	Lexington Range (ppm) Wells	Cynthiana Range (ppm) Springs	Cynthiana Range (ppm) Wells
pH	7.3-7.4	7.4-8.0	6.8-8.0	6.7-8.1	7.1-7.9	6.9-8.0
Number of springs or wells tested	3	3	18	26	4	7

Source: Hendrickson and Krieger, 1964.



(SOURCE OHIO RIVER COMPREHENSIVE SURVEY)

FIGURE 3.3-1 Kentucky River Basin (as shown within the Ohio River Basin)



LEGEND

- URBAN AREA
- WATERSHED INDENTIFICATION NUMBER
- COUNTY BOUNDARIES
- L&D LOCK AND DAM
- PIPELINE ROUTE

WATERSHEDS

1. TOWN BRANCH
2. WOLF RUN
3. STEELES RUN
4. MANCHESTER BRANCH
5. CAVE CREEK
6. & 6A SOUTH ELKHORN CREEK
7. WEST HICKMAN CREEK
8. EAST HICKMAN CREEK
9. HICKMAN CREEK

FIGURE 3.3-2 Study area

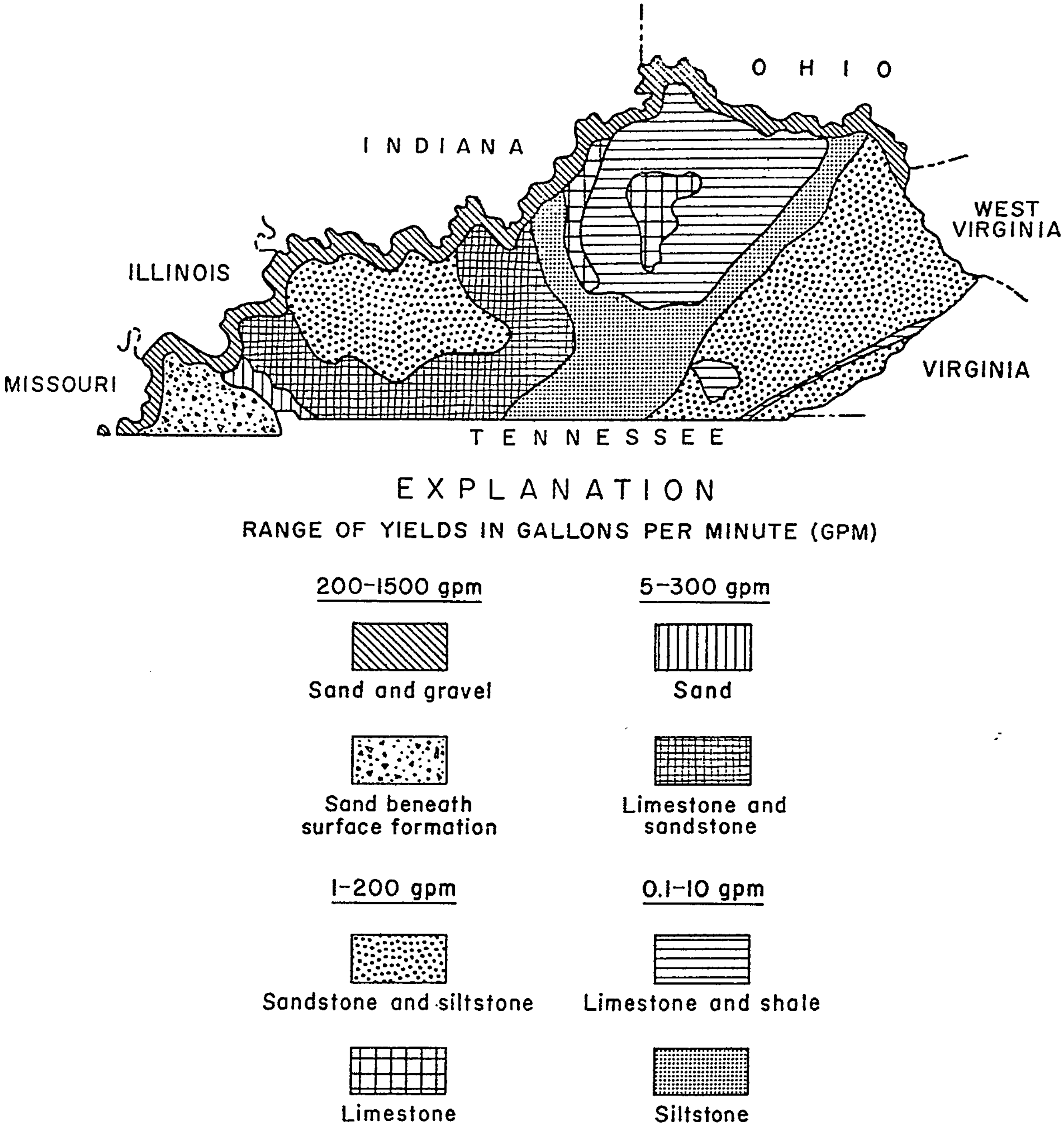


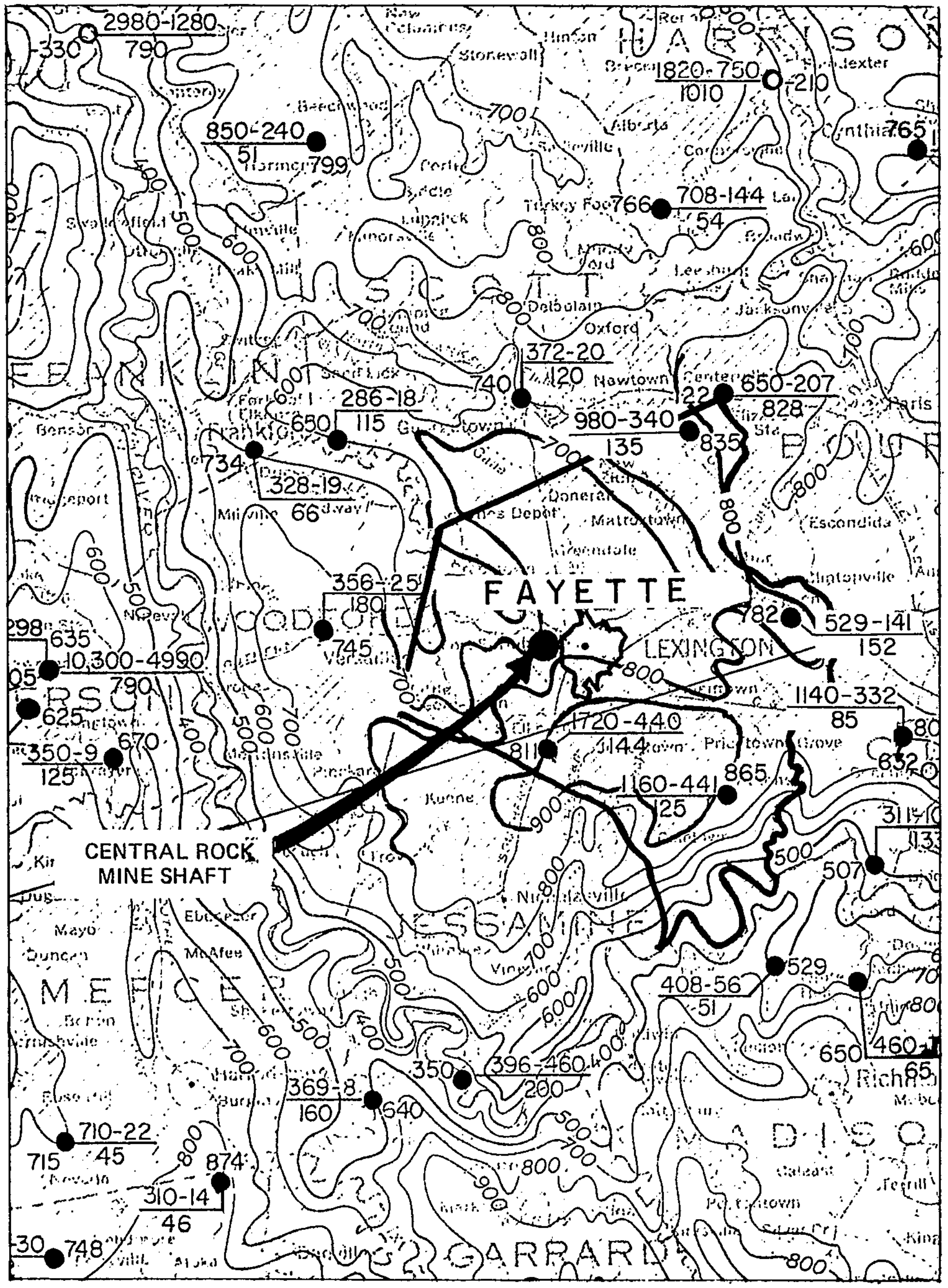
FIGURE 3.3-3 Type and range yield aquifers in Kentucky

Most drilled wells in this area will produce enough water for a domestic supply with a power pump and pressure system (more than 500 gallons a day) at depths of less than 100 feet. Some wells produce as much as 300 gallons per minute from alluvium or thick limestone along large streams. Water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

Most drilled wells in this area will produce enough water for a domestic supply with a hand pump (100 to 500 gallons a day) at depths of less than 100 feet. Some wells will produce more than 500 gallons a day except during dry weather. Water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

Most drilled wells in this area will not produce enough water for a dependable domestic supply (100 gallons a day). Wells in valleys may produce enough water for a domestic supply except during dry weather. Water is hard and may contain salt or hydrogen sulfide at depths greater than 100 feet.

FIGURE 3.3-4 Ground water availability in the vicinity of Central Rock Mine



EXPLANATION

HYDROLOGY

○ ●
WELL

WELLS FINISHED IN THE KNOX DOLOMITE EQUIVALENT ARE SHOWN WITH OPEN CIRCLES. THE ONLY KNOX WELLS SHOWN ARE IN THE BLUE GRASS REGION.

SPRING

370 ● 668-54 / 550

- 668 — TOTAL DISSOLVED SOLIDS, IN PARTS PER MILLION
- 54 — CHLORIDE CONCENTRATION, IN PARTS PER MILLION
- 550 — DEPTH OF WELL, IN FEET BELOW LAND SURFACE
- 370 — ALTITUDE OF BOTTOM OF WELL OR OUTLET OF SPRING, IN FEET REFERRED TO MEAN SEA LEVEL

TWO SETS OF FIGURES MAY BE SHOWN FOR ONE WELL SYMBOL INDICATING TWO ANALYSES OF DIFFERENT DEPTHS OR ANALYSES FROM TWO WELLS LESS THAN 100 FEET APART.

——— 800 ———

INTERFACE CONTOUR

SHOWS ALTITUDE OF THE BASE OF FRESH WATER THROUGHOUT THE STATE. DASHED WHERE APPROXIMATELY LOCATED. CONTOUR INTERVAL, 100 FEET.

DATUM IS MEAN SEA LEVEL.

FIGURE 3.3-5 Saline-fresh water interface in the vicinity of Central Rock Mine.

3.4 CLIMATOLOGY AND AIR QUALITY

3.4.1 Regional Climatological Conditions

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

The climate of northeastern Kentucky is determined by the surrounding continental land mass, the middle latitudes and their migrating cyclonic storm systems, and the anticyclonic circulation of the Azores-Bermuda high-pressure system.

The climate is classified as temperate with continental warm, humid summers and cool winters prevailing. Precipitation is abundant throughout the year, resulting mostly from cyclonic disturbances during the cooler months and from convective-type showers during the warmer months. There are no bodies of water large enough or close enough to Lexington to exert any influence upon the local climate. The most common air masses affecting the area are maritime tropical (MT), which originate over the Gulf of Mexico, and continental polar (CP), which originate in Canada and are characterized by relatively cold, dry air.

The MT air prevails during the late spring, summer and fall months, when the polar front lies far to the north. This air mass exerts its influence primarily as a result of the southerly flow associated with the Atlantic subtropical high-pressure system. During these seasons, the southward advancement of CP air is an uncommon occurrence and is always of short duration. Continental polar air affects northeastern Kentucky primarily during the winter months, bringing the colder, drier air representative of the continental winters. The influence of the CP air mass during the winter months is occasionally interrupted by modified MT air, which follows the passage of a well-developed high-pressure system. These situations bring mild mid-winter temperatures and high humidities.

The weather systems affecting the area are of the extratropical type. Tropical storms and hurricanes affect this area only after they have undergone an overland transition to an extratropical stage. Kentucky is located near the paths of the major storm tracks that migrate across the United States throughout the year. The frontal activity associated with these storms brings showers, thunderstorms, and occasional high winds. During the winter months when the storm tracks push to their southernmost positions, the Lexington area receives a combination of rain and snow, depending on local temperature patterns. Clearing skies and colder weather typically follow passage of a winter storm and its cold front. During the warmer months, the cyclonic activity is less frequent, although squall-line activity is more common.

Lexington is located in Fayette County, in a gently rolling plateau region. The county elevation varies between 900 and 1050 feet MSL. Because of the lack of abrupt changes of land elevation, the surface features of the area do not produce mesoscale (10 to 100 km) meteorological phenomena such as up-slope winds and orographic convection. The only large terrain features that exist near eastern Kentucky are the Appalachian foothills, which lie several hundred miles to the east. Because of the west-to-east movement of the weather patterns at these latitudes, these surface features do not affect the synoptic scale (100 to 1000 km) meteorological phenomena such as low-pressure systems and squall lines.

3.4.1.2 Temperature

Lexington is subject to rather sudden and large changes in temperature, although the temperature fluctuations are generally of short duration. Temperatures above $100^{o}F$ and below 0^{o} are relatively rare. Average temperatures are: winter, $35^{o}F$; spring, $62^{o}F$; fall, $50^{o}F$; and summer, $74^{o}F$.

Average and extreme temperatures for Lexington are presented below. The record highest and lowest temperatures were $108^{o}F$ in July, 1936, and $-20^{o}F$ in February, 1899, respectively. The maximum temperature exceeds $90^{o}F$ an average of 25 days per year; the minimum temperature falls below $0^{o}F$ an average of 2 days per year.

	Daily Maximum	Daily Minimum	Monthly Mean	Record Highest*	Year	Record Lowest*	Year
January	41.3	24.5	32.9	71	1972	-11	1972
June	83.5	62.5	73.0	97	1966	39	1966
July	86.4	65.9	76.2	98	1966	47	1972
December	43.7	27.2	35.5	72	1971	- 4	1963

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, 108 in July 1936; lowest temperature, -21 in January 1963.

* Based on 11 years (1964-1974) of data. Monthly means represent a 30-year (1945-1974) period of record.

Meteorological surface data recorded at the Lexington, Kentucky airport are used to describe regional weather conditions (U.S. Dept. of Commerce, 1974). January is the coldest month, with a monthly mean temperature of 32.9°F (41.3°F mean daily maximum; 24.5°F mean daily minimum). July, the warmest month, has a mean temperature of 76.2°F (86.4°F mean daily maximum; 69.5°F mean daily minimum).

3.4.1.3 General Wind Conditions

The following information represents the monthly mean and extreme wind speed and direction observed at Lexington (U.S. Dept. of Commerce, 1974).

	Mean Speed (mph)[a]	Prevailing Direction[b]	Fastest Mile[c] Speed (mph)	Fastest Mile[c] Direction	Year
January	11.6	S	39	250	1962
June	8.3	S	35	220	1968
July	7.4	SSW	37	290	1966
December	11.2	S	37	190	1971
Year	9.7	S	46	320	April 1963

a - Based on 28 years (1947-1974) of data.

b - Based on 17 years (1958-1974) of data.

c - Based on 13 years (1962-1974) of data.

The prevailing winds range from south-southwesterly during the late winter and spring to southerly during the remainder of the year. The more westerly component of the wind during the winter and spring is due to the larger influence of the polar jet stream at this latitude and to the smaller influence of the Atlantic subtropical high-pressure circulation, which produces a southerly component in the surface circulation over eastern Kentucky. The highest winds nearly coincide with the period of south-southwesterly flow. February is the windiest month, averaging 11.9 miles per hour. The high winds during this period are also related to the positioning of the polar jet stream near this region and the associated increased cyclonic activity. The lightest surface winds are observed during the summer, when decreased pressure gradients and upper-level air flow is the rule.

3.4.1.4 Precipitation

Precipitation is evenly distributed throughout the winter, spring, and summer. The fall season experiences the least amount of rainfall, averaging 8 inches for the entire season. July and March have the highest amount of precipitation, averaging 4.83 and 4.80 inches, respectively. The following table presents the mean monthly distribution, as well as maximum rainfall, at Lexington (U.S. Dept. of Commerce, 1974).

	Normal	Maximum Monthly	Year	Minimum Monthly	Year	Maximum 24 hrs.	Year
January	3.95	16.65	1950	0.95	1970	2.98	1951
June	4.31	11.69	1960	1.36	1966	5.88	1960
July	4.83	10.64	1958	1.83	1951	3.11	1974
December	3.62	7.30	1951	0.61	1965	2.97	1949
Annual	44.49	16.65	1950	0.24	1959	5.88	1960

The means and extremes are from existing or comparable exposures. Extremes have been recorded at other localities as follows: minimum monthly precipitation, 0.11 in October 1974; maximum precipitation in 24 hours, 8.06 in August 1932.

The early spring maxima are associated with the higher frequency of migrating middle latitude storm systems and frontal activity, while the summer rainfall is characterized by a higher percentage of thermal convective activity.

Figure 3.4-1 presents the rainfall rate versus rainfall duration for a variety of return intervals computed from Lexington rainfall data (Dames and Moore, 1972). The Lexington data do not approach or exceed what would be a 100-year return period rainfall, but a maximum 24-hour rainfall in the vicinity was reported to be 8.06 inches in August, 1932 (U.S. Dept. of Commerce, 1974), which exceeds the probable maximum 24-hour rainfall amounts at Lexington based on a 30-year climatic record. Monthly rainfall extremes ranged from 16.65 inches (January 1950) to 0.11 inches (October 1974; U.S. Dept. of Commerce, 1974).

3.4.1.5 Ice and Snow

Annual snowfall amounts vary greatly from year to year. In the past 30 years, annual amounts ranged from 2.3 inches (1949-1950) to 41.7 inches (1950-1951). The mean annual snowfall is 15.7 inches. Table 3.4-1 lists the monthly mean and maximum snowfall amounts recorded at Lexington. It shows that January and February experience the most snow, averaging 5.2 and 4.9 inches, respectively. The highest maximum snowfall ever recorded in a single month was 21.1 inches in January 1948 (U.S. Dept. of Commerce, 1974).

Because of the moderate temperatures observed during the winter, the ground does not retain snow cover for more than a few days at a time. Ice storms usually occur only one or two times a winter. However, the diurnal temperature range is responsible for frequent ice cover on surfaces following any snowfall. During December, January, and February, the daytime temperatures are usually warm enough to melt the snow cover but often fall below freezing at night, causing considerable icing.

3.4.1.6 Evaporation

Lexington experiences moderate evaporation in relation to the rest of the country. The mean annual lake evaporation of the area surrounding the site is 35 inches of water. The National Weather Service class A type pan evaporation is 47 inches. Approximately 75 percent of the annual evaporation occurs between the months of May through October (U.S. Dept. of Commerce, 1968). The annual peak of evaporation is usually realized during the months of September and October when the surfaces of the water bodies are their warmest.

3.4.1.7 Sky Cover

Because of the frequency of cyclonic and frontal activity and the high solar surface heating, the region surrounding the site is subject to frequent cloud cover. The area experiences the highest percentage of cloud cover during the winter, at which time the surface receives only 35 percent of possible sunshine. During the spring and summer, the area experiences 55 percent of the possible sunshine that reaches the ground. The fall is the sunniest season, receiving about 65 percent of the possible sunshine, reflecting the dominance of the Atlantic subtropical high at this time (U.S. Dept. of Commerce, 1968).

3.4.1.8 Fog

Radiation fog is a frequent meteorological phenomenon in eastern Kentucky. It develops as a result of nocturnal cooling (to the dew point) of low-level air over land, particularly during wind- and cloud-free nights when humidity is relatively high. Although heavy fog occurs on an average of just 30 times a year, the occurrence of fog with higher visibilities is more frequent.

3.4.1.9 Relative Humidity

Diurnally, the highest relative humidities are observed during the early morning hours when the daytime temperatures are lowest. The humidity is usually around 80 percent at this time of day. The relative humidity drops to its lowest daytime values (50 to 60 percent) by midday. Seasonally, the relative humidity averages the highest during the late summer (70 to 80 percent), and the lowest during the early spring, when readings between 50 and 60 percent are common (U.S. Dept. of Commerce, 1974).

3.4.1.10 Severe Weather Conditions

Thunderstorms and Hail

Thunderstorms are reported at Lexington on an average of 47 days per year. They occur monthly and are most frequent in June and July, with thunder occurring about one-third of the days in each month. The average monthly distribution for Lexington is shown in Table 3.4-2. The thunderstorms are of a convective nature, as well as of a frontal squall-line type origin, and can be as severe as thunderstorms in the central plains. The most severe thunderstorms are associated with squall-line activity and are reported in the months of April and May.

Hailstorms have occurred in all seasons in eastern Kentucky, although large hailstones of a damaging nature rarely occur. Figure 3.4-2 gives the number of reports of hailstones 3/4 inches and greater by 1^{o} squares for a 12-year period of record. The probability of hail occurrence is directly related to the amount of thunderstorm development as tabulated by Pautz (undated). Therefore, the months of most frequent hail occurrence coincide with the months of most severe thunderstorm activity.

Tornadoes and Cyclones

The occurrence of tornadoes in eastern Kentucky is rare. The proper combination of the favorable weather elements such as warm moist advection and strong insolation that are conducive to tornadic activity are not often realized in eastern Kentucky. In addition, the mid-level jet stream circulation favorable to the outbreak of severe weather events in the summer months is weak, even though surface heating (and instability) is at its peak. Figure 3.4-3 is a tabulation, by 1^{o} squares, of the number of tornadoes observed in the United States from 1955 through 1967 after Pautz (undated). In the 1^{o} square surrounding the site, there were 15 tornadoes reported during the period of study.

Lexington, Kentucky is situated far enough north of the Gulf of Mexico that it is only indirectly (and very infrequently) affected by tropical storms and hurricanes. By the time a former tropical storm system has advanced as far north as Kentucky, it has undergone the transition to the extratropical storm stage, with lesser winds but a heavier than average amount of rain. It is these rains depositing moisture from the Gulf of Mexico inland that pose the only problem from tropical storm systems.

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 eastern Kentucky exhibit fairly high speeds, the occurrence of extreme winds is not as likely as along the Gulf coast region to the south or the Atlantic coast to the east. This is attributed to the fact that the coastal areas are more open to the threat of tropical storms than is eastern Kentucky. Pautz (undated) determined that there were 32 reports of wind storms of 50 knots or greater intensity in the 1° by 1° area surrounding the Lexington site between the years 1955 and 1967. The highest wind speeds are observed during the months of February and March, when the monthly averages are greater than 11 miles per hour (mph). The strongest sustained wind reported (fastest mile of wind) at Lexington was 46 mph. The American National Standards Institute's (1972) annual extreme fastest-mile wind speed (at 30 feet above ground) for northeastern Kentucky is 75 mph for a 50-year recurrence interval, and 90 mph for a 100-year mean recurrence interval.

3.4.2 Climatological Factors Affecting Dispersion

3.4.2.1 High Air Pollution Potential

The meteorological conditions that are generally conducive to high air pollution potential are light winds, stable layers aloft, and surface-based temperature inversions. The region is characterized by summertime afternoon thunderstorms, high solar insolation and its associated instability in the lower layers, and relatively high surface winds. These meteorological conditions do not contribute to a high air pollution potential. In addition, the gently rolling plateau of eastern Kentucky is not considered to be a large factor for reducing surface air flow.

Since high air pollution is most often a city-related problem, Holzworth (1972) studied urban meteorological and pollution characteristics. This study was 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 frequency:

Season	Frequency (percent of all hours)
Winter	30
Spring	27
Summer	33
Autumn	37
Annual	32

Radiation inversions are usually eliminated by late morning because of surface heating.

3.4.2.2 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. A discussion of the relationships between meteorological parameters, mixing heights, and air pollution potential is presented in Appendix B. The higher the mixing height, the lower the pollution potential. Using United States 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 associated with the lower atmospheric layers throughout the contiguous United States. Mean morning and afternoon urban mixing heights in the general vicinity of the site were 500 and 1500 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 indicates the effect 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 conducive to the formation of early morning inversions that inhibit vertical atmospheric motion.

3.4.2.3 Stability

The system of classifying stability in this region is based upon Turner's method (1969), which 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 do nonurban areas, stability classes F and G were combined into a single class.

Seasonal and annual distribution of stability classes for Lexington (U.S. Dept. of Commerce, 1975) are listed below:

	(Percent by Season)				
Stability Class	Dec/Jan/Feb	Mar/Apr/May	Jun/Jul/Aug	Sept/Oct/Nov	Annual
A	0.0	1.1	3.5	0.3	1.2
B	0.9	5.1	12.0	6.0	6.1
C	5.7	12.5	17.5	11.0	11.2
D	67.3	55.8	26.4	40.9	47.5
E	12.8	12.4	11.6	14.2	12.7
F	13.2	15.1	28.7	27.6	21.2

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 the stability classes during the summer and fall months. There is a relatively small percentage of unstable conditions at the site, which is unusual for an area that experiences strong solar heating at the surface. The moderately high winds and large amount of cloud cover moderate the destabilizing effects of surface heating so that a smaller percentage of unstable conditions is realized. On a diurnal basis, most of the atmospheric instability occurs during the midday, which is followed by stable conditions at night. It is noteworthy that 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.

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. Commonwealth of Kentucky Ambient Air Quality Standards are identical to the federal standards with the exception of the settleable particulate standard of 15 tons per square mile per month (5.25 g/sq.mi/mo) - maximum three month average, not to be exceeded more than once a year, which is a Kentucky standard only.

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 concentration 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 the secondary standards; a priority III is indicative of concentrations generally below the secondary standards. Priority classifications in the Bluegrass AQCR of Kentucky, which includes Lexington, are presented below:

	Pollutant				
	Sulphur Dioxide	Particulates	Nitrogen Dioxide	Photochemical Oxidants	Hydrocarbons
Priority	III	II	III	III	III

The existing ambient air quality for several monitoring locations in Lexington is summarized in Tables 3.4-4 through 3.4-8 for sulphur dioxide, particulates, nitrogen dioxide, photochemical oxidants, and hydrocarbons, respectively. The tables are based on periods of record including October 1974 through December 1976, and are the most recent summarizations available (Kentucky State Division of Air Pollution, 1975 and 1976).

Geometric mean total suspended particulate concentrations were generally well below the primary standard. Only on two occasions was the secondary 24-hour standard exceeded with concentrations of 180 $\mu g/m^3$ and 164 $\mu g/m^3$ (Table 3.4-4). There was one station in which the annual secondary standard was exceeded (Station 2117 reported 73 $\mu g/m^3$).

At all of the monitoring locations, including both those with continuous monitors and 24-hour bubblers, observed concentrations of sulphur dioxide were well below the secondary standards. In no cases were the 3-hour or 24-hour standards exceeded (Table 3.4-5).

Despite the fact that the entire Bluegrass AQCR is listed as a priority III region, the 6 to 9 a.m. average exceeded the standard for all three of the hydrocarbon monitoring locations in Lexington in 1974 (Table 3.4-6). The maximum observed concentration of 0.73 ppm (481 $\mu g/m^3$) was three times greater than the primary and secondary standard of 0.24 ppm (160 $\mu g/m^3$). The priority classifications were established in the early 1970's and are applicable to the entire AQCR. It is possible that hydrocarbon concentrations are relatively higher in Lexington and may have increased between 1971 and 1974. Currently state authorities are considering the need to reclassify the Lexington area for ambient hydrocarbons.

Photochemical oxidants sampled at the Lexington primary reference site over the reporting period January through December, 1976, exceeded the primary and secondary standards of 160 $\mu g/m^3$ (0.08 ppm) 147 times in 6075 observations (Table 3.4-7). Because the levels of photochemical oxidants are related to the amounts and types of hydrocarbons in the air, the problem of control of photochemical oxidant emissions and of future levels of photochemical oxidants is viewed as similar to those of hydrocarbons.

The Bluegrass AQCR is also listed as a priority III region for nitrogen dioxide. In 1976, the annual arithmetic mean of 47.4 $\mu g/m^3$ (Table 3.4-6) was less than one-half the 100 $\mu g/m^3$ of nitrogen dioxide allowed by primary and secondary ambient air quality standards.

TABLE 3.4-1 Monthly mean and extreme snowfall (in inches) at Lexington, Kentucky*

	Monthly Maximum	Mean
January	21.1 (1948)	5.2
February	10.4 (1960)	4.9
March	17.7 (1960)	3.0
April	2.9	0.2
May	0.0	0.0
June	0.0	0.0
July	0.0	0.0
August	0.0	0.0
September	0.0	0.0
October	0.2 (1972)	T
November	9.7 (1950)	0.6
December	10.7 (1907)	1.8
Year	21.1 (1948)	15.7

* Based on a 30-year (1945 - 1974) climatic record.

TABLE 3.4-2 Monthly mean number of thunderstorm days reported at Lexington, Kentucky[a]

	Number of Days
January	1
February	1
March	3
April	4
May	7
June	9
July	10
August	7
September	4
October	2
November	1
December	b
Year	47

[a] Based on 30 years (1945-1974) of climatic data.

[b] Average is less than 1/2.

TABLE 3.4-3 Primary and secondary ambient air quality standards.

Air Contaminant	Standards Maximum Permissible Concentration
PRIMARY	
Suspended Particulate	75 μg/m3 (Annual geometric mean)
	260 μg/m3 (Maximum 24-hour concentration not to be exceeded more than once per year)
Sulfur Dioxide (SO_2)	80 μg/m3 or 0.03 ppm (Annual arithmetic mean)
	365 μg/m3 or 0.14 ppm (Maximum 24-hour concentration not to be exceeded more than once per year)
Hydrocarbons (other than Methane)	160 μg/m3 (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)
Total (Photochemical) Oxidants	58.8 $\mu g/m^3$ or 0.03 ppm (Annual arithmetic mean)
	98.0 $\mu g/m^3$ or 0.05 ppm (4-hour maximum)
	160 μg/m3 or 0.08 ppm (Maximum 1-hour concentration not to be exceeded more than once per year).
SECONDARY	
Suspended Particulate	60 $\mu g/m^3$ (Annual geometric mean)
	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 arithmetic mean)
	260 $\mu g/m^3$ or 0.10 ppm (Maximum 24-hour concentration not to be exceeded more than once per year)
Hydrocarbons (other than Methane)	160 $\mu g/m^3$ (0.024 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)
Total (Photochemical) Oxidants	58.8 $\mu g/m^3$ or 0.03 ppm (Annual arithmetic mean)
	98.0 $\mu g/m^3$ or 0.05 ppm (4-hour maximum)
	160 $\mu g/m^3$ or 0.08 ppm (Maximum 1-hour concentration not to be exceeded more than once per year)

TABLE 3.4-4 Kentucky air quality, statistical report for sulfur dioxide

Site (No.) Site Address	Reporting Period From - Thru	Num. Obs.	24-hour average Maximum*	24-hour average Times> 455	24-hour average Times> 365	24-hour average Times> 260	3-hour average Maximum*	3-hour average Times> 1300	Arithmetic Mean*	Measurement Method
Lexington (2003) 330 Waller Street	74/10-75/09	6390	102.2	0	0	0	193.9	0	27.6	continuous
(2003)	74/10-75/09	60	32.6	0	0	0	---	--	9.9	24-hr bubbler
Frankfort (2010) 275 E Main Street	74/10-75/09	60	34.8	0	0	0	---	--	10.9	24-hr bubbler
Lexington (2012) UK Mechanical Eng.Bld.	74/10-75/09	61	59.4	0	0	0	---	--	15.7	24-hr bubbler
Swallowfield (2026) National Fish Hatchery US	74/10-75/09	59	34.7	0	0	0	---	--	3.7	24-hr bubbler
Richmond (2117) E & E Main Street	74/10-75/09	55	41.9	0	0	0	---	--	11.4	24-hr bubbler
Winchester (2118) 41 South Main	74/10-75/09	57	30.3	0	0	0	---	---	6.1	24-hr bubbler
Danville (2119) Danville Water Plant,Lex	74/10-75/09	60	60.8	0	0	0	---	--	11.6	24-hr bubbler
Berea (2124) Hutchins Library, Berea C	74/10-75/09	53	31.3	0	0	0	---	--	6.5	24-hr bubbler
Cynthiana (2131) Pleasant Street	74/10-75/09	57	33.3	0	0	0	---	--	8.9	24-hr bubbler
Lexington (2132) Castlewood Park,Bryan &	74/10-75/09	435	99.6	0	0	0	393.0	0	9.4	3-hr bubbler
(2132)	74/10-75/09	61	39.8	0	0	0	---	--	9.4	24-hr bubbler
Lexington (2152) Southland Park	74/10-75/09	60	43.7	0	0	0			11.8	24-hr bubbler

* Units = Micrograms per cubic meter, 25°C, Bluegrass Air Quality Control Region

TABLE 3.4-5 Kentucky aerometric information system, statistical report for total suspended particulates

Site (No.)		Reporting Period From - Thru	Num. Obs.	24-hour observations: Maximum*	Times> 325	Times> 260	Times> 150	Times> 150	Minimum*	Arithmetic*: Mean	Arithmetic*: St.Dev.	Geometric*: Mean	Geometric*: St.Dev.
Lexington 330 Waller St..	(2003)	74/10-75/09	55	99.0	0	0	0	0	11.0	45.0	21.1	40.0	1.67
Frankfort 275 E. Main St.	(2010)	74/10-75/09	59	162.0	0	0	2	2	8.0	46.0	30.3	39.0	1.76
Lexington UK Mechanical Eng.Bld.	(2012)	74/10-75/09	61	93.0	0	0	0	0	6.0	41.0	19.7	37.0	1.66
Swallowfield National Fish Hatcher	(2026)	74/10-75/09	43	85.0	0	0	0	0	7.0	32.0	19.1	27.0	1.79
Richmond E & E Main Street	(2117)	74/10-75/09	54	261.0	0	1	2	2	21.0	81.0	38.3	73.0	1.55
Winchester 41 South Main	(2118)	74/10-75/09	58	130.0	0	0	0	0	8.0	49.0	28.2	42.0	1.80
Danville Danville Water Plant	(2119)	74/10-75/09	56	188.0	0	0	1	1	12.0	38.0	25.6	33.0	1.67
Berea Hutchins Library, Ber	(2124)	74/10-75/09	54	97.0	0	0	0	0	12.0	41.0	19.3	36.0	1.65
Cynthiana Pleasant Street	(2131)	74/10-75/09	57	108.0	0	0	0	0	15.0	57.0	23.2	52.0	1.57
Lexington Castlewood Park, Brya	(2132)	74/10-75/09	59	95.0	0	0	0	0	11.0	44.0	19.6	40.0	1.61
Lexington Southland Park	(2152)	74/10-75/09	58	118.0	0	0	0	0	8.0	44.0	26.2	37.0	1.83

* Units = Micrograms per cubic meter, 25°C, Bluegrass Air Quality Control Region

TABLE 3.4-6 Kentucky aerometric information system, statistical report for nitrogen dioxide.

Site (No.) Site Address		Reporting Period From-Through	Number of Observations	Arithmetic Mean	Measurement Method
Lexington 330 Waller St.	(2003)	76/01-76/12	5720	47.4	Continuous
Lexington 330 Waller St.	(2003)	76/01-76/12	51	26.6	24-hr Bubbler
Frankfort 275 E. Main St.	(2010)	76/01-76/12	57	27.4	24-hr Bubbler
Lexington UK Mechanical Eng. Bldg.	(2012)	76/01-76/12	55	36.3	24-hr Bubbler
Franklin Co. National Fish Hatchery US 127	(2026)	76/01-76/12	51	9.3	24-hr Bubbler
Richmond 457 East Main St.	(2117)	76/01-76/12	56	40.1	24-hr Bubbler
Winchester 41 South Main	(2118)	76/01-76/12	59	29.2	24-hr Bubbler
Danville Danville Water Plant, Lex. Ave.	(2119)	76/01-76/12	57	28.7	24-hr Bubbler
Berea Hutchins Library, Berea College	(2126)	76/01-76/12	54	25.2	24-hr Bubbler
Cynthiana Pleasant St.	(2131)	76/01-76/12	61	30.5	24-hr Bubbler
Lexington Castlewood Park, Bryan 4 Park VI	(2132)	76/01-76/12	48	35.7	24-hr Bubbler
Lexington Southland Park	(2152)	76/01-76/12	56	33.7	24-hr Bubbler

*Units = Micrograms per cubic meter, Bluegrass Air Quality Control Region

TABLE 3.4-7 Kentucky air quality, statistical report for photochemical oxidants.

Site (No.) Site Address	Reporting Period From - Through	Number of Observations	1 hr. Max.	2nd Max.	Times > 0.8 ppm
Lexington (2003) 330 Waller St.	76/1 - 76/12	6075	.131	1.29	147

TABLE 3.4-6 Annual maximum, in parts per million, for total nonmethane hydrocarbons in Lexington, Kentucky (primary standard 0.24 ppm; ( ) no. times exceeded standard)

Air Quality Control Region	City/State Number Address	1971	1972	1973	1974
Bluegrass (102)	Lexington/2003 F01-2300-002 330 Waller Ave.	--	--	--	0.73 (24)
	Lexington/2162 F01-2300-007 412 North Broadway	--	--	--	0.37 (5)
	Lexington/2168 F01-2300-008 1800 Nicholasville Rd.	--	--	--	0.30 (1)

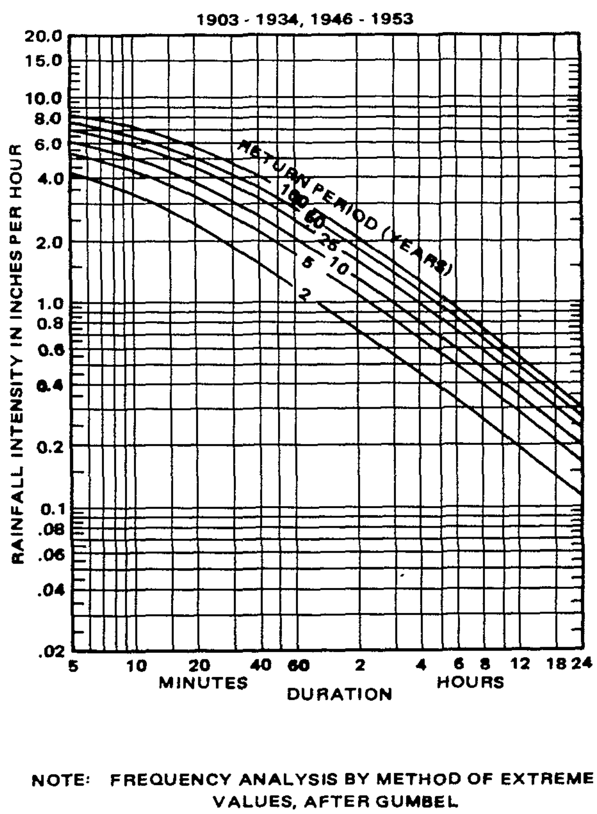
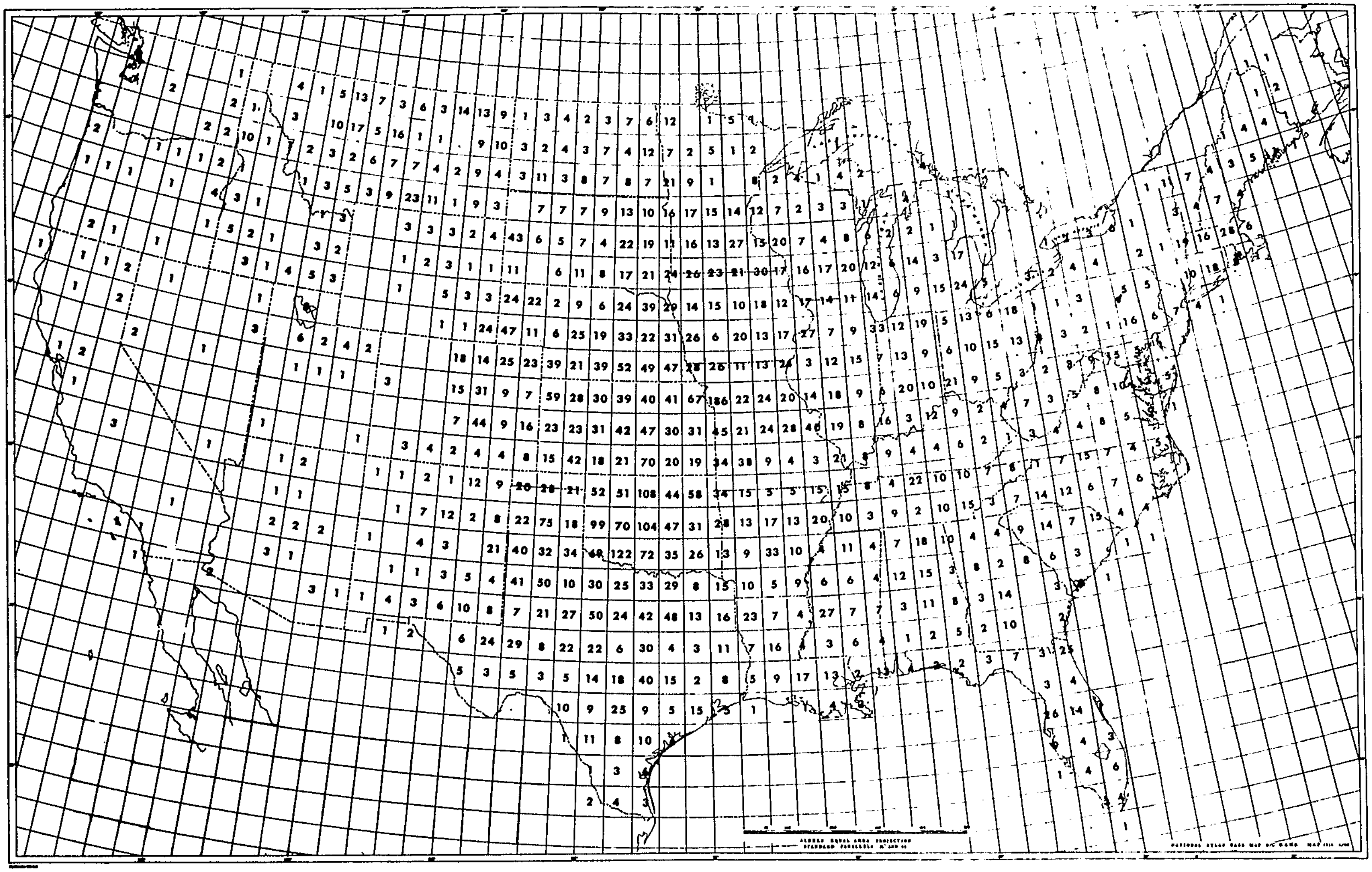
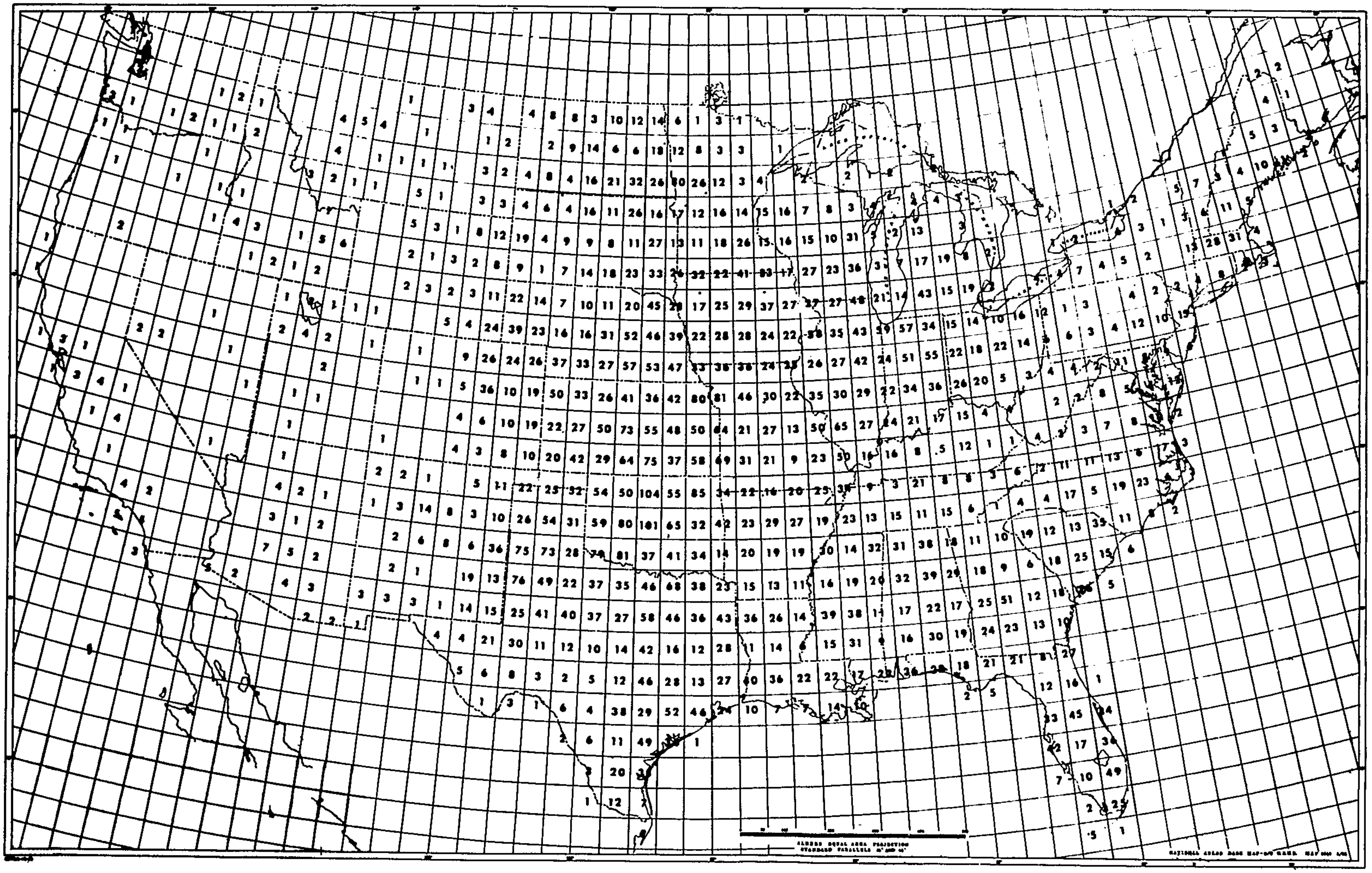


FIGURE 3.4-1 Rainfall versus duration at Lexington



Source: Pautz, no date.

FIGURE 3.4-2 Total number of hail reports 3/4 inch and greater, 1955-1967 by 1° squares



Source: Pautz, no date.

FIGURE 3.4-3 Total tornadoes 1955-1967 by 1° squares

3.5 BACKGROUND AMBIENT SOUND LEVELS

Background ambient sound levels were estimated for Central Rock Mine and its environs to assess the potential noise impact from the proposed action. The proposed storage facility is located in the western urban area of Lexington at an active limestone mining site. Oil will be transported to and from the storage facility by a pipeline route that passes around the southwestern part of Lexington, which is a sparsely populated rural area that also includes forested areas and pastureland. Nearby noise-sensitive land use areas include the Lexington suburbs south and west of New Circle Road (see Figure 2.1-1). The background sound levels were estimated from measurements made at a similar facility (Dames & Moore, 1972) and published data relating ambient sound levels to population distribution (Galloway, 1973).

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:

1. Center of the site
2. City of Lexington
3. Pasturelands
4. Noise-sensitive land uses along the pipeline route

A summary of these sound levels in decibels (dB) is as follows:

Summary of Background Ambient Sound Levels - dB

	L_d	L_n	L_{dn}
Center of site	66	68	74
City of Lexington	57	51	59
Pasturelands	45	35	45
Noise-sensitive land uses along the pipeline route	50	42	51

These values may be compared with sound levels identified by the Environmental Protection Agency 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.

3.6 BIOLOGY AND ECOLOGY

3.6.1 General Characterization of the Region

The Bluegrass Region of north-central Kentucky is generally considered to be an approximately circular area, 100 miles in diameter, that is underlain by Ordovician limestone. Lexington, Central Rock Mine, and the environs lie within the Inner Bluegrass Region (Figure 3.6-1). The gently rolling terrain of the Inner Bluegrass has a moderate karst topography and is bisected in the south by the Kentucky River and its tributaries.

The Bluegrass Region is classified by Braun (1950), and Wharton and Barbour (1973) as being within a western mesophytic forest region. Kucher (1964) considers the Bluegrass Region to lie within an oak-hickory forest region. Phytogeographers generally agree that the Inner Bluegrass possesses the most anomalous vegetation found in the eastern United States (Braun, 1950; Davies, 1953; Gibson, 1961; Wharton and Barbour, 1973). A high diversity of species exists in the area, including species and plant communities typical of areas to the north, south, east, and west. Many theories have been offered to explain this phenomenon, including glacial influence (Braun, 1921; Keith, 1967); soil and chemical properties (McInteer, 1946, 1947); and precipitation and climate (Transeau, 1935). Fire was even considered to be a causal factor many years ago (Shaler, 1885). More recently, a combination of factors including soil properties, geology, climate, and fire, in addition to natural selection, have been suggested to have had a combined influence on the vegetation of the Bluegrass Region (Braun, 1947, 1950; Wharton and Barbour, 1973).

The Bluegrass Region of Kentucky is the most heavily developed portion of the state (Gansner, 1968). The original forests of the region have been greatly reduced by agricultural cultivation and industrial and urban development. As a result, only roughly one-fifth of the total area is now in forested land (Gansner, 1966, 1968). Although the region accounts for more than 20 percent of Kentucky's gross area, less than 10 percent of the forestland of the state is found there (Gansner, 1968).

Generally, the Inner Bluegrass is composed of old forests sporadically situated among the extensive agricultural developments of the region. According to Wharton and Barbour (1973), bur oak and blue ash are the most characteristic tree species of the area. Generally, trees of the Inner Bluegrass are well spaced, indicative of an open canopy formation. The bur oak in particular cannot thrive in a closed canopy situation, which partially explains its prominence in the Inner Bluegrass.

The Central Rock Mine site is located in the western portion of Lexington, Kentucky, within Fayette County. The county has an area of approximately 280 square miles, or 179,200 acres (U.S. Department of Agriculture, 1968). Agriculture has become increasingly important in the county since early pioneer settlement. Tobacco and livestock are the major agricultural products; over two-thirds of the farmland is in pasture.

The surface water resources of the area (section 3.3.1.1) consist primarily of small streams that originate in the central part of the county and drain toward the south and north, away from the Lexington area, eventually entering the Kentucky River (Figure 3.3-2). Stream flow is variable and, during dry weather, ground water seepage is the major source of streamflow in all streams in the Lexington area except Town Branch (USGS, 1968). The major source of dry-weather flow in Town Branch is effluent from the Lexington sewage treatment plant. During periods of rainfall, urban runoff from the stormwater overflow system enters Town Branch and other creeks around Lexington.

3.6.2 Mine Site

Industrial development to the north, northeast, east, and south of the Central Rock Mine site (see Figure 2.2-1), coupled with a residential development to the southwest, constitutes the local land use around the site. The surface quarry is located on the eastern portion of the property; tobacco warehouses and an old farmstead are located on the western portion. The ecologically significant areas of the site include mesophytic wooded slopes on the eastern and southwestern edges and oldfield-pasture on the western and southern portions (Figure 3.6-2).

3.6.2.1 <u>Terrestrial Biology</u>

Vegetation

The Central Rock Mine site consists of 165 acres of land. Oldfield-pasture vegetation accounts for 29 percent, or 48.5 acres, of land. Mesophytic-wooded slopes account for 12 percent, or 19.5 acres. The remaining 59 percent (97 acres) is used for quarry operations, an asphalt plant, tobacco warehouses, and a concrete block factory.

The oldfield-pasture vegetation is situated on a hill in a west-central location on the site (Figure 3.6-2). The hill gradually slopes away from the 950-foot elevation in all directions. Portions of the vegetation were cultivated at one time. It is presently composed entirely of ground cover species with no overstory development. Some understory development is evident along the field borders. The dominant species is meadow fescue, followed by Kentucky bluegrass and red top (Table 3.6-1).

Oldfield vegetation species identified within the ground cover stratum include common milkweed, beggar-ticks, field thistle, jimsonweed, daisy fleabane, joe-pye weed, groundcherry, yellow foxtail, and tall goldenrod. Understory vegetation is situated along the field borders, and includes pasture rose and prickly ash.

The mesophytic-wooded slope vegetation (Table 3.6-2) is located in the southwest and southeast portions of the site along the Southern Railroad right-of-way. The topography is moderately sloped, ranging in elevation from a maximum height of 940 feet to a minimum of 910 feet. The area appears, by the height of the overstory vegetation, to have been abandoned many years ago. Few, if any, outside activities have affected this sloped area, primarily because the rolling topography and brushy vegetation have inhibited its use. The most dominant of the overstory species is slippery elm, followed closely by hackberry, blue ash, and bur oak. Other supportive species of the overstory stratum include American hornbeam, black walnut, sweet gum, sycamore, and black locust.

Species comprising the understory of the mesophytic site include hawthorn, red cedar, sweet gum, and slippery elm. Ground cover species include honeysuckle, greenbrier, tall goldenrod, and wooly mullein.

Successionally, both the oldfield-pasture and the mesophytic-wooded slope vegetation types are in the early stages of their development. The lack of a well-established understory in the oldfield-pasture type, and the lack of a definitive overstory canopy, support this observation.

Invertebrates

The mine site is located in a mixed residential-industrial portion of Lexington. As a result, no insect studies of note have been conducted for the immediate site environs. A county list of insects is in preparation, but was not available at the time of this study. However, on the basis of the type of host vegetation found in the immediate vicinity, certain insect species (Baker, 1972) can be expected to occur on or near the site. One of the predominant tree species of the area is the elm, which is subject to the fall cankerworm, spring cankerworm, elm leaf beetle, and elm leaf miner. Hawthorn is subject to aphids. Juniper is infested by juniper scale and juniper webworms. Bur oak is subject to injury from golden oak scale, gypsy moths, oak gall, oak lacebugs, oak twig pruners, and orange striped oakworms. Walnut is injured by nut borers, wood borers, leaf feeders, and walnut scale. Hackberry is host to bark borers and hackberry star gall. Sweet gum is affected by bark borers and luna moths.

Reptiles and Amphibians

Despite man's presence in nearly every available habitat type within the Bluegrass Region of Kentucky, many areas suitable for the existence of reptiles and amphibians still exist. At least 23 reptile species and 28 amphibian species (Table 3.6-3) are expected to occur in the region. The actual occurrence and abundance of these species at the mine site are unknown. The presence of several species is inferred from the known range and habitat requirements of individual species combined with the habitat available at the mine site. The site's urban location also undoubtedly influences which species inhabit the site.

Reptiles: Turtles - Neither aquatic nor terrestrial species of turtle are expected to inhabit the mine site. Aquatic and terrestrial habitat types are very limited on the site. This, coupled with the site's location in relation to various types of heavy industry and urban housing, makes it unlikely that turtles known to occur in the Bluegrass Region are present.

Reptiles: Lizards - Both the fence lizard and the five-lined skink are probable residents of the site. The dry open woodlands located on the slopes in the sink area at the site's eastern boundary and the piles of debris and presence of old buildings provide the required habitats of both species (Barbour, 1971).

Reptiles: Snakes - Several species of snake are likely to occur in the mine site area. Those species common to the Lexington urban area and whose habitat requirements are satisfied at least in part by the site include the milk snake, garter snake, queen water snake, and common water snake. Several other species are known to occur in the Bluegrass Region, but all are rare and least abundant in the Bluegrass Region compared to other areas of Kentucky.

Amphibians: Salamanders - Nineteen species of salamander are expected to occur in the Lexington urban area. Six of them are probable residents of the Central Rock Mine site. The mud and dusky salamanders may be found in McConnell Springs, which is located in the sink area near the site's western boundary. The small-mouthed salamander, zig-zag salamander, and ravine salamander probably can be found in the brush areas, under piles of debris, or on the wooded slopes near the site's western boundary. The cave salamander is another probable resident, particularly in areas where limestone caves are present. Many of the remaining species of salamander known to occur in the urban areas of Lexington are either rare or uncommon, or else not likely to find suitable habitat in the site environs (U.S. Army Corps of Engineers, 1974b).

Amphibians: Frogs - Seven species of frog are known to occur in the urban area of Lexington. Two species likely to occur in the mine site area are the bullfrog and the green frog, for which McConnell Springs and the intermittent standing water found near the site's western boundary provide suitable habitat. The oldfield-pasture, open woods, and spring areas also provide suitable habitat for the leopard frog, pickerel frog, spring peeper, and gray treefrog (Barbour, 1971); however, their occurrence in the Lexington urban area is either uncommon or rare (U.S. Army Corps of Engineers, 1974b). The isolated nature of the site undoubtedly contributes to the absence of several species whose ranges encompass, and whose habitat requirements are met by, the site.

Amphibians: Toads - Both species of toad known to occur in the urban area of Lexington are probable residents of the mine site. The American toad and Fowler's toad may be found among the buildings or in the moist woods.

Birds

The site lies in a region where extensive deforestation has resulted in the disappearance of forest birds (Mengel, 1968). Open country species clearly unlike the original forest ones are now favored by the "clean" farming practices in the region. Two hundred and fifty species of birds may be found in the Lexington urban area (see Appendix D). Of these 250 species, 79 were recorded during the 1973 and 1974 Lexington Christmas counts. The implied presence of certain species is based on previous records, species range maps, and habitat requirements compared with available habitat at the mine site. The urban location of the site also undoubtedly influences which species inhabit it, but the extent of this influence cannot be determined without onsite investigations.

Birds that have adapted to living around human habitations are numerous throughout the region and the site area, and most have increased in the last 50 years. Among these species are the common nighthawk, chimney swift, yellow-billed cuckoo, eastern phoebe, eastern wood pewee, great-crested flycatcher, barn swallow, purple martin, wood thrush, robin, common grackle, cardinal, and chipping sparrow (Mengel, 1968).

Typical common inhabitants of the remaining mixed forests of the region include the downy woodpecker, red-bellied woodpecker, eastern wood pewee, tufted titmouse, Carolina chickadee, Carolina wren, wood thrush, red-eyed vireo, cerulean warbler, Kentucky warbler, and scarlet tanager.

Waterfowl (including shorebirds and wading birds) - The only species within this grouping of birds that is likely to occur at the mine site is the killdeer. This bird has been seen in the cultivated portions of the oldfield-pasture at the eastern boundary of the site. There is no suitable habitat at the site for waterfowl, herons, or shorebirds.

Birds of Prey - Two species of hawk (the red-tailed hawk and marsh hawk) were seen at the mine site. Both were seen flying over the oldfield-pasture vegetation. The urban location and small size of the site may discourage the presence of most raptorial species. The screech owl, which is common in the Lexington urban area and is occasionally reported to inhabit cities (Barbour and others, 1973; U.S. Army Corps of Engineers, 1974b), may inhabit the wooded portions of the site.

Upland Gamebirds - The only upland gamebirds likely to inhabit the site are the bobwhite quail and the mourning dove. Two coveys of quail were observed in the oldfield-pasture area. Suitable habitat for quail is restricted and isolated by industry and urban housing. Mourning doves, on the other hand, have adapted completely to man and find living in towns and cities tolerable. As a result, they are common to the Lexington urban area. The oldfield-pasture vegetation provides food; the springs and wooded slopes provide water and cover.

Songbirds - Most of the songbirds common in the Lexington urban area, including the meadowlark, robin, horned lark, mockingbird, starling, common grackle, cardinal, field sparrow, and song sparrow, are likely to occur at the mine site.

Others - Many other bird species are common to the Lexington area, including pigeons, cuckoos, goatsuckers, swifts, and woodpeckers. The rock dove, or pigeon, is so common that it has become a pest in many areas; it is also common at the mine site. Other species likely to inhabit the site are the common nighthawk and chimney swift. Woodpeckers are less likely to be common as a result of the limited wood areas; however, species that may be seen there include the common flicker, red-bellied woodpecker, and downy woodpecker.

Mammals

Less than 50 percent of the 41 species of mammal occurring in the Bluegrass Region of Kentucky (Durrel, 1976) are likely to be found at the Central Rock Mine site. The paucity of mammal species is largely explained by the site's location within the city limits of Lexington, surrounded by various types of heavy industry and urban housing. Although segments of suitable habitat for several different mammal species are present, the limited size and isolated location of these segments preclude the presence of many mammal species.

The mammals likely to occur at the Central Rock Mine site can be categorized as fur-bearers, small game animals, small rodents, and bats (Table 3.6-4).

Fur-bearers - Possibly four species of fur-bearer occur at the Central Rock Mine site: the opossum, raccoon, red fox, and striped skunk. All of these species are common within Fayette County (Durrel, 1976). Evidence such as tracks and scat found at the mine site verifies the presence of the red fox and opossum. The oldfield-pasture, wooded slopes, spring areas, and piles of brush and debris provide suitable habitat for all four species. The occurrence of other fur-bearers at the mine site is doubtful because habitat is insufficient and/or unsuitable, and because the site is surrounded by residential-industrial development.

Small Game Animals - Five species of small game animals may be found at the Central Rock Mine site: cottontail rabbit, woodchuck, gray and fox squirrel, and raccoon. All of these species are common in the Lexington area and throughout Fayette County (U.S. Army Corps of Engineers, 1974b; Durrel, 1976). Gray squirrels were observed at the site. The wooded slopes and fencelines provide habitat for both species of squirrel. Cottontail rabbit signs (tracks and droppings) were common at the site, particularly in the oldfield-pasture and in the wooded edges and brush piles. The wooded edges and slopes adjacent to the oldfield-pasture provide good denning habitat for the woodchuck. Although no sign of this species was found during the brief site visit, county records (Gault, 1950) of its occurrence support it as a possible resident of the site. The sink area situated at the site's western boundary provides the woods and water of the raccoon's preferred habitat.

Small Mammals - Thirteen species of small mammals could occur at the site. All are common to abundant in the Lexington area (U.S. Army Corps of Engineers, 1974b). While it is extremely unlikely that all 13 species occur within the limited acreage found at the site, some habitat capable of supporting each species is present.

Grassland species that may inhabit the oldfield-pasture area are the least shrew, eastern mole, eastern harvest mouse, prairie deer mouse, meadow vole, prairie vole, pine vole, and southern bog lemming. In the Lexington area, where both the meadow and prairie vole occur together, the meadow vole will inhabit the moist, lower grasslands, while the prairie vole will inhabit the uplands (Barbour and Davis, 1974). The Norway rat and house mouse may be found in the oldfield-pasture, but are more likely to be found around buildings at the site.

Woodland species, or those which may inhabit the wood edges and fencerows, include the short-tailed shrew, chipmunk, and white-footed mouse. These species are more likely to be found in the piles of debris, brush piles, and fencerows, since the wooded slopes have little understory or ground cover.

Bats - Due to the absence of caves, only 4 species of bat are likely to be found at the mine site. (Because of the continuous human activity and vehicular traffic within and adjacent to the mine, it is unlikely that bats use the active limestone mine.) Species that may occur at the site are the little brown myotis, eastern pipistrelle, big brown bat, and red bat. The little brown myotis is uncommon, while the others are common in the Lexington area (U.S. Army Corps of Engineers, 1974b). The eastern pipistrelle and the red bat may inhabit the wooded edge and slopes in the sink area near the site's eastern boundary. The little brown myotis and big brown bat may be found in old buildings.

3.6.2.2 Terrestrial Ecology

Every species of plant and animal is of some importance to any given ecosystem. Because of the site's isolated location (in terms of a lack of contiguous habitat) and restricted size, all species found there are deemed essential to maintaining the balance of the local ecosystem.

The associations of a biotic community and its abiotic components are the elements of an ecosystem. An ecosystem involves and incorporates the interactions of organisms among themselves and their environment. A diagrammatic representation of the major ecological associations and biological components of the Central Rock Mine site is presented in Figure 3.6-3.

Soil

Soil is ultimately a storehouse for the raw materials required by plants (the primary producers) for development and growth. "Natural" soils serve as the starting point in the development of the carrying capacity of land for plant and animal communities. "Natural" soils, including the Maury silt loams and Huntington and Maury silt loam soils on hills in the site area, serve as the foundation for the development of a fundamental ecosystem. These soils (Maury and Huntington) have not been significantly altered by man.

Green Plants

Plants in their trophic position supply energy in several forms to the primary consumers of the biota. Basically, the energy from plants is in the form of forage materials from the Central Rock area, such as acorn, hackberry, greenbrier, smooth sumac, juniper berry, maple seed, persimmon, blackberry, strawberry, black walnut, and wild grape, plus a variety of grains and succulent shrubs which supply vitamins, starches, sugars, and other compounds necessary for the life of birds and animals (herbivores). In oldfields and transition areas, in particular, the forage value of the vegetation is very high, owing to the prevalence of grasses and shrub species used by herbivores, including several bird species, rabbits, and most small rodents, the animals that frequent these habitats (Figure 3.6-3).

Invertebrates

Invertebrates, especially insects, are an integral and essential component of every terrestrial ecosystem on the earth. Invertebrates are an abundant faunal form at the Central Rock Mine site. The multifarious insect species are the most important of the invertebrates; this is reinforced by their sheer numbers, both of species and individuals. Insects represent every conceivable trophic level from primary consumers to tertiary carnivores. Every available plant and animal species is either preyed upon or parasitized by insects. Many terrestrial insects (particularly diptera and orthoptera) contribute an important food source to stream fishes. The diets of a large number of the higher animals are based, at least in part, upon the availability of insects as food.

Reptiles and Amphibians

Many of the smaller reptiles and amphibians of the site prey on insects. The five-lined skink and fence lizard, which may live in the forested areas of the site or along their edges, feed exclusively on insects. Frogs and toads, which may occur near the springs and intermittent ponds, are also largely insectivorous.

The grassy areas may be inhabited by various species of snake which often prey on small rodent species. The garter snakes and rat snakes, which may inhabit both the oldfield and wooded areas, eat small mammals, lizards, skinks, baby birds -- almost anything available.

The reptiles and amphibians are, in turn, prey to a number of larger species, such as the hawk, crow, and red fox.

Birds

A diverse community of bird species is likely to inhabit the Central Rock Mine site area. Some birds, like the white-throated sparrow, grasshopper sparrow, and song sparrow, eat seeds and grains, and thus their preferred habitats include weed fields and various agricultural lands. Others are largely insectivorous, like the downy woodpecker, yellow warbler, cardinal, and red-eyed vireo. These birds may inhabit the woodlands or the fields and fencerows. Predatory birds, like the red-tailed hawk, feed largely on small mammals. They are often encountered soaring over fields or perched on a fenceline along or between fields. Other birds, such as the bobwhite and common grackle, are omnivorous, feeding upon a variety of plant and animal foods.

Birds are also preyed on by a variety of predators. Some larger hawks prey on mourning doves and quail, while many nests are raided by arboreal snakes, specifically the rat snake.

Birds are very important in the dispersal of vegetative seeds, especially weed seeds. This is important in the natural succession of vegetative communities.

Mammals

Mammals at the mine site are limited in both number and diversity as a result of the site's size and location; however, their position in the trophic food web cannot be overlooked.

The short-tailed shrew and least shrew, which probably inhabit the woods and oldfield, respectively, are almost exclusively insectivores, although the short-tailed shrew also preys upon young mice and ground-nesting birds.

Most rodents are herbivorous, although some also consume small amounts of animal matter. The white-footed mouse, a likely woodland resident, is a granivorous species, while the prairie vole, which probably inhabits the oldfield, feeds exclusively on grasses. The cottontail rabbit also consumes a variety of herbaceous plant parts.

The opossum is an omnivore that feeds on a variety of plant and animal foods.

Carnivorous mammals include the red fox, which feeds heavily on rabbits and small rodents. Small rodents are preyed on by snakes, hawks, and foxes, while medium-sized mammals are preyed upon by large hawks and foxes. Most of the top carnivores are preyed on only by man.

Man

Man is generally designated as a secondary or tertiary consumer and, as such, is found on the highest trophic level in the ecosystem. Therefore, man is an extremely important and influential component of the biological community. Modern technology has enabled him to assume a dominant role in the ecosystem, as opposed to the former dependent role of primitive man in his natural surroundings.

Rare and Endangered Species

None of the plants observed at the site are listed as rare or endanged in the Inner Bluegrass Region (Casey, 1974) or in Kentucky (Kentucky Academy of Science, 1973). Furthermore, none of the recorded plant species appear in House Document No. 94-51 (Ripley, 1974), or in the Federal Register (1975).

No species of wildlife presently listed by the Commonwealth of Kentucky or by the federal government as being rare or endangered has been recorded at the mine site (Kentucky Academy of Science, 1973; U.S. Dept. of the Interior, 1975).

3.6.2.3 Aquatic Biology

The only significant water resource on the site is the headwater for Wolf's Run, known as McConnell Springs. McConnell Springs receives the drainage from a 75-acre natural depression. Clear water wells up from below on its eastern end and flows westerly about 300 feet before it disappears into the cavernous limestone underlying the entire area. The stream resurfaces again at Wolf's Run, about 4000 feet away. The biota of this first-order stream system has not been studied, but first-order streams at adjacent Steeles Run were studied by Small (1975). Small reported that few algae, invertebrates, or fish were found in these streams. Because of the observed similarity between first-order streams in the area, it is probable that the McConnell Springs site has equally impoverished biota.

3.6.2.4 Species Important to Man

Commercially Important Species

There are no commercially important plant species on the Central Rock Mine site. The only species marginally valuable from a commercial standpoint are bur oak (for lumber) and black walnut (for nuts and veneer products).

The only commercially important wildlife species on the mine site are fur-bearers, such as the opossum, red fox, and perhaps the raccoon.

Recreationally Important Species

The following plant species provide wildlife forage in the form of mast, seeds, berries, and young shoots: redtop, meadow fescue, yellow foxtail, American hornbeam, hackberry, black walnut, honeysuckle, apple, oak, and greenbrier.

The mine site lies within the city limits of Lexington. Since it is illegal to discharge a firearm within the city limits, no recreational value is derived from hunting small game species at the site.

Several species of fur-bearers, such as the opossum, red fox, and perhaps the raccoon, could afford limited recreation to trappers, provided permission to trap in the mine area could be secured.

Although all bird species may be classified as recreationally important by bird-watchers, the use of the mine site for such purposes is, at best, extremely limited.

3.6.3 Proposed Pipeline Corridor

The proposed 13.5-mile oil transport pipeline between Central Rock Mine and Tates Creek Terminal (see Figure 2.3-4) will pass through a variety of ecosystems, including residential, railroad, industrial, horse farm, forest, crop, pasture, and stream areas. Horse farms and other agricultural areas are the most dominant land use activities along the pipeline corridor. In addition, the pipeline will cross about 7 small streams (see section 3.3.1.1), all of which eventually flow into the Kentucky River Basin (Figure 3.3-2).

3.6.3.1 Terrestrial Biology

The pipeline will cross a variety of terrestrial habitats containing a number of plant and animal species that are important components of the Inner Bluegrass Region of Kentucky. However, there have been no studies to quantify the carrying capacity of local habitats for the various species recurring along the proposed right-of-way. Refer back to sections 3.6.2.1 and 3.6.2.2 for a discussion of terrestrial flora and fauna in the region.

3.6.3.2 Aquatic Biology

Streams in the Region

Central Rock Mine is near a ridge line that divides a number of smaller drainage basins into first-, second- and third-order streams. Stream order is a measure of the position of a stream in the hierarchy of tributaries. First-order streams have no tributaries, but when two meet they become a second-order stream. Two second-order streams meet to form one third order and so forth. Extra downstream tributaries of an order lower than that of the receiving stream do not increase the order of that stream.

Several first-order streams originate near the Central Rock site. Most of these cut a narrow valley to the level of the Grier Formation of Lexington limestone, but many streams are subterranean. Small (1975) reported that, in Steeles Run, first-order streams were very tiny (approximately 2.5 feet wide). The bottoms of these streams consisted of medium-sized stones over a substrate of fine clay. The second-order section (13 to 16 feet in width) consisted of many shallow pools and short riffles over a substrate of fine clay and medium stones. The third-order section varied from about 16 to 25 feet in width. Steeles Run rises to third order before flowing into Town Branch near its confluence with Elkhorn Creek.

The smaller tributaries at the crossover points on the pipeline route have very low flow rates, and several (Wolf's and Steeles Runs, and Cave Creek) of these streams are intermittent in character. However, South Elkhorn and West Hickman Creeks are free-flowing.

Aquatic Flora

Primary production in the streams of the region is apparently high, especially in second-order streams where algae (*Cladophora*) completely chokes the stream in summer. Many algal species are found in all streams, suggesting that primary production is more important in these streams than is often the case for flowing (lotic) waters. These high rates of production could be due to sewage discharges and agricultural runoff in the area.

Benthic Fauna

The major benthic macroinvertebrates of Steeles Run (Small, 1975) listed below were found in densities that are suggestive of moderately enriched stream conditions.

Average Number (N) of Primary Food Organisms Present Per Square Meter of Stream and Their Percentage of This Food Base

Taxon	Stream Order 2 N	Stream Order 2 Percentage	Stream Order 3 N	Stream Order 3 Percentage
Lirceus fontinalis	371.0	27	13.5	8
Gammarus sp.	31.5	2	5.9	4
Stenonema sp.	1.9	< 1	66.1	40
Baetis sp.	13.6	1	22.2	13
Tendipedidae	942.6	69	51.5	31
Hydropsychidae	2.9	< 1	7.0	4

Both Hickman Creek and Town Branch receive considerable amounts of sewage, but Town Branch is in especially poor condition. The effects of the sewage waste on Hickman Creek are mitigated somewhat by the additional oxidation lagoon treatment that the wastes receive before discharge into the creek. Studies by Laflin (1970) showed that the deleterious effects of the Lexington Sewage Treatment Plant at Town Branch extend well into the South Fork of Elkhorn Creek. Dissolved oxygen concentrations below the confluence of Town Branch and the South Fork of the Elkhorn were recorded by Laflin to be as low as 0.4 parts per million (ppm), and to average less than 2.6 ppm from June through November. The average number of benthic macroinvertebrates was 163 per square foot above the confluence and 666 per square foot below the confluence. Ephemeroptera and colepotera were more abundant at the unpolluted station than at the polluted stations. Trichoptera and isopoda were most abundant in the recovery station. All five of the above groups of organisms were absent from the station immediately below the confluence with Town Branch. The oligochaete Tubifex was the prominent organism below Town Branch, averaging 643 organisms per square foot.

The benthic fauna of the North Fork of Elkhorn Creek was characteristic of a relatively unpolluted system, with trichoptera, ephemeroptera, and diptera predominant.

The effects of the Lexington Sewage Treatment Plant were evident in samples of benthic macroinvertebrates taken by Lau (1966) in Hickman Creek. Lau reported that isopods (Lirceus sp.), midges (Chironomus sp.), and oligochaete worms were the most common benthic macroinvertebrate forms in the creek. The samples taken below the sewage treatment plant contained a benthic fauna of low diversity and high density. Tubifex sp. was found in abundance below the sewage outfalls in all but one collection. Pollution-sensitive mayflies (ephemeroptera) were not found in any of the collections taken below sewage outfalls. Table 3.6-5 contains a list of benthic macroinvertebrates collected by Lau (1966) from Hickman Creek.

The study site and the proposed pipeline route all lie within the Kentucky River drainage. The results of studies by Jones for the Kentucky Department of Fish and Wildlife Resources (1968, 1973) and other fishery investigations are summarized in an annotated species list presented in Appendix E. This list provides a good description of the relative abundance of fishes and their distribution in the system. In addition, the recent work by Small (1975) in Steeles Run gives a good representation of species expected to be present in the small streams (first and second order) around Lexington (Table 3.6-6).

Probably the most significant aspect of the regional fishery is its degradation in Town Branch, the South Fork of Elkhorn Creek, and Hickman Creek due to sewage wastes from Lexington. The North Fork of Elkhorn Creek is also degraded to some degree, though not to the extent of the South Fork.

3.6.3.3 Rare, Endangered and Threatened Species

The following plant species are listed as rare or endangered in Kentucky by the Kentucky Academy of Science (1973):

Scientific Name	Common Name
Plants - Herbaceous	
Trichomanes boschianum	Filmy fern
Lilium superbum	Turk's-cap lily
Maianthemum canadense	Canada mayflower
Trillium unoulatum	Painted trillium
Cypripedium calceolus	Yellow lady's-slipper
Hydrastis canadensis	Goldenseal
Panax quinquefolia	Ginseng
Plants - Woody	
Taxus canadensis	Canada yew
Sambucus pubens	Red-berried elder
Decodon verticillatur	Swamp loosestrife
Pachistima canbyi	Mountain-lover
Spiraea alba	White spiraea
Rhododendron cumberlandense	Red azalea
Castenea pumila	Chinquapin

Plants listed by the federal government as being endangered or threatened in Kentucky (House Document No. 94-51 (Ripley, 1974)) are the following:

Species	Family	Status
Eupatorium resinosum var. Kentuckiense	Asteraceae	Endangered
Helianthus eggertii	Asteraceae	Endangered
Solidago albopilosa	Asteraceae	Endangered
Solidago shortii	Asteraceae	Endangered
Arabis perstellata var. Perstellata	Brassicaceae	Endangered
Leavenworthia exigua var. Laciniata	Brassicaceae	Endangered
Conradina verticillata	Lamiaceae	Endangered
Oxypolis canbyi	Apiaceae	Threatened
Prenanthes roanensis	Ateraceae	Threatened
Leavenworthia torulosa	Brassicaceae	Threatened
Lesquerella globosa	Brassicaceae	Threatened
Arenaria fontinalis	Caryophyllaceae	Threatened
Stellaria fontinalis	Caryophyllaceae	Threatened
Carex purpurifera	Cyperaceae	Threatened
Rhododendron bakeri	Ericaceae	Threatened
Apios priceana	Fabaceae	Threatened
Hypericum sphaerocarpum var. Turgidum	Hypericaceae	Threatened
Cypripedium candidum	Orchidaceae	Threatened
Platanthera flava	Orchidaceae	Threatened
Platanthera peramoena	Orchidaceae	Threatened
Muhlenbergia torreyana	Poaceae	Threatened
Phlox bifida var. Stellaria	Polemoniaceae	Threatened
Polemonium reptans var. Villosum	Polemoniaceae	Threatened
Asplenium kentuckiense	Polypodiaceae	Threatened
Dodecatheon frenchii	Primulaceae	Threatened
Saxifraga caroliniana	Saxifragaceae	Threatened
Sullivantia ohionis	Saxifragaceae	Threatened
Aureolaria patula	Scrophulariaceae	Threatened
Viola egglestonii	Violaceae	Threatened

Three bird species and four mammal species that are presently listed as endangered in Kentucky by the Kentucky Academy of Science (1973) may be found in the site region. The three bird species presently on the state list of endangered fauna include the golden eagle, southern bald eagle, and sandhill crane. All three species are migratory and are likely to be encountered in the region only during their migration. The four mammal species are the gray bat, small-footed myotis, Indiana bat, and bobcat. There are records of past occurrence for the gray bat, Indiana myotis, and bobcat in the site region; however, the present abundance of these species in the region is unknown. The small-footed myotis is included with this group despite the lack of regional records because there is a possibility that it occurs in caves within the region during the winter. Only the Indiana bat is listed on both the state and federal lists of endangered fauna.

None of the five fishes listed by the Kentucky Fish and Wildlife Resources Department and the Department of Fish and Wildlife Resources Commission (KRS 150.025) is known to occur in the region. However, the preliminary list provided by the Kentucky Academy of Science (1973) includes the hornyhead chub (nocomis biguttatus). An isolated population of this species was once reported from the North Fork of Elkhorn Creek, but none has been taken in recent years. They are rare in the study area, if not totally extirpated.

3.6.3.4 Species Important to Man

Commercially Important Species

The following vegetation species are important for saw timber or veneer production: softwoods, including shortleaf pine, yellow pine, and red cedar; and hardwoods, including white oak, red oak, hickory, maple, beech, black walnut, ash, sweet gum, black gum, cottonwood, yellow poplar, and basswood (Gansner, 1968).

Commercially important medicinal herbs include goldenseal and ginseng.

The only wildlife species in the region having commercial importance are the fur-bearers. Among this group are the opossum, muskrat, red fox, gray fox, raccoon, long-tailed weasel, mink, and striped skunk.

A limited commercial fishery is believed to exist in the Kentucky River. However, with the implementation of a recent (January 1976) ruling by the Kentucky Fish and Wildlife Resources Department prohibiting the use of gill and trammel nets in inland waters, commercial fishing in the area should decline drastically.

Recreationally Important Species

Eight species of mammals in the region offer hunters recreation throughout the year: the cottontail rabbit, woodchuck, gray and fox squirrel, raccoon, red and gray fox, and white-tailed deer.

Recreationally important birds include waterfowl and upland game birds. Although waterfowl are moderately scarce in Fayette County (Durrel, 1976), some species such as the wood duck provide recreation for hunters along wooded streams and creeks. Another species providing sport is the woodcock. Upland game birds of recreational importance are the bobwhite quail and mourning dove.

As a result of the fast-growing pastime of bird watching, all birds may be considered recreationally important. An increasing number of people from all age groups now spend part of their recreation time studying bird life during all seasons of the year.

The Inner Bluegrass section encompasses approximately 16 percent of the Kentucky River watershed. Jones (1973) states that the Kentucky River drainage is capable of providing the following linear miles of sport fishing streams:

County	Miles
Clark	51.84
Fayette	41.15
Jessamine	72.22
Scott	101.17
Woodford	87.30

Of the 353.7 miles of streams in the area capable of providing a sport fishery, nearly half are reported to be significantly degraded by pollution. Major degradation exists in Eagle Creek, the South Fork of Elkhorn Creek, and Hickman Creek (Jones, 1973).

Major sport fishing in the study area is conducted in Harrington Lake, the North Fork of Elkhorn Creek, and the Kentucky River. Before degradation by the sewage from Lexington, the South Fork of the Elkhorn was an excellent smallmouth bass stream. The North Fork of the Elkhorn was once considered a good native trout stream, as was Jessamine Creek. Trout fisheries in the area are now maintained only through a put-and-take stocking program.

Sport fishing in the area is directed mainly toward smallmouth bass, largemouth bass, white bass, and sauger. Catfish and sunfish such as rock bass and bluegill are also sought. Fishing pressure and creel data reported by Jones (1968) for Elkhorn Creek are presented in Tables 3.6-7 and 3.6-8.

TABLE 3.6-1 Oldfield-pasture vegetation of the Central Rock Mine site

Scientific Name	Common Name	Remarks on Growth Habits
Agrostis alba L.	Redtop	Pastures, roadsides, and oldfields
Asclepias syriaca L.	Common milkweed	Oldfields, roadsides, railroad embankments, streambanks
Bidens comosa (Gray) Wieg.	Beggar-ticks	Streambanks
Cirsium discolor (Muhl.) Spreng.	Field thistle	Abandoned fields, pastures, and waste places
Datura stramonium L.	Jimsonweed	Roadsides, streambanks, clearings, barnyards
Erigeron strigosus Muhl.	Daisy fleabane	Roadsides and oldfields
Eupatorium purpureum L.	Joe-pye weed	Mesophytic woods
Festuca elatior L.	Meadow fescue	Open wooded slopes, creek banks, roadsides, and pastures
Physalis heterophylla Nees.	Ground-cherry	Fields, roadsides, and creek margins
Poa pratensis L.	Kentucky bluegrass	Pastures, roadsides, open woods, and stream margins
Rosa carolina L.	Pasture rose	Dry ground. Frequent at edge of woods and in oldfields throughout the state
Setaria glauca (L.) Beauv.	Yellow foxtail	Fallow fields, pastures, roadsides, and waste places
Solidago altissima L.	Tall goldenrod	Fields and roadsides, sunny slopes and clearings; dry or moist soil
Zanthoxylum americanum Mill.	Prickly ash	Dry, open woods or borders of woods; sometimes moist situations. Widely distributed, infrequent but locally plentiful, forming thickets

Compiled during January 1976 field investigation

TABLE 3.6-2 Mesophytic-wooded slope vegetation of the Central Rock Mine site

Scientific Name	Common Name	Remarks on Growth Habits
Carpinus caroliniana Walt.	American hornbeam	Growing along wooded slopes, valleys, and creek-banks, and as an understory tree in mesophytic forests. It provides food for several species of birds and mammals and nesting sites for birds that choose low trees
Celtis occidentalis L.	Hackberry	In fencerows, along roadsides, and in oldfields; along streambanks
Crataegus sp.	Hawthorn	Streambanks, deciduous woods. Hawthorn is common in central Kentucky
Fraxinus quadrangulata Michx.	Blue ash	Limestone cliffs, slopes in deciduous woods, along railroad tracks, and in bluegrass pastures. Blue ash is most common in the Inner Bluegrass Region of Kentucky
Juglans nigra L.	Black walnut	On wooded slopes and hillsides, in dooryards and fencerows, and along roadsides
Juniperus virginiana L.	Red cedar	Common on south-facing slopes, in dry, open areas, along roads and fences; abundant only in calcareous areas
Liquidambar styraciflua L.	Sweet gum	Found on swampy flats in association with pin oak, but also on streambanks where it is associated with river birch and sycamore; uncommon in the Inner Bluegrass Region
Lonicera japonica Thunb.	Japanese honeysuckle	Thickets and woodlands, roadsides, and fencerows

TABLE 3.6-2 Continued

Scientific Name	Common Name	Remarks on Growth Habits
Lonicera standishii Jacques	Honeysuckle	Railroad tracks
Platanus occidentalis L.	Sycamore	Abundant along streams; reaches its greatest size in rich bottomland
Pyrus malus L.	Apple	Introduced and cultivated in farm orchards
Quercus macrocarpa Michx.	Bur oak	Characteristic of parklike grassy openings with scattered trees intermediate between forest and prairie; the most characteristic tree in the Bluegrass Region landscape
Robina pseudoacacia L.	Black locust	In thickets, pastures, oldfields, and dry sunny roadsides, railroad tracks, fencerows; the black locust is particularly abundant in the Bluegrass
Smilax glauca Walt.	Sawbrier	Old abandoned fields, thickets, and clearings
Smilax rotundifolia L.	Greenbrier	Clearings and second growth thickets, dry open woods and fencerows
Solidago altissima L.	Tall goldenrod	Fields and roadsides, sunny slopes and clearings; dry or moist soil
Ulmus rubra Muhl.	Slippery elm	Both on dry slopes and in moist well drained bottomlands; frequent in Kentucky
Verbascum thapsus L.	Wooly mullein	Dry ground in pastures and on roadsides

Compiled during January 1976 field investigation

TABLE 3.6-3 Reptiles and amphibians likely to occur in the Central Rock Mine site region

Scientific Name	Common Name	Status*
Cryptobranchus alleganiensis	Hellbender	U
Ambystoma jeffersonianum	Jefferson's salamander	U
Ambystoma texanum	Small-mouthed salamander	C
Ambystoma opacum	Marbled salamander	U
Ambystoma maculatum	Spotted salamander	U
Desmognathus fuscus	Dusky salamander	C
Desmognathus monticola	Seal salamander	U
Plethodon dorsalis	Zig-zag salamander	C
Plethodon richmondi	Ravine salamander	C
Plethodon glutinosus	Slimy salamander	C
Hemidactylium scutatum	Four-toed salamander	N.A.
Gyrinophilus porphyriticus	Spring salamander	R
Pseudotriton montanus	Mud salamander	C
Pseudotriton ruber	Red salamander	N.A.
Eurycea bislineata	Two-lined salamander	C
Eurycea longicauda	Long-tailed salamander	U
Eurycea lucifuga	Cave salamander	C
Notophthalmus viridenscens	Newt	U
Necturus maculosus	Mudpuppy	C
Rana catesbeiana	Bullfrog	C
Rana clamitans	Green frog	C
Rana pipiens	Leopard frog	U
Rana palustris	Pickerel frog	R
Bufo americanus	American toad	C
Bufo woodhousei	Fowler's toad	C
Acris crepitans	Cricket frog	R
Hyla crucifer	Spring peeper	U
Hyla versicolor	Gray tree frog	U
Chelydra serpentina	Snapping turtle	C

TABLE 3.6-3 Continued

Scientific Name	Common Name	Status*
Sternotherus odoratus	Stinkpot	C
Terrapene carolina	Box turtle	U
Graptemys geographica	Map turtle	C
Chrysemys picta	Painted turtle	U
Chrysemys scripta elegans	Red-eared turtle	C
Trionyx muticus	Smooth softshell turtle	R
Trionyx spinifer	Spiny softshell turtle	U
Sceloporus undulatus	Fence lizard	C
Eumeces faciatus	Five-lined skink	C
Carphophis amoenus	Worm snake	C
Diadophis punctatus	Ringneck snake	U
Heterodon platyrhinos	Hognose snake	U
Opheodrys aestivus	Rough green snake	U
Coluber constrictor	Black racer	U
Elaphe obsoleta	Rat snake	C
Lampropeltis getulus niger	Black king snake	R
Lampropeltis doliata triangulum	Milk snake	C
Thamnophis sirtalis	Garter snake	C
Storeria dekayi	Brown snake	R
Regina septemvittata	Queen water snake	C
Natrix sipedon	Common water snake	C
Agkistrodon contortrix	Copperhead	R

Source: U.S. Army Corps of Engineers, 1974b.

Status: C = Common to abundant, at least locally
U = Uncommon, but found regularly in small numbers
R = Rare, found infrequently but may be expected, especially at certain times of the year
A = Accidental visitor
N.A.= Not Available

TABLE 3.6-4 Mammals likely to occur in the Central Rock Mine site region

Scientific Name	Common Name	Status
Didelphis virginiana	Virginia opossum*	C
Blarina brevicauda	Short-tailed shrew	C
Cryptotis parva	Least shrew	C
Scalopus aquaticus	Eastern mole	C
Myotis lucifugus	Little brown myotis	U
Myotis grisescens	Gray myotis	R
Myotis sodalis	Indiana myotis	R
Lasionycteris noctivagans	Silver-haired bat	N.A.
Pipistrellus subflavus	Eastern pipistrelle	C
Eptesicus fuscus	Big brown bat	C
Lasiurus borealis	Red bat	C
Lasiurus cinereus	Hoary bat	N.A.
Nycticeius humeralis	Evening bat	R
Sylvilagus floridanus	Eastern cottontail*	C
Tamias striatus	Eastern chipmunk	C
Marmota monax	Woodchuck	C
Sciurus carolinensis	Gray squirrel*	C
Sciurus niger	Fox squirrel	C
Glaucomys volans	Southern flying squirrel	C
Castor canadensis	Beaver	R
Reithrodontomys humulis	Eastern harvest mouse	C
Peromyscus maniculatus	Deer mouse	C
Peromyscus leucopus	White-footed mouse	C
Neotoma floridana	Eastern woodrat	U
Microtus pennsylvanicus	Meadow vole	C

TABLE 3.6-4 Continued

Scientific Name	Common Name	Status
Microtus ochrogaster	Prairie vole	C
Microtus pinetorum	Woodland vole	C
Ondatra zibethicus	Muskrat	C
Synaptomys cooperi	Southern bog lemming	C
Rattus Norvegicus	Norway rat	C
Mus musculus	House mouse	C
Zapus hudsonius	Meadow jumping mouse	R
Canis latrans	Coyote	N.A.
Vulpes vulpes	Red fox	C
Urocyon cinereoargenteus	Gray fox	C
Procyon lotor	Raccoon	C
Mustela frenata	Long-tailed weasel	U
Mustela vison	Mink	C
Mephitis mephitis	Striped skunk	C
Lynx rufus	Bobcat	N.A.
Odocoileus virginianus	White-tailed deer	U

Source: U.S. Army Corps of Engineers Topographic Laboratories, 1974, Environmental resources inventory of the Lexington, Kentucky urban area.

Status: C = Common to abundant, at least locally
U = Uncommon, but found regularly in small numbers
R = Rare, found infrequently but may be expected expecially during certain times of the year
V = Very rare or irregular
A = Accidental visitor
N.A.= Not available

* Mammals and/or their signs observed at the Central Rock Mine site.

TABLE 3.6-5 Taxonomic list of benthic macroinvertebrates collected from Hickman Creek, Kentucky

Class	Family	Genus
Oligochaeta		Unidentified
		Tubifex
Turbelria		*Planaria*
Hirudinea		Unidentified
Crustacea		*Orconectes*
		Synurelia
		Lirceus
Insecta		*Peltoperla*
		Baetis
		Pseudocloeon
		Caenis
		Stenonema
		Gomphus
	Corixidae	Unidentified
		Agrion
		Ischnura
		Stenelmis
		Psephenus
	Culicidae	Unidentified
		Palpomia
		Simulium
	Halepledae	Unidentified
		Tendipes
Gastropoda		*Goniobasis*
		Physa
		Ferrissia
		Heliosoma
Pelecypoda		*Pisidium*
		Sphaerium
		Anodontoides

Source: Lau, 1966.

TABLE 3.6-6 Distribution of fishes by stream order in Steeles Run

Common Name	Scientific Name	Order 2	0 der 3
Fathead minnow	*Pimephales promelas*	X	
Bluntnose minnow	*Pimephales notatus*	X	X
Blacknose dace	*Rhinichthys atratulus*	X	X
Creek Chub	*Semotilus atromaculatus*	X	X
Green Sunfish	*Lepomis cyanellus*	X	X
Bluegill	*Lepomis macrochirus*	X	X
Fantail darter	*Etheostoma flabellare*	X	X
Orange throat darter	*Etheostoma spectabile*	X	X
Banded sculpin	*Cottus carolinae*	X	X
Rosefin shiner	*Notropis ardens*		X
Striped shiner	*Notropis chrysocephalus*		X
White sucker	*Catostomus commersoni*		X
Yellow bullhead	*Ictalurus natalis*		X
Mosquitofish	*Gambusia affinis*		X
Longear sunfish	*Lepomis megalotis*		X

TABLE 3.6-7 Fishing pressure, success, and methods used on Elkhorn Creek in 1960, 1961, 1962 and 1965

	Main Stream and North Fork of Elkhorn Creek				South Fork of Elkhorn Creek
	1960	1961	1962	1965	1960
Stream Miles	67	67	67	67	33
Total Fisherman Hours	21,950	23,764	23,000	19,131	846
Average Number Fish Harvested per Hour	0.86	0.78	0.84	0.60	0.87
Average Weight Fish Harvested per Hour (lbs)	0.29	0.33	0.20	0.13	0.24
Total Number Fish Harvested per Mile	473	307	332	171	22
Total Weight Fish Harvested per Mile	144	117	72	37	6
Percent of Total Number Fishermen Casting	9.3	8.4	12.4	8.4	20.8
Average Number Black Bass Harvested per Hour	0.05	0.04	0.05	0.02	0.09
Mean Weight of Black Bass Harvested	0.87	1.12	1.02	0.95	1.81

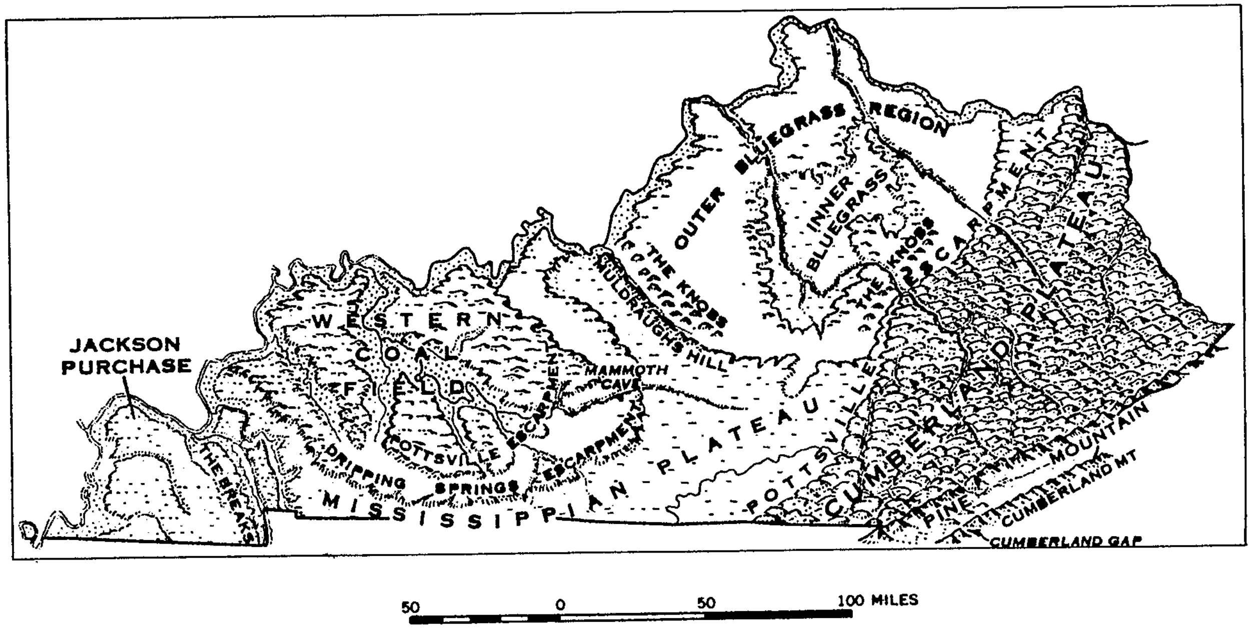
Source: Jones, 1968.

TABLE 3.6-8 Percentage composition of anglers' creels on North Fork and main stream of Elkhorn Creek for 1960, 1961, 1962, and 1965

	1960		1961		1962		1965	
	% total number	% total weight*	% total number	% total weight	% total number	% total weight	% total number	% total weight
Black bass	6.6	17.1	4.7	12.4	6.5	27.8	3.9	17.2
White bass	1.6	1.7					1.3	0.6
Crappie	2.2	2.2	2.3	1.8	1.6	1.5	4.6	4.6
Rock bass	27.6	39.7	23.7	18.7	11.1	8.3	15.1	12.1
Panfish	50.7	10.5	54.7	9.7	69.1	16.7	61.9	31.1
Catfish	3.6	7.2	3.2	3.6	5.2	12.7	8.4	11.5
Drum	3.0	5.7	1.5	1.3	2.3	6.8	0.9	3.5
Suckers	2.7	2.6	6.8	6.6	2.3	7.9	3.1	13.1
Carp	2.0	13.4	2.7	43.3	2.0	18.4	0.8	6.3
Buffalo			0.2	2.1				
Trout			0.2	0.5				
Total	100.0	100.1	100.0	100.0	100.1	100.1	100.0	100.0

Source: Jones, 1968.

* Weight in pounds



SOURCE: WHARTON AND BARBOUR, 1973

FIGURE 3.6-1 Physiographic diagram of Kentucky

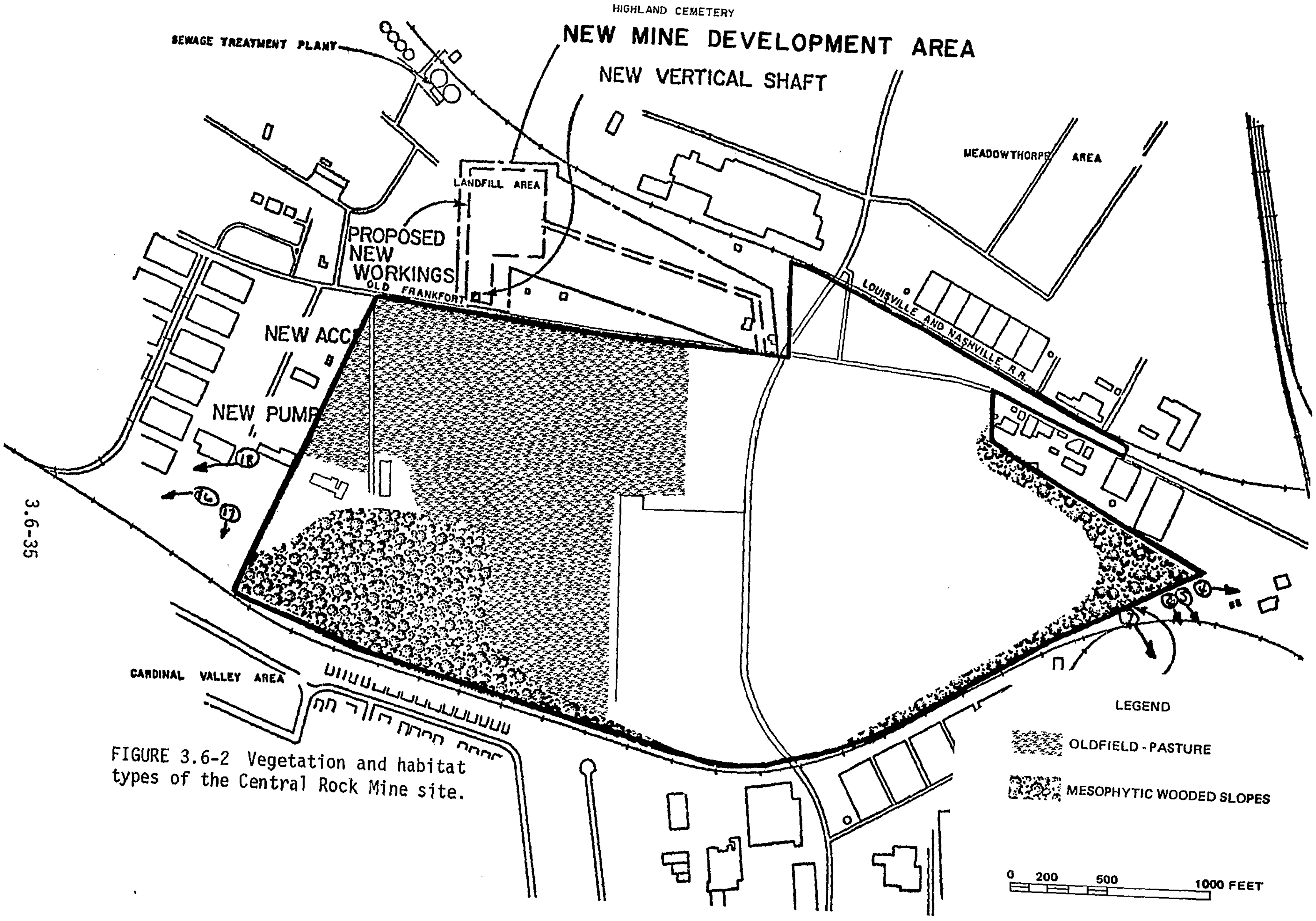
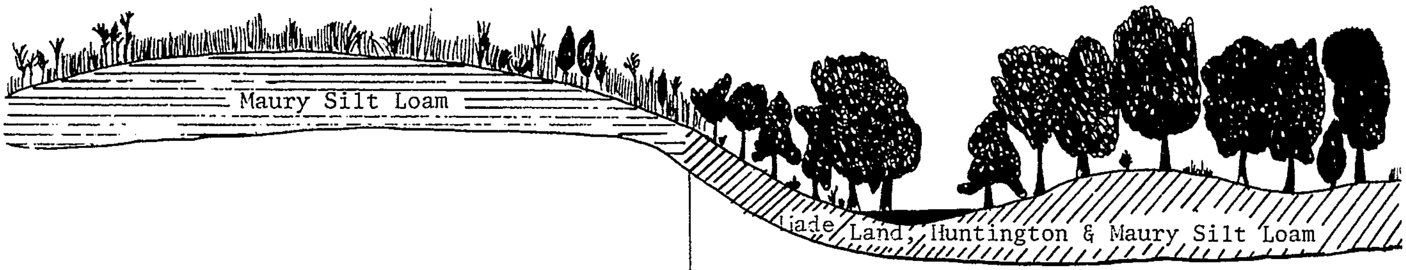


FIGURE 3.6-2 Vegetation and habitat types of the Central Rock Mine site.



Vegetation Type	Oldfield - Pasture	Mesophytic Wooded Slopes
Vegetation	Meadow fescue Kentucky bluegrass Redtop Daisy fleabane Yellow Foxtail	Bur oak Hackberry Slippery elm Sweetgum Black locust
Reptiles and Amphibians	Garter snake Rat snake	Small-mouthed salamander Ravine salamander Fence lizard American toad Rat snake (wet places, springs) Spring salamander Bull frog Leopard frog Water snake
Birds	Killdeer Meadowlark Song sparrow Bobwhite Starling	Crow Robin Cardinal Black capped chickadee Yellow-rumped warbler
Mammals	Least shrew Prairie deer mouse Prairie vole House mouse Pine vole Cottontail rabbit	Short-tailed shrew Gray squirrel Fox squirrel Opossum Red fox

FIGURE 3.6-3 Major ecological associations of the Central Rock mine site

3.7 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

3.7.1 Regional Historic Places

For the six-county area around Lexington, 731 historical places have been reported (U.S. Army Corps of Engineers, 1974b). Of this total, 41 sites are listed in the National Register of Historic Places; 690 sites were included as part of the Kentucky State Plan to identify and improve historic places in Kentucky. A list of registered historic places, together with their locations and a brief description, appears in Table 3.7-1.

The total number of archaeological sites recorded in Bourbon, Clark, Fayette, Jessamine, Scott, and Woodford Counties as of May 1974 was 98 (U.S. Army Corps of Engineers, 1974b). Exact locations and individual descriptions of known archaeological sites are not presented in this report in order to avoid the possibility of harm to the sites resulting from broad publication of the data. The number of sites, by county, is included in Table 3.7-1.

3.7.2 At the Central Rock Site

In August 1975, a plan was prepared to investigate the natural and urban environment of the McConnell Springs area, which is located on the western portion of Central Rock property (see Figure 2.2-1). The objective of this plan was to make recommendations for future development of the property (Bell Consulting Engineers, undated). The final plan recommended that the McConnell Springs area of Cahill Farm be developed into an historic nature park. The actual park site would be in harmony with the optional utilization of the farm but would allow for the continued existence of Lexington Concrete Products to the west, tobacco warehouses to the east, Southern Rail line and Cardinal Valley neighborhood to the south, and a proposed industrial area on presently vacant land to the north.

An agreement has been made with the State Historic Officer to survey the Central Rock Mine site and pipeline route for cultural resources when the route is specifically established. The investigation will determine whether any sites of sufficient archaeological or

TABLE 3.7-1 Historic and archaeological sites in the six-county project area listed in the National Register of Historic Places

Site	Location	Description
Bourbon County		
Duncan Tavern	323 High St., Paris	1788. Originally a tavern operated by Joesph Duncan
Eades Tavern	421 High St., Paris	pre-1793. Tavern and first post office
The Grange	U.S. 68, 4 mi. north of Paris	1808-18. Home of Edward Stone, a slave trader
Paris Railroad Depot	Paris	

There are 193 historical sites included in the Kentucky State Plan.
There are 18 archaeological sites in the county.

Site	Location	Description
Fayette County		
Ashland (Henry Clay Home)	On Richmond Rd., 2 mi. southeast of Lexington	1857. Home of James B. Clay, son of Henry Clay, rebuilt on foundation of former home of Henry Clay
Botherum	341 Madison Place, Lexington	1851. Architectural example; originally the home of Madison C. Johnson, prominent Lexington attorney and friend and associate of Henry Clay
Clay, Henry, Law Office	176 North Mill St. Lexington	1803-04. Used as law office by Henry Clay until 1810; believed to be the only remaining early 19th century professional office building in downtown Lexington
Gratz Park Historic District	Bounded by Second St., the Byway, Third St., and Bark Alley	Present park was original site of Transylvania University campus; contains building known as "The Kitchen," which is only surviving structure of old Transylvania campus
Kennedy, Matthew, House	216 North Limestone St., Lexington	1831. Home of Matthew Kennedy, early local architect
Lincoln, Mary Todd, House	574 West Main St., Lexington	ca. 1811-12. Home of Mary Todd's parents at the time of her marriage to Abraham Lincoln; visited by the Lincolns later

TABLE 3.7-1 Continued

Site	Location	Description
Fayette County continued		
Loudoun House	Corner of Bryan Ave. and Castlewood Dr., Lexington	1851. Architectural example; at one time was owned by Col. William Cassius Goodloe, nephew of Cassius Marcellus Clay and minister to Belgium under President Hayes
McAdams and Morford Building	200-210 West Main St., Lexington	
Old Morrison, Transylvania College	West Third St. between Upper St. and Broadway, Lexington	
Ridgely House	190 Market St., Lexington	1794-1806. Originally the home of Dr. Frederick Ridgely
Walnut Hill Presbyterian Church	Off U.S. 25/421, east of Lexington	
Waveland	Off U.S. 27, 5 mi. south of Lexington	1847. Architectural example; currently used as a museum
West High St. Historic District	West High St., Lexington	Now consists only of the Rev. Adam Rankin House (215 West High St.), William Bowman House (125 West High St.), Dr. John C. and Samuel B. Richardson House (129 West High St.), and the John Leiby House (133 West High St.)

There are 96 historical sites included in the Kentucky State Plan.
There are 24 archaeological sites in the county.

Site	Location	Description
Scott County		
Allenhurst	Cane Run Pike, west of Georgetown and south of U.S. 460	1844-49. Architectural example; originally owned by William G. Craig
Audobon	Moore's Mill Pike, off U.S. 62, southwest of Georgetown	ca. 1800, ca. 1840. Brick house expanded from early Kentucky stone house by C. B. Lewis, operator of stage coach line

TABLE 3.7-1 Continued

Site	Location	Description
Scott County continued		
Bradford, Feilding, House	Long Lick Pike, off U.S. 25, north of Georgetown	1790's. Example of log house
Branham House	208 South Broadway, Georgetown	Late 18th century. One of Georgetown's first trustees; architectural example
Buford-Duke House	Lisle Pike, off U.S. 75, southeast of Georgetown	ca. 1820-30. Home of James K. and Mary Buford Duke, hosts to many duels; birthplace of Basil Duke, Civil War general and historian
Cantrill House (or John Hawkins House)	324 East Jackson, Georgetown	ca. 1810. Building has been used in the lamp industry (1810-30, 1834-53), first building owned by Georgetown College (1830-34, 1852-58, 1938-39) and residence
Choctaw Indian Academy	Owenton Pike, off U.S. 227, 4.5 mi. west of Georgetown	1825. Academy for education of Choctaw children operated as mission project of Baptists from 1818 to 1844, at this location from 1825 to 1831
Giddings Hall	Giddings Drive, between Jackson and College Sts., Georgetown	1840. First building erected for Georgetown College
Holy Trinity Episcopal Church	South Broadway and West Clinton St., Georgetown	1865-70. Architectural example
Johnston-Jacobs House	205 North Hamilton St., Georgetown	Back, 1790's; 1830. Back section served as residence and tavern of Adam Johnston; front built later was home of W. W. Jacobs, blacksmith
Longview	Galloway Pike, off U.S. 460, 4 mi. west of Georgetown	1819. Home of Gen. David Thomson, hero of the War of 1812 and Scott County manufacturer, farmer and miller
McFarland House	510 Fountain Ave., Georgetown	ca. 1850-60. Architectural example

TABLE 3.7-1 continued

Site	Location	Description
Scott County continued		
Osburn (or Osborne) House	U.S. 25, 4 mi. north of Georgetown	1790-1842. Used as a stagecoach stop and residence by early owners
Royal Spring Park	West of Water and Broadway Sts. between Clinton and Jefferson Sts., Georgetown	McClelland's Fort was built here in 1776; also site of first paper mill in the state and possibly the first bourbon still
St. Francis Mission at White Sulphur	U.S. 460, 7 mi. west of Georgetown	1820. Known as "cradle of Catholicism in the West," built by second Catholic congregation in Kentucky
Sanders, Robert, House, (Echo Valley)	U.S. 25, 2 mi. south of Georgetown	1798. Originally the home of Col. Robert Sanders, who brought the first thoroughbred racing horse to central Kentucky and operated the first race track in Scott County
Scott County Courthouse	Corner of Broadway and East Main St., Georgetown	1877. Architectural example
Showalter House (James A. McHatton House)	316 North Hamilton St., Georgetown	ca. 1840. Summer residence of James McHatton, owner of eight plantations along the Mississippi
Shropshire House (John C. Buckner House)	355 East Main St., Georgetown	ca. 1814. Architectural example; from 1833 to 1835 was home of George W. Johnson, confederate (provisional) governor of Kentucky
Smith, Nelson and Clifton Rodes, House	Newtown-Leesburg Pike, northeast of Georgetown	Late 1700's - early 1800's. Example of log and frame house
Stone-Grant House	East Main St., Extended, Georgetown	
Ward Hall	U.S. 460, 1.5 mi. west of Georgetown	1856. Architectural example; built for the Junius Ward family, cotton and hemp growers

There are 217 historical sites included in the Kentucky State Plan.
There are 11 archaeological sites in the county.

TABLE 3.7-1 Continued

Site	Location	Description
Woodford County		
Crittenden, John Jordan, Birthplace Cabin	Off U.S. 60, 2 mi. east of Versailles	1782. Birthplace of John Jordan Crittenden, attorney, representative in Kentucky legislature, U.S. Senator, governor of Kentucky, U.S. attorney general
Jouett, Captain Jack, House	Craig's Mill Pike, 5 mi. southwest of Versailles	ca. 1792. Home of Jack Jouett, famed for night ride to save Thomas Jefferson from capture by the British

There are 77 historical sites included in the Kentucky State Plan.
There are 10 acchaeological sites in the county.

Clark County

No historical sites listed in National Register of Historic Places.
There are 46 historical sites included in the Kentucky State Plan.
There are 19 archaeological sites in the county.

Jessamine County

No historical sites listed in National Register of Historic Places.
There are 61 historical sites included in the Kentucky State Plan.
There are 16 archaeological sites in the county.

Source: U.S. Army Corps of Engineers, 1974.

3.8 SCENIC, NATURAL, AND CULTURAL RESOURCES

3.8.1 Regional

Within Fayette County and the 5 counties contiguous to it, there are 2 state parks, 1 wildlife management area, and 2 research and education centers (U.S. Army Corps of Engineers, 1974b). Two state parks, Waveland State Shrine (10 acres) and Kentucky State Horse Park (963 acres), are located in Fayette County. Buckley Hills Wildlife Sanctuary, a private 295-acre wildlife sanctuary, is located in Woodford County. The University of Kentucky Agricultural Experiment Station and the Plant Materials Project (private) are located in Fayette and Clark Counties, respectively, just north of Lexington.

In addition to these areas, as of 1974, there were 85 public recreational areas in the six-county area of Bourbon, Clark, Fayette, Jessamine, Scott, and Woodford Counties. There are also an additional 98 recreational areas in the six-county area that are private or semiprivate. Of the total, 133 are located in Fayette County (U.S. Army Corps of Engineers, 1974b).

Horsefarms in the Bluegrass area have a special significance, both culturally and commercially. They are a unique land resource, with important influence throughout the region. In recent years, the pressures of population growth and mobility have encroached on the rural areas required to maintain an environment suitable for horse breeding. There were 323 horsefarms in the six-county area in 1974 (U.S. Army Corps of Engineers, 1974b), over half of which were located in Fayette County.

An historical area plan of Fayette County prepared by the Lexington-Fayette County Planning Commission in 1973 portrays 13 historic sites within 0.5 mile of the proposed pipeline route. To date, none of these has been registered with the National Register of Historic Places.

Considerable private and public action to preserve historic structures in Fayette County has been concentrated upon Gratz Park, along Short and Mill Streets. Both Gratz Park and Mill Street have been designated as historic districts. Both are located near the downtown area of Lexington, quite removed from the site and proposed pipeline route. Only Gratz Park has thus far been recorded on the National Register of Historic Places as an historical district.

3.8.2 At the Central Rock Site

There are presently no parks, recreation, or open space facilities existing on or immediately adjacent to the site or the proposed pipeline route which are part of the Lexington-Fayette County Planning Commission Comprehensive Plan (Lexington-Fayette County Planning Commission, 1973). The Kentucky Trotting Track is located approximately 1/2 mile south of the Central Rock site.

3.9 SOCIOECONOMIC FACTORS

3.9.1 Regional Setting

3.9.1.1 History

In 1775, a small band of pioneers from Harrodsburg established a campsite along Town Branch and called it Lexington, in commemoration of the opening battle of the Revolutionary War. Since then, Lexington has served as the focal point for development in Fayette and surrounding counties (U.S. Army Corps of Engineers, 1974b). In 1792, when Kentucky became the 15th state, Lexington served as the temporary state capitol and, by 1812, was Kentucky's chief cultural and economic center. In the mid and late nineteenth century, trade on the Ohio River and the Great Lakes increased, population growth swung to those areas, and growth slowed considerably in central Kentucky. Today, development has resumed and the region is experiencing strong, stable growth.

3.9.1.2 Land-Use Patterns and Planning

Land and Water Use

Total land use for Fayette County and the 5 counties contiguous to it is presented in Table 3.9-1. Agricultural usage was by far the largest category as of 1974. Forested lands were scattered throughout the northern portion of Scott County and along the outer fringe of the six-county region to the west and south of Lexington. Urban built-up areas included Lexington, Winchester, Paris, Georgetown, Versailles, Nicholasville, and smaller scattered towns throughout the six-county region.

Numerous streams run through the area. The Kentucky River forms the western boundary of Woodford County and the southern boundaries of Jessamine, Fayette, and Clark Counties. Three major reservoirs include two owned by the Lexington Water Company which are located southeast of Lexington, and Winchester Reservoir, located southwest of Winchester.

Planning Authorities and Policies

The 1974 General Assembly of the Kentucky legislature reviewed planning legislation and made several changes (Kentucky Executive Dept. for Finance and Administration Office for Local Government, 1974). Under Kentucky legislation, any planning operations must be preceded by the development of a planning unit. These units may consist of a city or county acting independently or jointly. Regional planning units are also a viable option under the 1974 legislation. By law, each planning unit is required to publish a comprehensive plan. These plans are to provide the basis for promoting the general welfare of the public. The regional planning agency which includes Fayette County is the Bluegrass Area Development District (ADD).

Bluegrass ADD, Inc., consists of a team of elected and lay community leaders from 17 central Kentucky counties who have joined together to focus on the planned development of the area. The district was formally organized on October 28, 1971, and was registered as a nonprofit corporation with the Commonwealth of Kentucky on November 8, 1971. The organization has as its general purposes the promotion of economic development and the establishment of a framework for joint federal, state, and local efforts directed toward providing basic services, facilities, and opportunities essential to the social, economic, and physical development of the district.

3.9.1.3 Transportation

Highways

Lexington and its neighboring communities are served by an extensive system of highways. Interstate 76 provides access to Cincinnati to the north and Atlanta to the south. Interstate 64 connects Lexington to Frankfort on the west and to Huntington/Charleston on the east. These interstate highways intersect just northeast of Lexington. The Bluegrass Parkway also connects to Lexington, stretching westward across Kentucky. In addition, the multi-laned Circle Road encircles the city of Lexington.

A set of two-laned highways connects Lexington to Georgetown to the north, Paris to the northeast, Winchester to the east, Nicholasville and Wilmore to the south, and Versailles and Frankfort to the west. All major through roads in the area connect to Lexington.

Railroads

Fayette and its neighboring counties are served by three major railroads. The Louisville and Nashville connects Lexington to Frankfort in the west and continues on to Winchester in the east. A second line runs north-south from Cynthiana through Paris and Winchester to Richmond. The Chesapeake and Ohio System runs eastward from Lexington through Winchester. The Southern System runs from Cincinnati through Lexington and southward; a line also runs westward out from Lexington. A fourth line, the Frankfort and Cincinnati, runs in an east-west direction across the northern portion of the region connecting Paris and Georgetown to Frankfort.

Airways

The principal airport in the region is the Bluegrass Airfield, located 4-1/2 miles west of Lexington; it is used by four major airlines. Five other airlines in the area are considerably less developed.

Inland Waterways

The Kentucky River is the principal inland waterway in the region. Because of the size of the locks, however, modern barge equipment cannot utilize the system economically.

3.9.1.4 Population Characteristics

Number and Density

Fayette County and 5 adjacent counties comprise the region in which the primary socioeconomic impacts from the project will be experienced. The six-county area, consisting of Fayette, Bourbon, Clark, Jessamine, Scott, and Woodford Counties, had a 1970 population of 266,700 (Table 3.9-2). Fayette County alone accounted for nearly two-thirds of the regional population and experienced the most rapid expansion from 1960 to 1970.

Occupation

Occupation statistics for the six-county area focusing upon Fayette County are presented in Table 3.9-3. Employed persons totaled 107,273 in 1970, or about 40 percent of the regional population. Fayette County had about two-thirds of total employment, with occupations weighted toward professional, clerical, service, and operative vocations. In the surrounding counties, blue-collar occupations tended to predominate.

Fayette County had higher per capita median earnings ($7,191 in 1969) than did the other counties, reflecting the influence of professional occupations on the distribution of wages and salaries.

Income

According to the 1970 Census of Population, mean income per family ranged (in 1969) from a high of $11,003 in Fayette County to a low of $8,250 in Jessamine County. Per capita levels were similarly distributed, as is indicated in Table 3.9-4. As could be expected, the bulk of the income was in Fayette County where a significantly higher proportion of families had incomes in excess of $10,000 per year compared to the other counties. Families with income less than poverty level are more numerous in Fayette County (4,187) but constitute a much smaller proportion (9.7 percent) of the total number of families than do the same groups in the other counties, indicating that income and employment opportunities are better in Fayette County than in the others.

Housing

Housing characteristics for the six-county region are presented in Table 3.9-5. Substandard housing comprises a high proportion of total housing in the region except in Fayette County. Renter-occupied housing constitutes by far the largest component of substandard housing in the region. These conditions are consistent with the distribution of occupations and income, which trend toward less favorable living conditions and quality of life outside of Fayette County.

3.9.1.5 Economy

Economic Base

Manufacturing, trade, service, and government are the principal economic activities of the six-county region, although the composition of activity is weighted heavily by Fayette County. Outside Fayette County, farming, manufacturing, and services predominate. The distribution of economic activities is suggested by the distribution of personal income, by source, as presented in Table 3.9-6. Mining generates only a small part of total regional income.

With respect to commercial activity, the distribution and level of sales and service business among the counties is presented in Table 3.9-7. Fayette County clearly is the commercial center for the region, with retail and wholesale sales exceeding $1.1 billion in 1972.

In 1974, there were 285 manufacturing and processing industries in Fayette County and its 5 contiguous counties (U.S. Army Corps of Engineers, 1974b). Of these 285 industries, 169 were located in Fayette County. The principal manufacturing establishments in the area with their respective employees are listed in Table 3.9-8.

Employment

According to the 1970 Census, about three-fourths of the male population 16 years of age and over, and 40 to 45 percent of women 16 years and over, were in the labor force. Of these, about 3 percent of the men and 4 percent of the women were unemployed at the time. Table 3.9-9 provides the statistics for labor force participation and employment levels in each of the six counties.

The distribution of employment among industries (as distinct from occupations) is given in Table 3.9-10. As is evident, manufacturing, agriculture, and various commercial and professional services predominate. Mining is still a minor activity; it employed only 233 persons in 1970. Most were in Fayette County.

Employment levels have fluctuated in recent years in the region, with sharp differences between counties. Total employment, by county, is shown in Table 3.9-11. This table shows a general increase in employment from 1960-1970, but a decrease from 1970-1972.

3.9.2 Local Setting

3.9.2.1 History

A town plat submitted to the Virginia legislature in 1781 consisted of 710 acres of land in what is today downtown Lexington, Kentucky. Streets were laid out in a gridiron pattern to act as boundaries for the 1/2-acre urban "in-lots" around the Town Branch and the 5-acre rural "out-lots" for farming. The Town Commons was an open space in the center of the settlement, stretching along Town Branch to protect the town's water source and to offer a meeting, marketing, and recreation area.

In 1790, Lexington had approximately 835 residents. By 1810, this had increased to 4236 and, by 1815, Lexington could boast of two printing offices, several schools, bookstores, a musical society, and an important western university -- Transylvania. The end of the War of 1812 with its concomitant war economy, and the rise of a river economy that focused on the Ohio River, caused some faltering in Lexington's economy. After the Civil War, growth in the Midwest shifted from the Ohio River to Chicago and the Great Lakes. Growth in Kentucky lagged behind that of its northern neighbors until the mid-twentieth century.

From 1960 to 1970, the population of Fayette County increased approximately 32 percent, rising from 131,706 to 174,323. Housing units increased by 56 percent. Student enrollment in Fayette County public schools increased 60 percent; private and parochial enrollments dropped 9 percent; and university enrollments rose 130 percent. Historic "zoning districts" were added to the Zoning Ordinance and a Metro Historical Commission was formed. Overall, employment increased 64 percent to 88,000 in 1970, mostly in the nonagricultural sector. Commercial land increased by 50 percent in the county from 1960 to 1970.

Lexington was incorporated as a city in 1832. For many years thereafter, it operated under an "alderman-councilman" form of government. This gave way to a "commission" government with a mayor and a board of four commissioners in 1911, and a "city manager" system in 1931. In 1972, the community voted to merge its city and county governments. This merger between the governments of the city of Lexington and Fayette County became effective in January of 1974.

3.9.2.2 Land Use Patterns and Planning

Land Use

Between 1963 and 1972, almost 11 square miles of Fayette County's agricultural land was converted to urban-type activities. From 1972 to 1990, it is estimated that an additional 20 square miles of agricultural land will be converted to urban use. In 1963, urban land use in the county totaled 40 square miles, or 14 percent of the county's total 283 square miles. By 1972, urban land accounted for 18 percent of total county land use; it is projected to reach 25 percent by 1990.

The largest increase in developed land from 1963 to 1972 was in residential use (Table 3.9-12). Cultural, entertainment, and recreational use recorded the second largest increase, followed by services. The pattern of land use projected for 1980 and 1990 (Table 3.9-13) shows that residential use will account for the largest percentage of land use in the county, followed by the transportation, communication, and utilities category. Residential land use surrounds the urban core today and is projected to spread by 1990 to the boundary of Fayette County. Manufacturing extends primarily in a northwest direction from the Central Business District (CBD). This pattern is projected through 1990. Major commercial land use is presently in the downtown area, though there are shopping centers a few miles from downtown, primarily south of the CBD. Proposed commercial lands are to be constructed upon the existing patterns.

Planning Authorities and Policies

Community planning was formally instituted in Lexington and Fayette County in 1928 with the establishment of the City Planning and Zoning Commission. In 1931, the commission secured a master plan and zoning ordinance through the services of a planning consultant. In 1948, it hired its first resident professional planner. In 1950, a new "Master Plan" was prepared. A 1958 supplement proposed the concept of an "Urban Service Area," which proved to be valuable in the zoning policies and future work of the commission. The limits of the Urban Service Area, which centers on the existing urbanized portion of the community, have been adjusted from time to time to meet changing conditions. As delineated in 1973, the area covers 74.4 square miles, or approximately 26 percent of Fayette County's 283 square miles.

Since the 1960's, the Lexington-Fayette County Planning Commission has received sufficient funding and community support to conduct a comprehensive and continuing planning program.

3.9.2.3 Transportation

Highways

Highways provide the major access to resources throughout Lexington and Fayette County. A 1963 study estimated that county residents would travel 2.5 million miles in 1980 (Smith, 1963). By 1973, however, 2.4 million miles were traveled, predating the projections by 7 years.

Using developed space standards, the Lexington-Fayette County Planning Commission has estimated that 4 to 6 circumferential arterials are needed at a distance of approximately 5 miles between downtown and the existing beltline. Lacking such a system, the existing collector and local streets are forced to carry traffic volumes normally associated with arterial, or main, streets. The major highway improvements estimated to be needed between 1967 and 1990 in order to accommodate an estimated 290,000 population amount to over $101 million.

Public Transit

In 1961, about 5 percent (13,780) of the daily person-vehicular trips in Lexington were made on the privately-owned Lexington Transit Company. By 1970, this had decreased to 3 percent and, in 1972, the city created a Metro Transit Authority that, in effect, took over the private transit company. It is estimated that ridership could increase to 20,000 daily vehicular trips by 1980 if service and facilities can be improved.

Railroads

In 1965, the three major railroads operating in the area handled almost 1.6 million tons of locally generated freight. By 1970, passenger service had been eliminated. By 1980, it is estimated that locally generated freight will be in excess of 3.6 million tons; passenger service will not be initiated.

Airways

Fayette County is classified by the Federal Aeronautics Administration as a small air traffic hub (it generates between 0.05 percent and 0.24 percent of the total U.S. air passenger traffic). Eastern, Delta, Piedmont, and Allegheny Airlines service the area. Over the past 10 years, total airport operations increased 50 percent, while the number of enplaned passengers increased 152 percent.

Bluegrass Field, located south of Versailles Pike, about 1-1/2 miles from New Circle Road west of Lexington, handled 71,000 passengers, 833 tons of air cargo, and 20,800 air carrier operations in 1965. About 48 percent of the local air travel demand was handled that year at the Bluegrass Field. By 1970, this field was handling over 138,000 passengers, over 1,900 tons of air cargo, and over 1,900 air passenger operations: over 60 percent of the local air service demand. Estimates for 1990 project 401,000 passengers, 45,000 tons of air cargo, and 35,000 air carrier operations, serving 75 percent of the local demand.

3.9.2.4 Population Characteristics

Number and Density

Fayette County's 1970 population was 174,323 (620 people per square mile). Of this number, 108,137 lived in the city and 66,186 in the rest of the county. In terms of urbanization, there were 161,711 persons in the urban service area and 12,612 in the rural service area.

Lexington-Fayette County population has increased at a rapid pace during the past 15 years. The 1960-1970 period showed a 32 percent increase. Between 1970 and 1972, population declined slightly but, by 1975, growth had resumed, resulting in a 19 percent gain for the 5-year period. It should also be noted that the net in-migration of population to the Lexington-Fayette County area for the 1970-1975 period exceeded the net in-migration of the entire 1960-1970 period (Table 3.9-14). Southern Lexington is currently experiencing the greatest growth rate, while the areas surrounding and including downtown are losing population.

Although fertility rates in the county are decreasing, population in Fayette County is expected to continue to rise. This is because the number of births anticipated will increase, not because fertility rates will rise, but because the greatest proportion of the population is at child-bearing age. In addition, in-migration is expected to increase.

Table 3.9-15 presents population projections for Lexington-Fayette County to the year 2000. Though projections as far in advance as 2000 allow for a high chance of error, it is probable that the rapid population growth of the Lexington-Fayette County area will continue in the future.

Occupation and Income

For the past 20 years, the proportion of white collar workers in Fayette County has grown, owing to the county's increasing dependence on industry rather than agricultural activities. White collar jobs increased 46 percent between 1950 and 1960, and 68 percent between 1960 and 1970.

Total personal income in Fayette County increased by 137.6 percent between 1959 and 1967. The median family income in 1969 was $9,597 for Fayette County, and $8,769 for the city of Lexington. Household incomes increased from $8,295 to $10,821 (30 percent) over the last

10 years. Median household income is projected to increase to $13,900 by 1990, a rise of 28.5 percent.

Per capita income rose by 80 percent in the 1959-1969 period. In terms of real income, total personal income registered a gain of 81.3 percent, while per capita income rose by 37 percent. By 1990, it is estimated that total income will increase by 132 percent, and per capita income by 79 percent.

Housing

In 1970, Fayette County contained almost 59,500 housing units accommodating 174,000 people. By 1990, it is estimated that 92,700 housing units will be needed to house almost 290,000 people.

Household population trends indicate that the number of persons per household is decreasing. Relatively, the proportion of renters increased slightly in the 1960-1970 period, though there are still fewer renter-occupied than owner-occupied households. Although the number of single-family homes increased the most from 1960 to 1970, their percent of the total housing stock decreased. The median value of owner-occupied units rose from $13,600 in 1960 to $19,100 in 1970, an increase due primarily to inflation. Median gross rent increased from $68 in 1960 to $113 in 1970.

According to data on overcrowding and number of housing units that lacked some or all plumbing, the housing stock in Lexington is improving. Other housing trends indicate future changes as follows:

1. The percent of households with 1 or 2 people will increase, while the percent of households with 3 or more will decrease.
2. The percent of renters will increase slightly, while the percent of homeowners will decrease slightly.
3. Multi-family units will increase more rapidly than single-family units. (Forecasts include a 5-percent vacancy rate.)
4. In 1970, there were 24,394 rented units. By 1990, there will be about 16,000 more rental units, an increase of 66 percent.

3.9.2.5 Economy

Economic Base

The economy of Fayette County showed increasing prosperity during the 1960-1970 period. The natural resources of the area and its proximity to large national markets helped to create a favorable climate for economic development. Employment in the 10-year period showed an annual average growth of 6.4 percent. This is a higher rate than those of the state or Louisville, which were 3.7 and 3.6 percent, respectively.

Three of the major employment sectors in the economy have continued to be especially important during the past decade: wholesale trade, retail trade, and the continued growth of the medical centers and universities. Although horse breeding and the tobacco industry remain significant monetarily, their employment capacities have declined with improvements in management and technology. If the 1950's saw the emergence of manufacturing as one of the main props of the Lexington economy, the 1960's saw its confirmation (Table 3.9-16).

The prominence of "trade and services" employment reflects the role of Lexington as a service and distribution center for the Bluegrass Region. A survey of manufacturing showed that highways are the most favored mode of transportation. Completion of the interstate highways connecting Lexington with major southern markets in Atlanta, New Orleans, and Memphis, as well as the midwestern centers of Cincinnati, Cleveland, and Chicago, have been partly responsible for the growth of trade. Growth in services, however, probably received its primary impetus from the increases in population and income in the area.

Employment

In terms of employment, every sector of the Fayette County economy except agriculture registered increases between 1960 and 1970. The fastest growing sectors were finance, insurance, and real estate, which rose 105 percent, and government, which went up 100 percent. These were followed by manufacturing, construction, services, and transportation, communication, and utilities. Trade was the sector with the smallest positive growth, which was still over 42 percent. Agriculture dropped 29 percent over the 10-year period.

Employment in manufacturing provided 17,300 jobs in the Lexington SMSA in 1970, a rise of 78.4 percent over 1960. The biggest single increase was in the durable goods sector, especially in the machinery and metals products category, which gained 104 percent in the 10-year period (Table 3.9-17). Notable in the durable goods sector, however, was the decline in stone, clay, and glass employment. In the nondurable sector, there was an overall increase of 50 percent in employment, but food and tobacco manufacture declined while "new line" industries such as chemical petroleum and plastics, printing, publishing, and paper products grew.

From 1970 to 1990, it is estimated that employment will increase by over 59,000 jobs, or 67 percent. Agricultural jobs are expected to decrease, however, by almost 67 percent, whereas nonagricultural jobs are estimated to increase by almost 61,000, or 71 percent. Within the nonagricultural sector, the greatest increase is estimated for nonmanufacturing (almost 80 percent). Manufacturing is expected to rise only 40 percent. A partial explanation for this variance is that some manufacturing plants are located in adjacent Bluegrass counties and contribute expansion factors to Fayette County's nonagricultural, nonmanufacturing sector. The fastest growing nonagricultural areas are estimated to be services (up 112 percent), local and state government (up 103 percent), and finance-insurance-real estate (up 89 percent).

3.9.2.6 Government

Jurisdictions

As of January 1, 1974, the Lexington city government and the Fayette County government were merged into a single unit. The new city/county government has jurisdiction over all areas within Fayette County.

As a result of the 1970 Clean Air Act, the Commonwealth of Kentucky established the Kentucky Air Pollution Control Commission on February 15, 1972. In the regulations, nine state air quality control regions were established. Lexington is the center of the Bluegrass Region.

Public Services

As private areas develop, they immediately create a need for various types of public services, including schools, libraries, parks, fire protection, police protection, administration buildings, and service buildings. Future growth projections for Fayette County, therefore, include expected increases in needed public services.

In 1970, over 62,000 people attended educational programs in Lexington and Fayette County. Lexington public schools were merged into the Fayette County school system in 1968. The Fayette County public schools served 35,000 students in 1970, and are projected to serve 52,800 students by 1990. In 1973, the educational facilities in Fayette County included 35 elementary schools, 13 junior high schools, 6 high schools, 6 Catholic schools, 3 private schools, and 5 universities and colleges. An additional 11 public schools are proposed by 1990, mostly in southern Fayette County.

It is estimated that, by 1990, there will be 56,700 people in Fayette County between the ages of 6 and 18. The public school system will absorb approximately 95 percent of this total. With the addition of 17,300 new school-age children, an estimated 118 acres will be needed for new school sites.

In 1960, Fayette County had 138 acres of park land. By 1973, an additional 1998 acres of land had been acquired (1 acre per 90 people). By 1990, an additional 640 acres will be required to maintain minimum standards.

In February 1973, the fire departments of Lexington and Fayette County were merged into a single system. The improved fire protection resulted in an estimated savings of $2 million in insurance premiums to the county. Two fire protection districts were established: the urban and the outer urban. By 1974, the Metropolitan Fire Department had 15 stations in operation, with approximately 400 employees.

Between 1972 and 1990, it is estimated that an additional 20 square miles of land will become urbanized, requiring 8 new fire stations, and new and enlarged water mains and hydrants. The cost of construction and equipment for these 8 stations is expected to total $1.5 million. Net fire station operating costs are expected to increase by $600,000 to $2.7 million by 1990.

There are presently 415 police protection employees providing services to Fayette County. (Lexington and Fayette County merged police departments in January 1973.) An additional force of 325 employees is estimated to be necessary by 1990.

In 1971-1972, over 4000 people attended health department clinics, and over 7000 were admitted to on-going personal care programs. Most primary and acute care services are presently located in the southern part of the urban area, where most of the population is located. Most public health facilities are located to the north of the city. A need exists to geographically balance the health facilities in the community. Based on 1973-1974 expenditures of $1.1 million, it is projected that total health department costs in 1990 will be approximately $1.6 million. Of this, $800,000 will come from local government sources.

In 1969, the Bluegrass Regional Health Planning Council was established for planning and coordinating the development of health facilities throughout the 17-county Bluegrass Region.

There are 7 social service agencies in Fayette County that are operated by the city and county governments specifically to serve low income and disadvantaged people in the community. (All are at least partially funded through federal sources.) These are: Fayette County Children's Bureau, The County Welfare Department, Julius Marks Home for the Indigent Aged, Detention Services, Human Rights Commission, Legal Aid, and the Lexington Public Housing Authority. (The housing authority is a semipublic agency under the auspices of the city.) Most of these agencies are centrally located in older downtown areas of the community.

In fiscal year 1972-1973, Fayette County appropriated $537,755 for social services, about 15 percent of the total budget allocations. This included support for six of the agencies mentioned above, plus the Bluegrass Association for Mental Retardation, Salvation Army, Community Action, and Manchester Center.

The city of Lexington allocated $202,965, or 1.3 percent, of its budget to social services during 1972. Funds were allocated to charities and contributions, and included disbursements primarily to those agencies mentioned above. Combined city and county spending for these social services in 1972 amounted to $4.08 per capita.

It is estimated that, by 1990, Fayette County will contain about 263,000 people. Average household income is expected to reach $15,000. About 7 percent, or 5600, of Fayette County households are expected to have incomes below $6000. To meet the needs of this group and to assure a more coherent system of social service delivery, it is necessary to effect a system of coordination, planning, and outreach. In part, this has given rise to the Department of Social Services in the merged urban county government. The new department will help to coordinate the programs of social service agencies in the community, both public and nonprofit, and to assist in planning for future programs.

TABLE 3.9-1 Land use by county in the six-county project area, 1967 (Acres)

County	Total Land Area	Cropland	Open Pasture	Forest	Grazed Forestland	Other Land	Federal Noncropland
Bourbon	192,000	103,271	70,530	5,100	2,500	8,624	0
Clark	165,760	46,000	94, 273	12,200	6,100	7,194	0
Fayette	179,200	68,220	72,167	5,500	3,500	8,446	1,088
Jessamine	113,280	51,973	39,529	12,200	4,750	3,457	10
Scott	181,760	36,950	111,687	25,600	12,100	3,624	0
Woodford	123,520	35,704	67,189	8,700	3,050	6,856	0

County	Small Water Area	Urban and Built-Up	Residential	Commercial	Industrial	Public/ Semipublic	Trans- portation
Bourbon	624	3,851	2,468	70	120	266	927
Clark	960	5,133	2,583	75	150	220	2,105
Fayette	2,037	24,450*	14,500*	1,000*	1,100*	3,050*	4,800*
Jessamine	909	5,202	2,610	80	90	850	1,572
Scott	874	3,025	1,450	85	142	288	1,060
Woodford	1,141	3,930	1,890	62	98	290	1,590

Source: U.S. Army Corps of Engineers, 1974.

* 1970 figures

TABLE 3.9-2 Population characteristics of the six-county project area, 1970

County	Total 1970 Pop.	1960-70 Change Number	1960-70 Change Percent	Persons Per Sq. Mi.	Urban Population	Percent Negro	Median Age	Persons Per Household	Median School Years Completed	Percent Moved 1965-70
Bourbon	18,476	+ 298	+ 2	62	7,823	12.3	30.4	3.08	9.6	2.7
Clark	24,090	+ 3,015	+14	93	13,402	7.6	27.9	3.13	9.6	4.0
Fayette	174,323	+42,617	+32	622	159,538	12.4	25.8	3.01	12.4	6.0
Jessamine	17,430	+ 3,805	+28	99	9,295	6.6	24.8	3.17	9.8	5.7
Scott	17,948	+ 2,572	+17	63	8,629	9.2	26.3	3.10	10.0	5.8
Woodford	14,434	+ 2,521	+21	73	5,679	10.7	27.2	3.23	10.7	3.3
TOTAL/AVG	266,701	+54,828	+19	168	204,366	9.8	27.0	3.12	10.3	4.5

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

TABLE 3.9-3 Occupation in the six-county project area, 1970

Occupation	Bourbon	Clark	Fayette	Jessamine	Scott	Woodford
Total employed, 16 years old and over	7,298	9,149	71,165	7,026	6,901	5,734
Professional, Technical, and Kindred Workers	668	968	14,611	811	769	754
Managers and Administrators except Farm	426	680	6,295	387	354	368
Sales Workers	319	505	6,063	377	301	273
Clerical and Kindred Workers	855	1,229	13,807	1,179	1,139	717
Craftsmen, Foremen, and Kindred Workers	894	1,243	7,958	1,008	732	714
Operatives, except Transport	1,276	1,785	5,931	826	1,175	929
Transport Equipment Operatives	190	403	2,109	263	281	121
Laborers, except Farm	338	389	2,683	419	284	174
Construction Laborers	101	92	387	160	62	56
Farmers and Farm Managers	560	539	614	490	633	404
Farm Laborers and Farm Foremen	774	365	1,185	288	458	452
Service Workers, except Private Household	802	816	8,333	821	604	603
Private Household Workers	196	227	1,576	157	171	225

Source: U.S. Army Corps of Engineers, 1974.

TABLE 3.9-4 Income and poverty status in the six-county project area, 1969

Income of Families and Unrelated Individuals	Bourbon	Clark	Fayette	Jessamine	Scott	Woodford
All Families	4,854	6,490	43,131	4,512	4,599	3,751
Less than $1,000	86	206	820	170	124	54
$1,000 to $1,999	283	328	1,362	276	264	197
$2,000 to $2,999	404	417	1,701	303	352	200
$3,000 to $3,999	390	446	2,167	301	350	190
$4,000 to $4,999	362	484	2,253	323	285	216
$5,000 to $5,999	384	447	2,527	296	355	239
$6,000 to $6,999	426	397	2,853	384	384	304
$7,000 to $7,999	333	455	3,171	395	311	326
$8,000 to $8,999	385	522	3,018	334	333	209
$9,000 to $9,999	360	462	2,838	334	285	270
$10,000 to $11,999	478	869	5,708	475	595	507
$12,000 to $14,999	440	717	5,951	448	431	517
$15,000 to $24,999	402	562	6,842	411	443	388
$25,000 to $49,000	95	157	1,531	62	78	92
$50,000 or more	26	21	389	-	-	42
Median Income	$7,276	$8,125	$9,597	$7,514	$7,568	$8,715
Mean Income	$8,493	$8,875	$11,003	$8,250	$8,463	$10,223
Per Capita Income of Persons	$2,519	$2,567	$3,154	$2,353	$2,401	$2,895

Source: U.S. Army Corps of Engineers, 1974.

TABLE 3.9-5 Characteristics of housing in the six-county project area, 1970

County	Number of Occupied Housing Units	Overcrowded and Substandard			Substandard			Total Sub-Standard Housing Units	Percent of Occupied Sub-Standard Units
			Renter-Occupied			Renter-Occupied			
		Owner-Occupied	Single-Family	Multi-Family	Owner-Occupied	Single-Family	Multi-Family		
Bourbon	5,927	46	199	13	448	694	141	1,263	21.3
Clark	7,646	53	186	14	543	630	140	1,313	17.2
Fayette	54,307	47	463	57	708	1,553	416	2,677	4.9
Jessamine	5,247	57	165	9	541	560	112	1,213	23.1
Scott	5,418	62	153	10	594	519	111	1,224	22.6
Woodford	4,354	37	105	8	358	356	79	793	18.2
TOTAL	82,899	302	1,271	111	3,192	4,312	1,999	8,483	17.8

Source: Kentucky Housing Corporation, 1970.

TABLE 3.9-6 Personal income by source in the six-county project area, 1973 (in dollars)

County	Farm	Manufac- turing	Mining	Contract Construc- tion	Trade	Finance, Insurance & Real Estate	Transportation, Communication, Public Utilities	Services	Govern- ment
Bourbon	13,509	9,345	*	4,427	5,986	1,551	1,674	5,091	5,709
Clark	9,537	42,907	*	5,860	10,456	1,969	11,001	*	5,963
Fayette	17,892	209,588	1,848	69,272	134,696	43,353	47,183	149,495	210,177
Jessamine	6,074	3,969	*	2,773	3,880	792	860	4,852	3,265
Scott	9,408	16,693	*	2,341	5,082	978	1,345	5,533	4,182
Woodford	12,545	27,316	0	2,064	3,391	1,127	1,732	6,101	3,139

Source: Kentucky Department of Commerce, 1975.

* Withheld to avoid disclosure

TABLE 3.9-7 Trade and service sales and receipts in the six-county project area, 1972

County	Retail Sales (000)	Wholesale Sales (000)	Selected Service Receipts (000)
Bourbon	$ 26,095	$ 18,381	$ 2,976
Clark	50,757	24,211	8,834
Fayette	504,646	664,853	114,888
Jessamine	23,057	14,814	2,246
Scott	25,551	7,421	2,711
Woodford	20,245	3,596	2,684

Source: Kentucky Department of Commerce, 1975.

TABLE 3.9-8 Major manufacturing firms in the six-county project area, 1973

County	Name	Product	Employment
Bourbon	Blue Grass Industries	Garments	403
	Hansley, Inc.	Garments	275
	Dura Corp.	Motor vehicle parts	501
Clark	Bundy Tubing Company	Steel tubing	482
	Rockwell Standard	Truck axles	1,200
	Sylvania Electric	Lamps	751
	Curlee Clothing	Suits	364
	Legget & Platt	Mattresses	308
Fayette	IBM Corporation	Typewriters	5,583
	Irvine Industries	Parachutes	800
	Parke Seal Company	Rubber seals	900
	R. J. Reynolds Tobacco	Tobacco	400
	The Square D Company	Electrical equipment	1,642
	Trane Company	Air conditioning	750
Jessamine	Sargent & Greenleaf, Inc.	Locks	125
	Hoover Ball & Bearing Co.	Steel balls	50
Scott	Universal Wire	Springs	401
	Clark Equipment	Hi-lifts	505
	Electric Parts Corp.	Power cords	470
	Johnson Service	Environmental devices	299
Woodford	Rand McNally Company	Printing	800
	Texas Instruments	Thermostats	600
	Kuhlman Electric	Transformers	326
	GTE Sylvania	Lamps	225
			17,985

Source: Kentucky Directory of Manufacturers, 1974.

TABLE 3.9-9 Employment characteristics of the six-county project area, 1970

Employment Status	Bourbon	Clark	Fayette	Jessamine	Scott	Woodford
Male, 16 years old and over	6,119	7,757	58,480	5,983	6,021	4,484
Labor force	4,655	6,087	43,422	4,285	4,436	3,574
Percent of total	76.6	78.5	74.3	75.0	73.7	79.7
Civilian labor force	4,679	6,073	43,222	4,485	4,436	3,572
Employed	4,521	5,861	42,156	4,368	4,314	3,493
Unemployed	158	212	1,066	117	122	79
Percent of civilian labor force	3.4	3.5	2.5	2.6	2.8	2.2
Not in labor force	1,434	1,670	15,058	1,498	1,585	910
Female, 16 years old and over	6,916	8,784	45,405	6,339	6,715	5,295
Labor force	2,860	3,335	30,216	2,727	2,353	
Percent of total	41.4	38.5	46.1	43.8	40.6	44.4
Civilian labor force	2,860	3,385	30,211	2,775	2,727	2,349
Employed	2,777	3,288	29,009	2,658	2,587	2,241
Unemployed	83	97	1,202	117	140	108
Percent of civilian labor force	2.9	2.9	4.0	4.2	5.1	4.6
Not in labor force	4,056	5,399	35,389	3,564	3,968	2,942

Source: 1970 Census of Population.

TABLE 3.9-10 Industry of employed persons in the six-county project area, 1970

Industry	Bourbon	Clark	Fayette	Jessamine	Scott	Woodford
Total Employed, 16 Years Old and Over	7,298	9,149	71,165	7,026	6,901	5,734
Agriculture, Forestry, and Fisheries	1,398	1,012	2,245	793	1,157	912
Mining	5	57	158	5	8	-
Construction	446	580	4,141	620	376	332
Manufacturing	1,739	2,508	11,767	1,222	1,765	1,537
Railroads and Railway Express Service	23	39	126	8	36	18
Trucking Service and Warehousing	56	102	888	118	115	21
Other Transportation	38	36	485	63	52	25
Communications	65	235	1,082	77	32	28
Utilities and Sanitary Services	97	246	1,260	101	107	74
Wholesale Trade	112	178	2,668	164	101	128
Food, Bakery, and Dairy Stores	242	240	1,444	200	112	84
Eating and Drinking Places	85	180	2,170	67	107	82
General Merchandise Retailing	67	257	2,209	146	73	46
Motor Vehicle Retailing and Service Stations	178	208	1,369	193	203	109
Other Retail Trade	319	420	4,965	378	353	269
Banking and Credit Agencies	84	115	1,087	113	74	97
Insurance, Real Estate, and Other Finance	119	125	2,834	136	136	124
Business and Repair Service	134	156	1,893	103	174	122
Private Households	207	197	1,240	171	171	231
Other Personal Services	170	249	3,199	185	239	106
Entertainment and Recreation Services	47	77	808	47	12	72
Hospitals	325	212	4,680	286	184	262
Health Services, except Hospitals	211	94	1,510	96	101	92

TABLE 3.9-10 Continued

Industry	Bourbon	Clark	Fayette	Jessamine	Scott	Woodford
Elementary and Secondary Schools, Colleges-Government	228	354	7,464	489	248	283
Elementary and Secondary Schools, College-Private	192	125	1,334	696	431	150
Other Education and Kindred Services	5	45	345	9	32	17
Welfare, Religious, and Nonprofit Membership Organizations	34	126	1,041	191	41	111
Legal, Engineering, and Miscellaneous Professional Services	70	169	2,596	126	155	157
Public Administration	602	807	4,157	273	296	245

Source: U.S. Army Corps of Engineers, 1974.

TABLE 3.9-11 Employment trends in the six-county project area, 1964-1972

County	1964	1970	Percent of Change	1972	Percent of Change
Bourbon	5,835	6,237	7	5,740	-8.0
Clark	8,429	10,087	20	9,420	-6.6
Fayette	67,824	88,157	80	86,810	-1.5
Jessamine	3,792	3,000	-21	3,140	4.7
Clark	5,912	4,950	-16	4,740	-4.2
Woodford	4,655	5,525	19	5,480	-0.8

Source: Lexington, Fayette County Planning Commission, 1973.

TABLE 3.9-12 Lexington-Fayette County land-use changes, 1963-1972

Item	1963		1972		1963 - 1972 Change		Percent of County Land Area	
	Acres	%	Acres	%	Acres±	±%	1963	1972
Total County	181,352	-	181,352	-	-	-	100.0	100.0
Developed	25,814	100.0	32,598	100.0	6,780	26.3	14.3	18.0
Residential	13,021	50.5	16,949	52.0	3,923	30.1	7.2	9.3
Manufacturing	924	3.6	1,171	3.6	247	26.7	0.5	0.7
Transportation, Communication, and Utilities	6,717	26.0	7,373	22.6	656	9.8	3.7	4.1
Trade	544	2.1	805	2.5	261	48.0	0.3	0.4
Services	2,483	29.6	3,282	10.0	799	32.2	1.4	1.8
Cultural, Entertainment, Recreation	2,125	8.2	3,026	9.3	901	42.4	1.2	1.7
Undeveloped	155,306	N.A.	148,522	N.A.	-6,784	-4.4	85.7	82.0
Resource Productions and Extractions	150,430	N.A.	144,017	N.A.	-6,413	-4.3	83.0	79.4
Vacant	5,108	N.A.	4,513	N.A.	-595	-11.7	2.7	2.6

Source: Lexington-Fayette County Planning Commission, 1973.

TABLE 3.9-13 Land-use projections for Lexington-Fayette County, 1980 and 1990

Item	1972 Actual		1980 Estimated		1990 Estimated		1972-1980		1980-1990		1972-1990	
	Acreage	%	Acreage	%	Acreage	%	Acreage	%	Acreage	%	Acreage	%
Total County	181,352	100.0	181,136	100.0	181,136	100.0	-	-	-	-	-	-
Developed Area	32,598	14.3	38,391	21.2	45,241	25.0	5,793	17.7	6,850	17.8	12,643	38.7
Residential	16,949	7.2	19,302	10.7	22,177	12.2	2,353	13.8	2,875	15.0	5,228	30.8
Manufacturing	1,171	0.5	1,471	0.8	1,746	1.0	300	25.6	275	18.6	575	49.1
Transportation, Communication, and Utilities	7,373	3.7	9,687	5.4	12,352	6.8	2,314	31.4	2,665	27.5	4,979	67.5
Trade	805	0.3	981	0.5	1,214	0.7	176	21.8	233	28.7	409	50.8
Services	3,282	1.4	3,463	1.9	3,697	2.0	181	5.5	234	6.7	415	12.6
Cultural, Entertainment, and Recreation	3,026	1.2	3,487	1.9	4,050	2.2	461	15.2	563	16.1	11,024	33.8
Undeveloped Area	148,522	85.7	142,745	78.8	135,895	75.0	-5,777	-3.8	-6,850	4.8	12,627	-8.5
Resource Production and Extractions	144,017	83.0	138,432	76.4	131,795	72.8	-5,535	3.8	-6,637	4.8	12,222	8.5
Vacant	4,513	2.7	4,313	2.4	4,100	2.3	-200	4.4	-213	4.9	413	9.2

Source: Lexington-Fayette County Planning Commission, 1973.

TABLE 3.9-14 Components of population change in Lexington-Fayette County, 1960-1970-1975

Population		Number of Persons	Percent of Total Change
1960		131,906	
1960-1970 Change			
Natural Increase			
Add: Births	+33,266		+78.4
Subtract: Deaths	-13,299		-31.4
Net Increase	19,967		46.9
Net In-Migration	+22,450		+53.2
Total Change		42,417	100.0
1970		174,323	
1970-1975 Change			
Natural Increase			
Add: Births	+15,882		+48.6
Subtract: Deaths	- 7,337		-22.5
Net Increase	8,545		26.1
Net In-Migration	+24,132		+73.9
Total Change		32,677	100.0
1975		207,000	

Source: Lexington-Fayette County Planning Commission, 1973.

TABLE 3.9-15 Lexington-Fayette County population projections to 2000

	1970		1985		1980		1990		2000
Population	174,000		207,000		230,000		290,000		350,000
Change		33,000		23,000		60,000		60,000	
Percent Change		19		11		26		20	

Source: Lexington-Fayette Planning Commission, 1973.

TABLE 3.9-16 Change in employment in Lexington-Fayette County, 1960-1970

	Number Employed		Change		% of Total	
	1960	1970	Number	Percent	1960	1970
Total Employment	53,833	88,160	24,327	63.8	100.0	100.0
Agricultural	2,938	2,100	-838	-29.4	5.5	2.4
Nonagricultural	50,895	86,060	35,165	69.1	94.5	97.6
Manufacturing	9,700	17,300	7,600	78.4	18.0	19.6
Durable Goods	5,700	11,300	5,600	98.2	10.6	12.8
Nondurable Goods	4,000	6,000	2,000	50.0	7.4	6.8
Nonmanufacturing	41,195	68,760	27,565	66.9	76.5	78.0
Construction	3,000	5,300	2,300	75.6	5.6	6.0
Transportation, Communications, and Utilities	2,500	4,300	1,800	72.0	4.6	4.9
Trade	10,500	14,900	4,400	41.9	19.5	16.9
Wholesale	2,200	2,800	600	27.3	4.0	3.2
Retail	8,300	12,100	3,800	45.8	15.4	13.7
Finance, Insurance, and Real Estate	1,800	3,700	1,900	105.6	3.4	4.2
Services and Mining	7,400	13,000	5,600	75.7	13.8	14.7
Government	10,500	21,000	10,500	100.0	19.5	23.8
Federal	4,630	6,500	1,870	40.4	8.6	7.4
State and Local	5,870	14,500	8,630	147.0	10.9	16.4
Other*	5,495	6,560	1,065	19.4	10.2	7.5

Source: Kentucky Department of Economic Securities, 1970.

* Includes self-employed, domestic, and private household workers

TABLE 3.9-17. Changes in manufacturing employment in the Lexington SMSA, 1960-1970

	1960 Number	1970 Number	Percent Change
Durable Goods			
Lumber, Wood Furniture	160	450	+181.2
Stone, Clay, Glass	450	300	- 33.3
Metals and Machines	5,000	10,200	+104.0
Other Durables	90	350	+288.9
Total Durable Goods	5,700	11,300	+ 98.2
Nondurable Goods			
Food	1,200	1,000	- 16.7
Tobacco	1,400	1,100	- 21.4
Printing and Publishing	600	900	+ 50.0
Textiles and Apparel	350	850	+142.8
Chemicals, Petroleum, Etc.	100	750	+650.0
Other Nondurables	350	1,400	+300.0
Total Nondurable Goods	4,000	6,000	+ 50.0
TOTAL MANUFACTURING	9,700	17,300	+ 78.4

Source: Kentucky Department of Economic Securities, 1970.

3.10 ENVIRONMENTAL SETTING OF OIL TRANSPORTATION ROUTE

As no new facilities will be constructed to transport oil from the Gulf to Tates Creek, 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 Central Rock 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 or transhipped to 45 MDWT tankers in the Gulf near the Southwest Pass of the Mississippi River;

(2) Oil is transported by tanker through Southwest Pass, up the Mississippi River to St. James, Louisiana (150 miles above Head of Passes);

(3) Oil is transferred from tanker to surface storage tanks at St. James;

(4) Oil is pumped through the 40-inch diameter Capline Pipeline north from St. James through western Mississippi, Tennessee and Kentucky to Patoka, Illinois.

(5) From Patoka, the oil is transferred to the Ashland pipeline and pumped to the east across Kentucky to Tates Creek Terminal.

Marine transport utilizes the heavily traveled Mississippi River corridor to the Capline Terminal at St. James. 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 the river are the Delta National Wildlife Refuge and the Pass a Loutre and Bohemia Wildlife Management Areas. Oil spilled in the lower reach of the river could reach these sensitive wetlands through one of the many river tributaries.

Between Venice and St. James, much of the river is contained within man-made levees. Traffic levels are high, maintenance dredging is common, and the banks are heavily industralized. Except for impacts on water supplies at New Orleans, oil spilled in the river would be quickly diluted and have little significant environmental impact.

The banks of the Mississippi River below Baton Rouge 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 (U.S. Dept. of Transportation, 1976).

Southern Louisiana is very level, much of it barely above sea level. Weather is humid subtropical with a strong marine influence. Rainfall is heavy, averaging over 60 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 St. James, the Capline and Ashland pipelines are currently in operation. Excess capacity would be used to transport additional oil for storage at Central Rock.

The pipelines pass through generally level to rolling terrain (less than 500 feet elevation) in the Coastal Plain as far north as southern Illinois. Patoka, Illinois is located in the Central Lowland Plains; western and central Kentucky are within the Interior Uplands (generally 500 to 1000 feet elevation). Vegetation ranges from oak-hickory-pine associations in Mississippi to oak-hickory further north and mixed mesophytic in eastern Kentucky. Annual average rainfall decreases to the north, from more than 60 inches around St. James to approximately 40 inches in Illinois.

The pipeline crosses many streams and rivers; major crossings are the Mississippi River at St. James, the Ohio River (twice) at the Kentucky border and the Kentucky River in central Kentucky. The route does not cross any national forests, parks or wildlife refuge lands. Aquifers are generally of the unconsolidated sand and gravel type.

Potential natural hazards include those associated with earthquakes and with potentially unstable karst (limestone) foundation conditions. Capline passes just a few miles to the east of New Madrid, Missouri, site of three major earthquakes (modified Mercali intensity XI) in 1811-1812. Much of the pipeline route north of Mississippi is classified either Zone 2 (moderate damage potential) or Zone 3 (major damage potential), as shown in Figure 3.2-6.

Karst lands occur in a broad band along the Arkansas-Tennessee border, just west of Capline, extending across the pipeline route into east-central Illinois. Karst topography also occurs throughout much of central Kentucky.

Except for transfers to storage tanks at Patoka, Illinois and Owensboro, Kentucky, pipeline transportation of oil will have negligible emissions of atmospheric pollutants. Ventilation and atmospheric dispersion conditions are generally good at Patoka and Owensboro.

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 Central Rock. 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 28 tons of hydrocarbons per day from marine transport operations in the Gulf of Mexico and Mississippi River, 300 pounds per day from tank farms at St. James, Louisiana, Patoka, Illinois and Owensboro, Kentucky, and 85 pounds per day from Tates Creek Terminal; sedimentation in downstream impoundments as a result of pipeline construction; annoyance of nearby residents as a result of construction noise; and the possible layoff of a substantial number of Central Rock 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 extremely small (less than 40 barrels over the entire transportation system from the Gulf of Mexico to Lexington, Kentucky) 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 Capline or Ashland pipelines; 2500 barrels from the spur pipeline between Tates Creek and Central Rock Mine) could severely pollute a 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. There is also a very remote (but non-quantifiable) possibility that a "worst case" hydrocarbon vapor explosion within the mine could exceed the lithostatis pressure of the cavern roof and result in oil being displaced to the quarry and possibly to the new mine.

Hydrocarbon emissions from transport, transfer and storage of crude oil between the Gulf of Mexico and Central Rock Mine may result in ambient concentrations exceeding 160 $\mu g/m^3$ under worst case conditions at the following locations: (1) Gulf of Mexico, south of Mississippi River: for a distance of approximately 9.6 miles downwind of VLCC transfer location; (2) St. James, Louisiana tanker terminal: for a distance of 7.5 miles downwind; (3) Patoka, Illinois and Owensboro, Kentucky tank farm terminals: for a distance of 0.5 miles downwind; (4) at the Tates Creek 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 Tates Creek during withdrawal). High ambient hydrocarbon concentrations would extend the area of air quality standard exceedance slightly.

Estimates of erosion potential within the several watersheds crossed by the pipeline indicate that as much as 50 percent of the storage capacity of the Old Grand Dad Distilling Company impoundment on Elkhorn Creek might be filled with sediment over a period of years as a result of pipeline construction. However, the volumes of sediment which actually reach the water body are likely to be less than the maximum potential. No other impoundments are expected to be significantly affected.

Construction noise at Central Rock Mine may cause some annoyance to area residents within one-half mile of the site. Continuous day/night average sound levels may reach 63 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.

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, Central Rock Mine would be closed for an estimated 20 weeks. If the mine alone were affected, a total of 30 workers would be temporarily without work. If the concrete and cement block plants were affected (which is unlikely), as many as 180 workers would be affected. 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 limestone production began at the new mine.

4.2 SITE PREPARATION AND CONSTRUCTION

Preparation of an oil storage facility at Central Rock involves modification of existing mine facilities to receive oil and development of a new limestone mine. No new construction is required to deliver oil from the Gulf of Mexico to Tates Creek Terminal.

Modification of the existing mine includes sinking a pump shaft; sealing the existing service shaft and production tunnel; constructing an electrical power substation, piping, and manifolds; regarding the mine caverns to promote oil drainage; constructing a 13.5-mile pipeline; and expanding Ashland's Tates Creek Terminal.

Development of a new mine involves excavation of a new service shaft and production tunnel; preparation of sufficient working faces in the mine; and possible relocation of new crushing and screening equipment. No new material handling equipment is needed. Further information on site preparation and construction can be obtained from section 2.0.

The following sections describe the expected and potential effects of the proposed project. For clarity, effects are treated within major areas of concern, e.g., geology, hydrology, air quality, and so forth.

4.2.1 Geology and Soils

The Central Rock oil storage project is not expected to have any significant effect on geology or topography. Construction will cause some minor disruption of the weathered bedrock surface due to excavation and blasting for surface structures and the pipeline trench. 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 inclined shaft and pipeline trench. Soil erosion rates are not expected to increase significantly. The gently rolling topography of the region and clayey nature of the soils minimize erosion potential. However, there will be some erosion of bare ground before new plant growth begins.

Access tunnel sinking is common practice in limestone mines. There is one 15- by 20-foot vertical access shaft and a 20- by 30-foot inclined shaft at the existing mine. A new access tunnel will be excavated to a depth of about 650 feet (see Figure 2.2-3). This tunnel will be located a sufficient distance from the existing decline to eliminate any interference. The tunnelling techniques proposed utilize standard engineering practice designed to prevent shaft collapse and ground water migration. Extensive safety precautions have been designed into the pump shaft to prevent any possible destructive failure.

Virtually all of the materials extracted from the shafts will be used as raw material for continuing limestone production. The nonusable material (5,000 to 10,000 cubic yards maximum) will be placed in a landfill on the northwestern end of the property or in large surface quarry areas near the mine portal in a manner designed to minimize potential impacts involving runoff and erosion. Any materials that are unsuitable for use as raw material or land fill will be placed and stabilized in the existing underground mine workings. 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, but no significant adverse effects are expected.

Known economically recoverable mineral deposits in the vicinity of the mine and the pipeline are limited to limestone. This resource will not be significantly affected by oil storage. Although the limestone rock below the level of the present mine may be inaccessible during oil storage because of possible mining regulations, mining will continue at an adjacent location in the new proposed mine. After termination of the oil storage project, the entire mine area will again be available for mining. Because of the nonreactivity of oil with limestone, the oil will not have irreversible effects on the rock.

The same or similar limestones are potentially mineable along the entire pipeline route. However, because the vertical and lateral extent of the pipeline trench is limited to a few feet, the pipeline will not have any measurable impact on future development of the rock resources.

None of these effects are considered to be significant even locally to the Central Rock area.

4.2.2 Hydrology

4.2.2.1 Surface Water

The construction phase of the project will impact the surface waters of the Central Rock area mainly because of the construction of the pipeline.

In general, these impacts will involve:

1. An increase in sedimentation
2. An increase in infiltration
3. A decrease in water quality

The excavation and refilling of the 13.5-mile long pipeline trench will disturb the natural soil along the route. The total amount of disturbed soil along the route is estimated to be about 41 acre-feet. An estimated 20 percent of this material, or about 8.2 acre-feet of soil, will be subject to the runoff-erosion process (Table 4.2-1). This eroded material will gradually enter the streams of the watersheds crossed by the pipeline and be carried as a bed load and suspended load by these streams until finally deposited behind Lock and Dam No. 7 on the Kentucky River below Hickman Creek or behind a small impoundment on Elkhorn Creek. 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, which will cause a temporarily higher infiltration rate in the part of the stream catchments along the pipeline trench. However, this impact is considered very insignificant to both the local and regional environment.

The most significant hydrologic impact will be the increased sedimentation within small impoundments downstream of project construction (Table 4.2-1). The Old Grand Dad Distilling Company impoundment on Elkhorn Creek (about 13.8 acre-feet of storage) is used for water supply (fire protection) purposes. It is about 4500 feet downstream of the confluence point of South and North Elkhorn Creeks (See Figure 3.3-2).

All subwatersheds affected by the proposed pipeline (except West Hickman Creek) discharge either directly or indirectly into South Elkhorn Creek and hence into Elkhorn Creek. It is estimated that about 6.45 acre-feet of additional sediments could accumulate over several years in the reservoir of this impoundment as a result of the project This accumulation represents approximately 45 percent of the impoundment's storage capacity. Although it is gradually silting in from other sediment sources, the impoundment will undoubtedly have a more severe siltation problem due to the project despite any available mitigating measures (see Section 5.0). At some future date the impoundment might not have the storage capacity to serve its intended water supply purpose and may have to be dredged.

Lock & Dam No. 7 on the Kentucky River is located about 18.0 miles downstream of the confluence of Hickman Creek and the Kentucky River. Hickman Creek will receive sediments from West Hickman Creek. The additional increase in sediments delivered to Lock and Dam No. 7 is estimated to be 1.72 acre-feet, which is considered to be insignificant relative to the existing load in the Kentucky River.

During the erosion-sedimentation process, the turbidity and suspended solids of the creeks will increase slightly. However, this increase is not considered to be a significant impact on water quality, except perhaps for a brief period immediately downstream of a pipeline crossing following excavation. No toxic materials or heavy metals are expected to be resuspended into the water column.

The surface drainage pattern will not be altered significantly by surface facilities of the project. During construction and modification of the site, an estimated maximum of 35 gallons per minute of fresh water will be required for about 1 year for drilling, concrete, washing, and general human consumption. This minor amount of water will be drawn from the municipal supply. No freshwater lakes will be directly affected by construction or operation of the facilities.

4.2.2.2 Ground Water

Significant levels of ground water contamination or drawdown are not expected to result from construction activity. No rock cuts or excavations for the pipeline will be carried below the ground water table. Therefore, the adverse impact of the storage site or pipeline route on the natural ground water regime will be minimal. Locally, high levels of suspended solids may occur if surface runoff along the pipeline construction zone should enter the ground water system through karst solution openings in the exposed bedrock sections. However, this effect will be local and temporary. Exposed bedrock may also offer a route to other contamination sources such as road salt, sewage, agricultural chemicals, spilled fuel, hydraulic oil, and other fluids that are common to a large construction project. The quantities of material subject to such migration will be very small relative to the local aquifer volumes except in the case of a major oil spill (see section 4.3.8).

Very few (if any) water users are dependent upon shallow ground water supplies along the pipeline route because city water supplies are available. It is highly unlikely that any of the construction activities will have a significant effect on existing water wells. Thus, should local contamination of the shallow aquifer occur, no existing users would be affected.

4.2.3 Air Quality

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 (dirt) and diesel exhaust (SO_2, NO_x, CO, hydrocarbons) emissions resulting from use of the construction equipment. Most of the construction activity at the mine site (installation of bulkheads, channelization of mine floor) 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 the following sources:

a. General construction vehicles
b. 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. E.P.A. Compilation of Air Pollutant Emission Factors (December, 1975). The total emissions were calculated using the E.P.A. 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 construction equipment is assumed to be in use 20 hours per day and to have a 2,000-working hours/year duty load. In addition, it is assumed that equipment will be used at 2/3 maximum power output during construction.

Light Duty General-Use Traffic

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 4.2-2 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 one-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 amount is high for the Central Rock site because the estimate was determined for a semiarid climate. Dust emission is inversely proportional to the square of ground moisture, and ground moisture is 1-1/2 times the semiarid level in the Appalachian foothills. Therefore, dust emission during construction at Central Rock is estimated to be approximately 0.6 ton of dust per acre of construction per month of activity. This is approximately 25 percent of the emission rate given in Table 4.2-2.

4.2.3.2 Impacts on Air Quality

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

Air pollutant concentrations resulting from Central Rock project construction equipment are given in Table 4.2-3. The concentrations were calculated using construction area emission rates (Table 4.2-2) and assuming an area source model and an area having dimensions of 250 meters on a side. The downwind concentration was 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 by Table 4.2-3 will be lower with increasing distance. Therefore, the concentration at .5 km from the site is the maximum concentration likely to be attained offsite.

All primary standards are easily met for the given assumptions. The concentration levels shown in Table 4.2-3 do not include ambient levels due to sources outside the project. The closest ambient measurements are given in section 3.4. No significant 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 Central Rock construction site. Sound levels from construction activities (not including detonation) are summarized in Table 4.2-4. It is estimated that construction activities will take place over approximately 6 months. Sections 4.2.4.1 through 4.2.4.3 specify the noise levels associated with the major construction equipment. Using the assumption of a 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).

4.2.4.1 Construction of New Mine

Surface equipment associated with construction of a new mine includes the simultaneous use of 1 ventilation blower, 3 air compressors, 2 trucks, 1 crane, and 1 or 2 concrete trucks. The equivalent sound level (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 daytime and nighttime equivalent sound level contributions, L_d and L_n, are therefore estimated to be 69 dB at 500 feet (Table 4.2-5).

The use of explosives during the excavation process is required. It is estimated that there will be three to four detonations of 200 to 700 pounds of dynamite each day. During the initial stage, detonation will take place near the ground surface. As excavation proceeds deeper into the ground, detonation will occur further underground. Since the overpressure created from detonation depends on the depth of the detonation, it is difficult to estimate the overpressure level created from this activity. Overpressure from surface blasts are expected to produce impact sound levels of 91 dB at 1000 feet and 83 dB at 0.5 mile. As shaft sinking operations reach 10 to 20 feet or more below ground levels, much reduced sound levels will be produced.

Underground noise sources for construction at the new mine i clude drills, explosives, and excavation equipment. The audible sound level above the existing ambient sound level due to underground construction activity is expected to be negligible.

4.2.4.2 Conversion of Present Mine to Storage Facility

Most of the construction activity for conversion will be underground, and the audible sound level above the existing ambient sound level is estimated to be negligible.

Aboveground construction will consist of sealing the existing vertical shaft and decline with concrete bulkheads, and drilling six one-shaft/one-pump arrangements. These shafts will not be of sufficient diameter to require blasting. The surface equipment necessary for the mine conversion is similar to that to be used for the new mine.

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. In the case where limestone rock is encountered along the route, the use of 2 impact hammers, 2 rock drills, 1 loader and detonator will be required. If it is determined that frequent blasting is necessary, the use of a rock saw will be considered as an alternate mode for limestone removal. Sound level data associated with this construction equipment are presented in Table 4.2-6. Pipeline construction activity is generally scheduled for 10 hours in the daytime. Equivalent sound level (L_{eq}) contributions at 500 feet from construction activity through pasturelands are estimated to be 68 dB. Pipeline construction activity noise (L_{eq}) at 500 feet from construction through limestone areas is estimated to be 72 dB. Thus, the average daytime sound level (L_d) contribution for construction through pastures and limestone rock is 66 dB and 70 dB at 500 feet, 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 above were extrapolated, using hemispherical sound radiation theory, and are combined with the background ambient sound levels. The assumption of hemispherical sound radiation does not include attenuation due to foliage, air or ground absorption, and is therefore conservative. The construction at the mine site is assumed to occur concurrently with the construction of the pipeline. Ambient sound levels are estimated for the worst cases of construction where pipeline activity is closest to the area of concern. The results of this computation are presented in Table 4.2-7.

The results indicate that, except at the mine site and during blasting, the increase in ambient equivalent sound levels is small. At Lexington, ambient L_d and L_n are estimated to increase by 2 dB and 5 dB, respectively. During the noisiest phase of pipeline construction, where rock removal equipment is used, ambient L_d at pasturelands 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

The impacts during construction of the proposed facility on nearby residents were evaluated using background ambient sound levels and simultaneous construction of the mine facility and pipeline. The impact assessment presented in this section is based on federal guidelines. (Kentucky regulations are no more stringent than the U.S. EPA's guidelines.)

The U.S. Environmental Protection Agency has promulgated 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 (Appendix C). During the noisiest phase of construction at Central Rock Mine, ambient day-night equivalent sound level (L_{dn}) at residential areas in the city of Lexington (0.5 mile from the site) is estimated to increase from 59 to 63 dB. This anticipated increase in ambient sound level may cause some public annoyance to residents living within a 1/2-mile radius of the site. However, surface construction activity will be temporary; most construction activity will occur underground. At noise sensitive land uses south of New Circle Road (Figure 2.1-1), the ambient L_{dn} is estimated to be about 53 dB during the construction period. This sound level is below the EPA's suggested criterion of 55 dB (L_{dn}).

Areas of Lexington further than 1/2 mile from 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 day-time construction sounds and limestone rock blasts. The frequency of these blasts will depend on the quantity of limestone 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 (Federal Register, 1969).

4.2.5 Ecology

Within the Central Rock project area, no detailed wildlife inventories have been undertaken to establish population indices or densities. Available inventory data does not quantify wildlife populations for the Lexington area (U.S. Army Corps of Engineers, 1974b). The scarcity of this type of information for the Lexington 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 have been based on field observations and general background knowledge of the site. Species discussed in this section are the most probable organisms to be impacted by construction of the storage facility and pipeline.

4.2.5.1 Terrestrial Ecology

Approximately 2 acres will be impacted by construction at the Central Rock storage site. All of this area is now used for limestone production activities and is disturbed land. Some adjacent lands may be made temporarily unsuitable for certain species or activities by the noise and activity associated with construction. The loss of this habitat is not significant when compared to the total acreage of similar habitat on the site (approximately 165 acres). To the extent that construction of the oil storage facility at Central Rock precludes other potential development from this land during the life of the project (for security reasons), existing habitat will be temporarily preserved.

There are no known significant breeding or nesting sites in the area to be impacted and no threatened, endangered, or otherwise unique or important species are known to occur there. Mobile populations of mammals and birds will experience temporary difficulty in locating suitable replacement habitats, but the potential for relocation is good to the west of the site.

Locations of the pump station, terminal site, and pipeline corridor were selected to minimize the ecological effects of construction and operation. Two ecosystems, oldfield-pasture and mesophytic wooded slopes, will be impacted during construction of the pump station. The oldfield-pasture ecosystem is more sensitive and subject to damage than the mesophytic wooded slopes because it is limited in areal extent.

Construction of Tates Creek Terminal will result in the total destruction of vegetation within the confines of the facility. This construction will result in a loss of 9.0 acres of pasture-cropland habitat type. Removal of vegetation will result in a reduction of habitat for several bird species. Those that may be affected include the bobwhite quail, eastern meadow lark, marsh hawk, American kestrel, and killdeer. Whether or not the surrounding areas can support the displaced populations of these species is unknown. The acreage and populations affected will be relatively small, however.

Rodents are the most numerous of the mammal species to be affected in the pasture-cropland area. Those animals that survive construction activities probably will be displaced into the surrounding area. It is unknown whether habitats adjacent to the terminal will be able to adequately absorb the population shifts. Other mammals that may be affected by terminal construction are the rabbit, raccoon, striped skunk, opossum, and red fox. The loss of reptile and amphibian species is difficult to assess because they are likely to be clumped rather than randomly distributed throughout the area. Species likely to be affected are the fence lizard, rat snake, and garter snake.

A tabulation of land use acreages and linear distances traversed by the pipeline is given in section 4.2.7.1. Horse farms and other agricultural activities are the most important land-use activities in the vicinity of the pipeline corridor. While pipeline construction activities will be completed in less than 6 months, it cannot be assumed that the land will be productive the year following construction. The maximum length of displacement from grazing or crop production is estimated to be 2 years to allow time for revegetation. Loss of less than 65 acres for two years is not a significant economic impact to the local resources.

Removal of the oldfield-pasture habitat will result in displacement of certain bird species. Some ground-dwelling species, such as eastern meadowlark, killdeer, quail, and horned lark will probably be displaced into adjacent, nonimpacted areas. Small rodents probably will be affected more than any other mammal species by removal of habitat and protective cover, and by temporary barriers to movement presented by spoil piles and the pipeline trench. Other mammal species that may be affected include the raccoon, striped skunk, rabbit, opossum, and red fox. Removal of the oldfield-pasture habitat may affect several reptile species, including the fence lizard, five-lined skink, rat snake, and garter snake. Several species of amphibians that inhabit the creeks, streams, and wetland areas may be affected by placement of the pipeline and resulting turbidity, siltation, and habitat disruption. These species include the spring and mud salamander, bullfrog, leopard frog, snapping turtle, and water snake. It is not anticipated that any great impact will be made upon the insects of the area. The small extent of project activities poses no threat to any of the terrestrial species which may use the area.

4.2.5.2 Aquatic Ecology

No direct on-site impacts are anticipated from any of the project activities at Central Rock Mine since there will be no excavation in aquatic habitats and no dewatering at the mine. Therefore, degradation of local water resources will not occur.

The proposed pipeline route crosses the upper portion of two tributaries to South Elkhorn Creek as well as its main fork (see Figure 3.3-2). The small tributaries are intermittent streams, but South Elkhorn Creek is free-flowing at the point of pipeline crossing. Construction activities at stream crossings, including trenching, pipelaying and backfill operations, have several potential adverse effects on the aquatic environment. Construction unavoidably will produce physical disruption of streambeds at stream crossings, with the consequent disruption and/or displacement of the associated biota. Stream bank erosion, siltation, and increased water turbidity may extend for 1.5 to 2.5 miles downstream of the site. The magnitude of construction disturbance will in large measure determine the exact amount of siltation and turbidity attributable to project activities.

Physical disruption of streambeds will destroy some existing aquatic habitats (estimated at 300 square feet) at the proposed crossing of South Elkhorn Creek. Mobile organisms, primarily fish, will move to other areas within the system, possibly exerting a slight pressure on adjacent habitats. Local fish populations could be most severely affected if construction occurs during the spring spawning and egg maturation periods. Immobile benthic organisms and rooted vegetation in the dredged area and immediately downstream will be eliminated directly. The time required to reestablish these populations is quite variable and is dependent upon the water quality, sedimentation, and biological characteristics of the crossing. Assuming the worst case possible, aquatic populations will take 18 to 26 months to recover to current population levels.

Some erosion of the disturbed stream banks and displacement of dredged materials downstream will occur even when erosion prevention plans are implemented. The extent of possible impacts will depend upon the time of year that construction takes place and the precipitation and flood incidents that follow. It is anticipated that erosion will extend downstream of the site from 3/4 to 1-1/2 miles, depending on water volume and level. Largely this erosion will be the result of bank scouring as well as bank failure. Such occurrences should be localized in nature and not have widespread effects.

Increased dissolved and suspended solids in a river system will alter water quality and may affect the aquatic biota by raising nutrient levels and biochemical oxygen demand, and by releasing toxic materials to the system. An increase in nutrient level may be desirable in systems with low biological productivity, but is detrimental to a system with accelerated eutrophication, such as areas downstream of a sewage outfall. These systems would undergo further stress if the biological oxygen demand were increased. It has been shown that the oxygen uptake demands of resuspended bottom sediments are exceedingly high compared to observed normal rates (Seattle University, 1970). Therefore, during construction, an expected increase in oxygen uptake demand will be probable. However, subsequent to construction, when siltation and turbidity have decreased, the oxygen demand will also decline.

Increased turbidity also decreases light penetration, and therefore can decrease photosynthesis of phytoplankton, attached algae, and submerged vegetation. Persistent high turbidity may ultimately affect high trophic level organisms. Plant life and bottom fauna, upon which fish depend, cannot be very productive if turbidity levels continuously exceed 200 Jackson Turbidity Units (FWPCA, 1968). Turbidity levels of 50 JTU's or less are usually satisfactory for aquatic life in streams. Turbid waters can impair fish vision and respiration; high levels of suspended solids can clog gills.

4.2.6 Historical and Archaeological Resources

There is no direct physical conflict between the proposed facilities and the McConnell Springs Historic Nature Park site. It should be possible to design a facility to allow access to the park without compromising site security or facility operations. The Lexington-Fayette

County Planning Commission's 13 historic sites within 0.5 mile of the proposed pipeline route have not been registered with the National Register of Historic Places. Upon final location of the pipeline route, an in-depth field reconnaissance will be made of the proposed pipeline route in accordance with federal requirements (Public Law 93-291) to identify and recommend measures to avoid possible effects on historical, archaeological, and other cultural resources.

4.2.7 Socioeconomics

4.2.7.1 Land Use

Site

The Central Rock Company will continue operations at the existing site using another shaft and mine. Both the concrete block and cement operations will remain where they are. Other than construction of a pumping station and maintenance facilities associated with the oil storage facility, surface land use will be very little affected. The terminals at Central Rock and Tates Creek will use approximately 10 acres of industrial land.

The immediate vicinity of the project site will be withdrawn from use for limestone production for the duration of the project. Access will be controlled by the FEA for safety and security reasons.

Pipeline Route

The following tabulation lists the acreage and miles of various land uses through which the pipeline will pass. During construction and while the pipeline is operational, residential and industrial uses of the land will not be possible.

	Miles	Acres
Horse Farm	1.70	8.24
Industrial	0.12	0.58
Railroad Right-of-Way	2.53	12.27
Forest	0.15	0.73
Residential	0.50	2.42
Crop and Pasture	8.30	40.24
TOTAL	13.30	64.48

Note: Width ranges from 20 to 60 feet. Average width for calculation is 40 feet.

Since construction is only short term, and the area affected is relatively small, the changes caused by construction will be relatively insignificant. Once the pipe is in the ground, agricultural land can be reclaimed. Access roads, totaling less than two miles, may be required for pipeline construction.

Construction of Tates Creek Terminal will alter the land-use patterns in the immediate area. Some 8 to 9 acres will have to be taken out of proposed residential zoning and be rezoned industrial.

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

Site Periphery

Peripheral changes resulting from construction at the site will be minimal. The Central Rock site is adequately served by existing roads. No new state or county roads will have to be constructed to service the change from mining to oil storage.

No significant new land uses will be induced as a result of construction at the site. The relatively low level of effort required to convert the site and the availability of labor in Lexington make it improbable that significant numbers of construction workers will migrate to Fayette Count. Except for specialized requirements, most construction services will be provided by personnel and equipment from within the county.

4.2.7.2 Transportation

Primary access to the Central Rock site is afforded by Old Frankfort Pike and Forbes Roads, major arterials in the northwestern portion of the urbanized area (Figures 2.1-1 and 2.2-2). These two roads are in need of extensive repair in the site vicinity; road surfaces are poor and drainage inadequate.

Impact on surrounding roads resulting from construction at the site will be minimal. Most of the site-generated traffic will result from truck deliveries of limestone. Traffic volume generated by construction of an oil storage facility will be small compared to the local truck traffic already traveling on roads near the site. No major fabrication and no major movement of heavy equipment will be required at the plant site during construction. Local traffic levels are light enough to allow some increase in traffic without significant impact. The level of traffic will depend on provisions made for transporting employees to the site.

Impact upon traffic flows and roads will be more extensive as a result of pipeline construction than on-site construction. Most of the area crossed by the pipeline is rural, and much of the actual route is not serviced by any type of road. Movement of pipe, personnel, and equipment will necessitate construction of new access roads (probably less than two miles total length) and the probable improvement of existing county roads surrounding the pipe route. During construction, the use of existing roads, especially in the construction zone, will generally exceed present traffic volume.

4.2.7.3 Population

Construction of the oil storage and new mine facility should have little impact on local population characteristics. With careful planning, there is no reason for construction of the facility to dislocate people.

The peak number of workers required for construction is estimated to be 170 (see Table 2.3-2). This represents 0.16 percent of the total working age population in Fayette County in 1970. Since a maximum of 50 workers are expected to come from outside the project area (see Tables 2.3-1 and 2.3-2), impact of the oil storage facility construction personnel upon the total population residing in Fayette County, and therefore on housing and public services, will be insignificant.

4.2.7.4 Employment

Assuming that a maximum of 150 to 170 new workers will be employed in the construction of the oil storage facility and development of a new mine between 1977 and 1980, this project will account for about 0.15 percent of the 1980 total employment in the county. This is an insignificant addition to the total job availability.

If temporary shutdown of the existing limestone mine and all the related plants on site should occur, about two-thirds of the current workers (approximately 120 persons) would be underemployed or unemployed for about 20 weeks. The other third would probably find work on the project construction crew. If only the mine were temporarily shut down, only 6 people are estimated to be out of work for the 20 weeks (with 24 mine workers finding substitute employment).

4.2.7.5 Economics

The total earnings from project construction are estimated at about $2.9 million (see Tables 2.3-1 and 2.3-2). Of this total, about $1.7 million will go to local workers and $1.2 million to nonlocal workers for the option of no mine shutdown (Table 2.3-1). The disposable income (that portion of income available for spending after taxes and social security payments) of all workers is estimated at 75 percent of total earnings, or about $2.2 million. Local workers (those who reside permanently within commuting distance) may be expected to spend more of their disposable income in the local area than would nonlocal workers who, although living temporarily in the area, will probably send part of their pay home to their families and/or save larger portions of it. Most local workers are expected to be residents of Fayette County. Nonlocals will be mostly specialists and some skilled workers.

The impact upon construction, government, transportation, manufacturing, trade, and services within Fayette County will be minimal. Total personal income in Fayette County in 1973 was $910 million. Assuming that personal income in the county grows to $932 million by 1980, the project directly will contribute a maximum of 0.2 percent of the total county personal income in the first year of construction.

In addition to the direct impacts of such a project, indirect effects upon personal income also will be generated. Although no data on employment multipliers is available, is may be conservatively assumed that for every dollar of direct income generated by the project, at least one additional dollar of indirect income is induced. The total impact of the project upon income will then be approximately 0.4 percent of total county personal income.

If the limestone mine and its related plant facilities were temporarily shut down, as many as 120 Central Rock workers could be unemployed (or underemployed) for approximately 20 weeks. About 60 would be re-employed for mine construction. Due to the accelerated construction schedule requiring more workers per week, and the additional 60 local workers available for the construction jobs, one of the results of this option would be $.2 million more in local earnings and $.2 million less in nonlocal earnings from the project (Table 2.3-2).

Even though local earnings from project construction would be increased by the temporary limestone mine shutdown, the loss of earnings by the Central Rock workers who were laid off would reduce the total increase in earnings of the project over existing income by $.7 million. The $.7 million is represented by $508,000 in salary lost by 120 workers for 20 weeks (assuming an $11,000 average annual salary)* and $250,000 for the loss of 60 new jobs that would have been available if current Central Rock employees had not been laid off and then taken those jobs as substitute work. In other words, without mine shutdown,

---

*This would be offset to some degree by unemployment benefits.

total project construction earnings will add $2.9 million to existing earnings in the area; with temporary mine shutdown, the net increase in area earnings over present income would be $.7 million less, or $2.2 million.

The temporary mine shutdown option as discussed above has included the shutdown of all related plant facilities in order to consider the worst possible case under this option. However, there is a very good chance that, if this option were chosen, only the mine itself would close, putting only 30 people out of work. Only 6 of these 30 would probably be unable to find substitute employment for project construction, so the economic and resulting social impacts of the shutdown would be minimal.

The likelihood of only the mine shutting down is based on the fact that the mining of limestone in Fayette County has been depressed over the last 2 years (due to the depressed construction industry, its primary market), and present production is far below capacity. Assuming no sudden resurgence in the construction industry, limestone production will probably remain below capacity for the next few years. Therefore, it is logical to assume that other mines would produce limestone in place of Central Rock for the 20-week shutdown period and supply it to the Central Rock cement and concrete block plants. (Central Rock limestone production presently constitutes approximately one-third of the total limestone output in Fayette County.)

4.2.7.6 Government Finance

The major sources of revenue collected by the state that will be affected by conversion of the existing mine to an oil storage facility include:

1. Corporation Income Tax
2. Corporation License Tax
3. General Property Tax
4. Individual Income Tax
5. Sales and Use Tax

Several other taxes are collected by the Kentucky Department of Revenue, but none will be affected to any significant degree by conversion of the mine. In addition to the state taxes, there is a city income tax, computed at 2 percent of gross salary, and a net profit tax of 2 percent.

During the construction phase of the project, the major impact upon local revenues will occur as a result of new salaried workers employed in Fayette County. To the extent that the mine continues to operate during construction, current corporation income tax, license tax, property tax, and employees' local and state income taxes will also continue. Shutdown of the mine for a 20-week period would terminate these revenues.

The 2 percent city gross income tax will yield a total of $58,000 from the projected $2.9 million in construction wages. Some of these monies may not be new income but revenue from a new source, since much of the required labor force is believed to be presently employed on other jobs. Using Lexington-Fayette County Planning Commission data depicting 1980 personal income of $932,200,000, local revenues of $18,644,000 were estimated. The $58,000 generated from salaried workers employed during construction will constitute an insignificant portion of the total.

4.2.7.7 Aesthetics

Possible aesthetic impacts from construction will result principally from laying the pipeline and constructing the terminal facility. In both cases, rural lands will be modified. The terminal facility is considered to be permanent. The pipeline will cause only a temporary change in scenic value, since it will be buried. After construction, the trench will be covered and reseeded, allowing grazing and farming activities to resume. Access roads and stockpiling of pipe and equipment needed for the pipeline will have visual impact. Whether or not this impact is permanent depends on treatment of the areas after the pipeline is completed (see section 5.1.6.4).

Construction of a pumping station will not create any significant change at the site. Because of the low profile of the existing and new facilities required at Central Rock, they will be concealed by the existing light industrial area surrounding the site. However, flaring may constitute a visual impact in the immediate area, especially when the gases are burned at night and are visible from residential areas.

TABLE 4.2-1 Sedimentation characteristics due to pipeline construction in Central Rock watersheds

Name of the Watershed	Length of the Pipeline in watershed (ft.)	Volume of the disturbed soil (acre-feet)	Volume of the disturbed soil subject to erosion-sedimentation process (acre-feet)	Steam flow velocity (ft/sec)
1.) Town Branch	1,580	0.91	0.18	0.6
2.) Wolf Run	10,720	6.15	1.23	0.7
3.) Steeles Run	8,030	4.61	0.92	0.6
4.) Manchester Branch	3,220	1.81	0.36	0.6
5.) Cave Creek	9,930	5.70	1.14	0.8
6.) South Elkhorm Creek	22,810	13.10	2.62	0.6
7.) West Hickman Creek	15,000	8.61	1.72	0.8
Total	71,290	40.89	8.17	

TABLE 4.2-2 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 4.2-3 Pollutant concentration 0.5 km downwind from site construction (source area: .25 km x .25 km)

Pollutant	Federal and State Standards	($\mu gm/m^3$)	Calculated down-wind 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

Downwind concentration of durations greater than one hour was estimated by methods recommended by Turner (1969).

TABLE 4.2-4 Summary of sound level contribution from construction activities--[estimated at 500 feet from center of activity (dB)]

	L_{eq}	L_d	L_n
Shaft Excavation (new mine and conversion of existing mine)	69	69	69
Pipeline Construction (through pasture lands)	68	66	-
Pipeline Construction (through limestone rock areas)	72	70	-

TABLE 4.2-5 Shaft excavation equipment

Equipment	Number	A-Weighted[1] Sound Level at 50 feet (each 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 Truck	2	85	65	0.4

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

[b] Dames & Moore files

[c] Estimated

(1) U.S. EPA, 1974, Background document for proposed portable air compressor noise emission regulations: U.S. EPA, EPA-550/90/9-74-016, Washington, D.C. (October)

TABLE 4.2-6 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) U.S. EPA, 1974, Background document for proposed portable air compressor noise emission regulations: U.S. EPA, EPA-550/90/9-74-016, Washington, D.C. (October)

TABLE 4.2-7 Ambient sound level during construction (dB)

	Background Ambient			Construction Ambient 1[a]			Construction Ambient 2[b]		
	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}
Center of Site	66	68	74	72	71	78	73	71	78
City of Lexington [c]	57	51	59	59	56	62	60	56	63
Pasture Lands [d]	45	35	45	49	35	48	51	35	50
Noise Sensitive Land Uses Along Pipeline Route [e]	50	42	51	52	42	52	54	42	53

[a]Construction of pipeline with conventional methods.

[b]Construction of pipeline through limestone rock areas.

[c]Estimated at 1/2 mile from site.

[d]Estimated at 1 mile from pipeline route.

[e]Estimated at Stonewall Estates.

4.3 ENVIRONMENTAL IMPACTS OF OPERATION AND OIL STORAGE

4.3.1 Geology and Soils

4.3.1.1 Permeability

The oil storage program does not present any major impacts to current geologic or soil conditions. The impermeable nature of the limestone and the natural seal formed by external ground water pressure will prevent oil seepage out of the cavern.

4.3.1.2 Subsidence

The pipeline will be laid across shallow karst material on the upper portion of the limestone bedrock surface. Land subsidence due to sinkhole collapse could have a direct impact on the pipeline, causing loss of support and possible structural failure. Any sinkholes that may underlie the pipeline route will probably be undetected during construction, and could afford foundation support for a long time during operation before a collapse occurs. Unlike construction of major structures, such as pumping stations and terminal facilities, which is usually preceded by a subsurface investigation, the foundation along the pipeline route cannot be economically investigated in detail over its entire course. Therefore, the possibility of foundation collapse leading to a break in the oil-filled pipeline must be considered as a possibility. If a break in the oil-filled pipeline does occur as a result of sinkhole collapse, then a major spill may be expected to result in oil contamination of shallow ground water aquifers and land surfaces.

Land subsidence from sinkhole collapse would not affect the stability of the mine, which is below the level of karst development. Surface terminal facilities will warrant a detailed subsurface investigation prior to construction. Solution cavities large enough to cause structural damage will be identified during the drilling program. Particular attention will be given to providing a firm foundation for the storage tanks at Tates Creek.

4.3.1.3 Seismic Stability

The site is located in an area of very low seismic intensity and frequency. According to the available seismic risk maps, the maximum horizontal acceleration of gravity due to historical seismic events in the region is less than 5 percent gravity. This low level of seismic loading is not expected to have a significant impact on the mine, pipeline, or any of the ancillary structures. The mine, in particular, 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 low level of seismic activity anticipated for the region indicate that no impact can be expected from seismic activity.

4.3.1.4 Structural Stability

The cavern appears to be stable and does not show any indication of pillar distress. The lithostatic pressure ranges from about 160 to 300 psi. The limestone pillars carry a load of approximately 600 to 1200 psi, based on a typical recovery factor of 75 percent. This is probably less than 10 percent of 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 be applied by means 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 235 to 280 feet of overburden and carries an approximate overburden (lithostatic) pressure of 200 to 300 psi. However, a surface quarry 140 feet deep is located over parts of the underground mine, reducing the cover to about 140 feet, or a lithostatic pressure of about 160 psi. It is doubtful that an explosion-related overpressure could exceed the lithostatic pressure in any portion of the existing mine, thereby creating a collapse condition that would significantly impact on the geology and mineral resources.

In the worst possible case, a mine explosion which exceeds the minimum lithostatic pressure could lead to rock fracturing and complete collapse of the mine roof. Stored oil could be displaced to the level of the quarry above the collapsed cavern and from there would flow through existing or manmade drainage channels such as the new mine incline. It is unlikely that the oil could reach the ground level at the mine site. However, the location of the new mine incline within the quarry provides a potential risk to the Central Rock Mine and the underground workers. The likelihood of such an explosion and roof collapse is extremely remote.

The most likely circumstance for a hydrocarbon vapor explosion would be following withdrawal of most or all of the oil, because air must be drawn into the cavern during pumping to avoid creation of a partial vacuum. Under these circumstances, there is very little potential for any remaining oil to escape from the cavern. Damage would probably be limited to the cavern structure and pump shaft equipment, with no significant loss of oil and no direct effect on mine operations.

4.3.2 Hydrology

4.3.2.1 Surface Water

Water requirements of the existing mine facilities are minimal, limited primarily to sanitary purposes, drinking, mining, and fire prevention. These waters are presently supplied from the Lexington municipal water system. Water requirements for the new mine (and to supply the negligible requirements of the storage facility) will be similarly supplied, without further impact on surface waters.

Cavern Storage

During normal operation 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 (assumed to occur once every 5 years), no impacts to surface water are expected. Since no water will be introduced into the cavern, either purposely or accidentally, any impacts on surface water will be limited to the possible effects of accidental oil spills at the surface, described in detail in section 4.3.8.

Surface Facilities

There is expected to be no discharge of wastes to surface waters at the mine site. As stated previously, no ground water seepage into the mine is expected after the existing shafts are sealed. The major potential impact to the surface water is from the possibility of small or large spills of oil at the surface. However, the risk of a large spill is small. (See section 4.3.8). A small oil spill would affect the surface water quality, but the impact is important primarily to biological resources in the spill zone. Frequent small spills, if occurring with greater than expected frequency, could have a cumulative effect on the water quality in the area.

Flooding

As indicated in section 3.3, the 100-year return flood level at the Kentucky River is predicted to be +549 feet MSL. The major surface facilities are located at elevation +945 feet MSL and will be unaffected by any conceivable storm water level. The pipeline will be buried to prevent impacts by floods.

4.3.2.2 Ground Water

New Limestone Mine

Impacts of the new mine on the ground water at Central Rock will be negligible. Like the present mine, the new underground workings are anticipated to be essentially dry and unconnected to the ground water regimen. Also, the modest amounts of water required for mining and production will probably be supplied from the municipal system derived from the Kentucky River and not from local ground water aquifers.

Cavern Storage

Except for a small quantity of surface drainage that enters through the shaft, the mine is essentially dry. The fact that virtually no ground water is seeping into the mine under a minimum hydrostatic pressure of 65 psi is a good indication that the mine is hydraulically isolated from the ground water regimen.

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 will thus prevent release of vapors from the cavern and into surrounding aquifers.

The mine is neither located in an aquifer nor hydraulically connected to one. Therefore, dewatering of shallow aquifers above the mine is not expected to occur as a result of mine conversion. Any contamination would be limited to incidents involving explosive expulsion from oil pressurization, seepage of the oil from the mine, or displacement of oil resulting from water flowage into the mine. Each of these possibilities is very remote. Volume changes from pressurization are easily accounted for in establishing the size of the unfilled space in the workings.

Failure of the mine, either by collapse or closure, would only be possible in the case of an unusually strong hydrocarbon explosion (see section 4.3.1). If a local collapse occurred, it would probably arch only about 30 to 40 feet above the roof of the mine because of cavern geometry. The 150 feet or so of impermeable rock above the mine would prevent oil from escaping into the surrounding material.

If leakage of oil did somehow occur as a result of any of the above mechanisms, the oil would be restricted to the immediate vicinity of the mine, trapped within the local cone of depression of the water table caused by drainage into the surface quarries.

The sole remaining potential for contamination, then, involves upward displacement of oil by water infiltration through the shafts, vent lines, or intake and discharge pipes. (There is no evidence of significant amounts of gas in the rock above the caverns in the vicinity of the shaft which might force water into the caverns.) If the pipes through the limestone above the caverns are broken, water in the shaft would be free to mingle with any oil in the ruptured pipes and would sink into the mine, forcing oil upward into the flooded shaft. However, once enough water entered the cavern to fill the sump up to the bottom of the pipes, no more oil would be able to escape from storage. 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. Since none of the aquifers above the limestone are artesian, the oil and water column in the shaft would rise to the local piezometric surface, about 140 feet below the shaft collar. The worst result would be minor oil intrusion into local aquifers that might be bared by shaft lining failures. Once the shaft water reached the piezometric surface, the hydrostatic heads in both the aquifer and the shaft would be equal and the water pressure would cease to drive the oil/water mix upward in the shaft. For the same reason, the oil would not significantly penetrate the aquifer.

Surface Facilities

One major impact that could affect ground water would be a break in the oil distribution pipeline as a result of sinkhole collapse, introducing large quantities of oil into the aquifer. A small leak in the buried pipeline could also result in ground water contamination if it remained undetected for a long period of time. Since a major portion of the pipeline will be embedded in the upper bedrock surface, it is reasonable to assume that oil originating from a leak would be rapidly distributed into the karst limestone aquifer.

Although the risk of oil contamination in the shallow aquifer is probably not great, there are no data to yield a quantitative estimate of the risk potential (see section 4.3.8). However, contamination of the shallow aquifer would have little impact on ground water availability or use because the aquifer is not capable of extensive development. Deeper aquifers would not be affected because oil is buoyant and would not migrate below stream level. Oil carried by the karst aquifer would be difficult to trace because of the complex flow pattern in the limestone solution channels. The greatest environmental consequence would probably occur when the oil reappeared on the ground surface through springs and seeps and entered the terrestrial or aquatic environment. Such discharge could foul the discharge area for an extended period of time.

There will be no significant discharge of waste to the ground water. Sanitary wastes from the storage facility and mine personnel will be routed to the municipal sewage system or to a portable chemical treatment facility.

4.3.3 Air Quality

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 B).

Preliminary estimates of leakage and flaring from the mine have been determined and are presented in Appendix B. Hydrocarbons in the amount of 42 pounds per day (lbs/day) (0.22 grams per second) and hydrogen sulfide in the amount of 0.04 lbs/day (0.0002 gm/sec) are expected to be lost from leakage during pumping. Fourteen lbs/day (0.08 gm/sec) of H_2S will be emitted from an unflared cavern, and 28 lbs/day (0.15 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 28,000 bbls/day of oil. The concentrations of SO_2 on Figure 4.3-1 assume 0.15 gm/sec of emissions from flaring. The concentrations of hydrocarbons (lower curve, Figure 4.3-2) result from pipe system leakage; therefore, a ground release mode was assumed. The H_2S concentration on Figure 4.3-3 would result from filling the mine without flaring of displaced vapor.

The highest ground-level concentration of SO_2 (Figure 4.3-1) is 2.3 micrograms per cubic meter ($\mu g/m^3$), which is well below both the maximum 24-hour concentration (365 $\mu g/m^3$) and the annual (80 $\mu g/m^3$) standards. The highest concentration of hydrocarbons at ground level is 107 $\mu g/m^3$ at a distance of 300 meters downwind of the site, which is below the 3-hour primary air quality standard of 160 $\mu g/m^3$ (Figure 4.3-2). The maximum concentration of H_2S that could be realized even if the vented gases were not flared, is 2 $\mu g/m^3$ one km downwind from the site, which is well below the local standard of 14 $\mu g/m^3$ for Lexington.

4.3.3.2 <u>Hydrocarbon Vapor Emitted During Oil Transport</u>

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 Mississippi River; (2) tanker transport of oil up the Mississippi River to St. James, Louisiana; (3) transfer of oil from tankers to surface storage tanks at St. James; (4) temporary storage of oil at St. James; Patoka, Illinois; Owensboro, Kentucky; and Tates Creek 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 B.

Hydrocarbon emissions are summarized in Table 4.3-1 for the principal sources. The major emissions occur in Louisiana 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 B), 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 9.6 miles from the Gulf of Mexico VLCC transfer point and up to 7.5 miles from St. James, Louisiana (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 a 8 mi/hour average wind speed, 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 ug/m^3 no further than 0.5 miles downwind (Table 4.3-1 and Figure 4.3-4). Emissions would be attributable to the Central Rock project only for brief periods during each fill at St. James, Patoka and Owensboro. However, at Tates Creek emissions would occur for approximately 500 days during each cavern fill (at 28,000 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 3672 tons (24,420 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 Central Rock SPR project appears to be greatest in southern Louisiana 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.

Neither EPA nor the state of Louisiana monitor hydrocarbons in southern Louisiana. However, data are available as a result of a short-term ambient air quality study performed in Lafourche Parish (Kem-Tech Laboratories, 1975). In this study air quality was monitored continuously during two weekly periods in non urban areas of coastal Louisiana. One site was in a fresh marsh area of Lafourche Parish, 45 miles southeast of St. James; the other was within five miles of the Gulf of Mexico, 70 miles southeast of St. James. The samples indicated that the national ambient air quality standard (NAAQS) for non-methane hydrocarbons (160 ug/m^3 during a 3-hour period) was exceeded 39 percent of the time in September and 16 percent in December. Maximum concentrations ranged from a high of 812 ug/m^3 to a low of 83 ug/m^3; average hourly concentrations ranged from a high of 518 ug/m^3 to a low of 71 ug/m^3. The report concluded that, though based on limited data, the NAAQS for non-methane hydrocarbons is probably exceeded quite frequently in southern Louisiana (as is true for much of the nation). The hydrocarbons were felt to be generally of the non-reactive (not precursors of ozone) type, however.

Photochemical oxidants (ozone) have been measured in three areas of southern Louisiana, as well as in Lafourche Parish. Second highest hourly concentrations for 1975 were 0.094 ppm in New Orleans, 0.174 ppm in Lake Charles, and 0.170 ppm in Baton Rouge (Medal, 1976). Thus the NAAQS of 0.08 ppm (160 ug/m^3) was exceeded more than once in each location. The annual arithmetic mean at all three locations was approximately half the state standard of 0.03 ppm, however. In Lafourche Parish, maximum levels of ozone ranged from 0.09 ppm to 0.04 ppm; average hourly levels ranged from 0.08 ppm to 0.01 ppm (Ken-Tech, 1975). Thus, the NAAQS for ozone may be occasionally exceeded in southern Louisiana.

As indicated in Section 4.3.3.2, locally high rates of hydrocarbons will be emitted from tankers along the Mississippi River from St. James to the Gulf. The 3-hour standard of 160 ug/m^3 may be exceeded as far as 9.6 miles downwind in the nearshore Gulf waters and as far as 7.5 miles at St. James. Total annual emissions may be as high as 700 tons (as a comparison hydrocarbon emissions from existing sources are estimated at 9995 tons/year in Plaquemines Parish, 39,792 tons/year in Jefferson Parish, 162,619 tons/year in East Baton Rouge Parish and 22,870 tons/year in St. James Parish; EPA, 1976).

Much of the hydrocarbon vapors emitted from the tankers will be methane or ethane, generally non-reactive fractions. Also, the emissions will occur only over a relatively brief (25 days or so) period during each cavern fill operation. Though local levels of hydrocarbon concentrations may be adversely affected by the project, the quantity and type of emissions are not expected to caruse adverse regional impacts to photochemical oxidant concentrations.

Atmospheric emissions along the Capline/Ashland pipeline route are limited to the tank farms at Patoka, Illinois, Owensboro, Kentucky and Tates Creek. The quantities to be released are quite small (Table 4.3-1). Existing vapor releases at Patoka and Owensboro are much larger; however, no ambient air quality data is available. Disregarding ambient levels, hydrocarbon concentrations due to the project would exceed NAAQS no further than 0.5 miles downwind. Also, these emissions would occur for only 30 to 40 days per fill period.

At Tates Creek, emissions would occur at lower rates for as long as 500 days per fill period. Concentrations would exceed 160 ug/m^3 only as far as 0.25 miles downwind. At the storage site, all significant vapor emissions will be flared.

Thus, only local hydrocarbon concentrations in Louisiana may be significantly affected by the project. The effect would be short-term and intermittent. Levels of photochemical oxidants, SO_2, H_2S, and particulates should not be adversely affected.

4.3.4 Noise

The major noise 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 be driven by electric motors. Continuous filling and emptying will occur for periods of 16 and 5 months, respectively.

Operation noise levels are estimated from measurements at a similar facility in New York State. This facility is a liquefied propane gas storage plant with similar material handling and processing equipment; the major differences are the use of dehydrators and trucks for transportation. 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 Tates Creek Terminal, where the proposed pipeline connects with the main carrier 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.

Along the oil transportation route between the Gulf of Mexico and Tates Creek Terminal, no new noise-producing activities will be initiated; however, there will be a slightly greater frequency of these activities as the volume rate of oil movement is increased. The most obvious increase will be tanker movements through the Mississippi River. A total of 47 tanker round trips between the Gulf of Mexico and St. James, Louisiana will be required within a period of about 25 days to provide oil to fill Central Rock Mine. This is a minor increase in traffic level and represents a negligible effect on noise level along the river. Some additional activity would be required at the St. James tanker docks and at the several tank farms along the Capline/Ashland 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.

4.3.5 Ecology

Impacts of normal operations are described in this section; impacts of oil spills are treated in section 4.3.8.

Wildlife will return to the outer fringes of the surface facilities after construction is completed. Daily activities of storage operating personnel will be minimal. No noise impacts on wildlife are expected. Road use will be less than that during construction; road kills of small mammals and birds will be minimal. The peak time for road kills during operation will be when traffic density is highest and young fauna are emerging from their nests. Normally, this peak is during the summer months.

Other impacts on wildlife might occur if seeding and revegetation of the construction site and pipeline corridor is poor and subsequent wildlife management practices are unsatisfactory.

Operational impact of the storage area on aquatic ecology of the site will be negligible since there will be very little interaction between the project and aquatic resources. The major aquatic impacts will be from oil spills (see section 4.3.8) and from erosional effects caused by construction.

4.3.6 Historical and Archaeological Resources

There will be no impact on historical or archaeological resources as a result of project operation.

4.3.7 Socioeconomics

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 genera 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 conditions of oil supply interruption. As soon thereafter as feasible, the cavern will be refilled with oil. Withdrawal will take 5 months and a total work force of approximately 8 to 10. Refill operations will take approximately 16 months 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.

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 limestone production from the storage caverns will be prevented for the length of the project.

4.3.7.2 Transportation

During operations, the oil storage facility will have no adverse effect upon transport facilities on or near the site: a maintenance and operating crew for the entire operation will amount to approximately three people, and oil will be transported by pipeline.

Movement of crude oil between the Gulf of Mexico and Tates Creek Terminal will utilize existing capacity in the nation's oil storage systems. There are also plans or potential for expanding both the Capline and Ashland pipeline 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 program (see Section 8.3.5).

Distribution of oil to refinery and market centers during a period of oil supply interruption should not be a problem. The Ashland/Capline 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

Operation of the oil storage facility will have no significant direct or secondary impacts upon population within Fayette County. Assuming that a maximum of 10 people are employed at the oil storage facility and that the average household size is 3 (the average for Fayette County in 1970), a population increase of only 30 people will be associated with standby operation of the oil storage facility. This compares to a 1980 Fayette County population projection of 214,400, as projected by the Bluegrass Area Development District staff. Consequently, there will be no significant increase in population, employment, or housing demands either locally or regionally as a result of project operation.

4.3.7.4 Economics

Since a replacement mine is planned at Central Rock, 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 Fayette 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 Finance

Assuming that mining operations will continue during operation of the oil storage facility, no loss of tax revenues to the county/city or state will occur. If the oil storage facility were owned and operated by a private company, an estimated $85,000 in local property taxes would be generated annually.

4.3.7.6 Aesthetics

Normal operation of the oil storage facility will have no adverse impact upon aesthetic features in the area. If an oil spill occurred, 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 Central Rock Mine are due to the possibility of accidental oil discharge into the surrounding land areas and watershed. This risk begins with the transport of oil from the Gulf of Mexico 180 miles up the Mississippi River by tanker to St. James, Louisiana. From St. James, oil would be varried through the 40-inch diameter Capline pipeline 575 miles north to Patoka, Illinois and then 280 miles east through the Ashland pipeline system to Tates Creek (Figure 2.3-8). From Tates Creek, a 13.5 mile long pipeline is proposed to connect with Central Rock 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 Tates Creek only during fill operations. Transport operation between Tates Creek and Central Rock Mine is considered for both fill and withdrawal. Allocation of oil from Tates Creek during an oil supply interruption has not been determined as yet and, consequently, no oil spill analysis is presented.

The following sections of this report describe in detail these potential sources, together with locations, expected frequencies, and volumes of accidental oil release into the environment. In addition, the major impacts of these spills on the physical and biotic resources of the site vicinity are discussed. Further information concerning the methodology used in calculating the oil spill risks is provided in Appendix F. An oil spill containment and recovery plan is presented in Appendix G.

4.3.8.1 Oil Spill Risk from Pipeline Transport

A useful data base to project pipeline oil spill risk is the 1968 to 1973 oil transport record reported by the Office of Pipeline Safety, U. S. Department of Transportation. Risk projection is based upon exposures of time and pipeline length. The applicable spill rate appropriate for new U.S. oil pipelines is estimated at 50×10^{-5} spills per mile per year, or 0.5 events per year per 1000 miles (see Appendix F). Because the Central Rock pipeline must be laid through karst topography, there is an additional element of risk associated with possible foundation collapse. Since there is no data available to quantify this additional risk, it will be treated only qualitatively in this analysis.

The pipeline corridor between the Central Rock site and Tates Creek Terminal was chosen to avoid as much urban area as possible, rather than to minimize length. The route for the 16-inch pipeline begins at Central Rock Mine, travels in a westerly direction away from the urbanized area of Lexington, and then turns to the south and southeast, where it connects with Tates Creek Terminal near the Fayette-Jessamine County line (see Figure 2.3-4). Tates Creek is a terminal of the Ashland oil pipeline, which connects with the national oil distribution system. The Central Rock connector extends for a distance of about 13.5 miles.

During standby operation of the oil storage facility, the pipeline could be operated in two modes: 1) it could be left completely full of oil; or 2) it could be purged with an innocuous fluid. If the Central Rock 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 exposure mode is projected to be 0.15 events, or 1 chance in 7 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 Central Rock in this mode would be 161 barrels over the life of the project. The expected frequency of a spill would be:

None in 22 years 86 percent
One in 22 years 13 percent
Two or more 1 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 (probable rate for most of the fill cycles), a withdrawal period of 150 days, and 5 full cycles of use (5.9 years total pipeline use), the number of spills in the life of the project would be 0.04 (1 chance in 25), and the total spill volume expectation would be 43 barrels. The spill probabilities for this mode are:

None in 22 years - 96 percent
One in 22 years - 3.9 percent
Two or more - 0.1 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 20,000 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 small risk of oil spillage under either option, the Central Rock pipeline will be designed to remain full of oil throughout the life of the storage facility. Even if the risk of oil release due to karst topography were an order of magnitude greater than normal pipeline spill risks, expected oil spillage during the life of the project would be only 1600 barrels.

The maximum credible spill for a closely supervised spur pipeline connecting Central Rock Mine with Tates Creek Terminal is estimated to be about 2500 barrels, based on various combined static and pumping losses (see Appendix F).

The Capline and Ashland pipelines will be subject to additional spill risk exposure as a result of pumping crude oil to Central Rock Mine. The approximate distance between St. James, Louisiana and Patoka, Illinois, through the Capline pipeline, is 575 miles; from Patoka, to Tates Creek Terminal, through the Ashland pipeline, is approximately 280 miles. Pumping 14 million barrels of oil to Central Rock represents approximately 14 days of capacity for Capline and 50 days for Ashland. At 50×10^{-5} spills per mile per year and a 1083-barrel spill average, the expected pipeline spill risk per fill is the following: for Capline, 12 barrels with an expectation of 0.011 spills; for Ashland, 21 barrels with an expectation of 0.019 spills. Total expected spillage for 5 fill operations is 162 barrels (Table 4.3-2), with a frequency of 0.15 events (1 chance in 7 of a spill occurring). Even if potential risks due to earthquakes and karst topography should increase risks by an order of magnitude, only 1600 barrels of oil would be spilled.

Because of the greater line size and pumping rates, the maximum credible spill from the Capline and Ashland pipelines 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 (a total of 0.015 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 Mississippi River Transport Operations

Movement of oil to the Capline terminal at St. James, Louisiana might occur by several possible modes. The source and origin of crude oil to be stored at Central Rock 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 tankers (e.g., 45,000 DWT) in the Gulf and a second transfer to surface tanks at St. James for injection into Capline. However, the oil could also be shipped directly from the point of origin to the St. James Terminal in small tankers, or it could be offloaded from VLCCs to deepwater port terminal facilities at various locations in the Caribbean and then transported to St. James via small tankers. Each of these methods would require 47 trips up the Mississippi River to St. James to achieve one fill cycle if 45,000 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 47 transfer operations. Spills occur approximately once in each 18 transfers; spill volume rate is estimated at 3.0×10^{-6}. Thus, 2.6 spills, totaling 42 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 3 percent chance of occurring from this mode during the life of the project (13 spills times 0.19 percent chance).

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 St. James because pumping rates are greater and sea-state conditions are more hazardous.

Transport Between VLCC and St. James

Transport of oil between St. James and the VLCC involves approximately 175 miles of travel in the Mississippi River (via Southwest Pass), and 5 to 10 miles in the Gulf of Mexico. For transport by 45,000-DWT tankers, the accident rate is considered to be 0.078 per vessel/year. The vessel transport time is estimated at 5 days round trip. Average spill size is taken to be 428 barrels (U.S. Coast Guard, 1973). During each fill operation, the total number of expected spills is therefore 0.05 (1 chance in 20), and total expected spillage is 22 barrels. During the life of the project, therefore, the total number of tanker spills in the Mississippi River is 0.25 (1 chance in 4), and total expected spillage is 110 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 0.5 percent chance of occurring with tankers.

Transfer in the Mississippi River

Transfer from 45 MDWT tankers to the tank farm at St. James will take place while these vessels are secured at existing dock facilities. Total spillage volume is estimated at 1 X 10 units per unit transferred, or 14 barrels per fill (70 barrels over the life of the project). Spill frequency is estimated at once in 90 offloadings. This yields an estimated 2.6 accidents averaging 27 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 1.4 percent chance of occurring.

Maximum credible spill size for oil transfer operations at St. James 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 Mississippi River (60,000 barrels maximum; 428 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 (210 barrels total; 13 spills). The total oil spillage expected during five complete fill operations is 387 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 0.45 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 oil transfer equipment for operation at the site (for example, meters, meter provers, remote controlled valves, pressure regulators) are very similar to facilities at a normal oil terminal except for the storage tanks. At Central Rock these "tanks" are underground. Estimated terminal spill probabilities (U.S. historical base) require correlation of the spill exposures with those of the national petroleum industry. The event base is a part of the pipeline spill record. From this base it is estimated that 5×10^{-10} spills per barrel will occur for oil moving through the controls, valves, pumps, and so forth, at both the Central Rock and Tates Creek Terminals (see Appendix F). Five emptying and filling cycles during the life of the program (140 million barrels total movement) indicate an expectation of 0.07 events, or 1 chance in 14 of a spill over the project life at each terminal. For an estimated average spill size of 300 barrels, the expectation of spill volume at each terminal would be about 21 barrels. The 300 barrel average spill size, which is lower than the U.S. average for terminals, is based upon the maximum amount of oil that would be in the terminal pipeline systems at any one time.

Design modifications at Tates Creek Terminal include two 120,000-barrel batch holding tanks for use as surge tanks to interface with the Ashland pipeline. Because of these tanks, higher frequency and larger maximum size spills can be expected compared to those at the Central Rock site. However, the hazard to the environment associated with these spills will be eliminated because of the standard diking system to be constructed around the tanks. The pumping station, which is outside the dike, will present the same risk as the Central Rock operation. Thus, the total spill expectation from each terminal is taken as 21 barrels, with a frequency expectation of 0.7 events during the life of the project.

The tank farms at St. James, Patoka and Owensboro are existing facilities. Spills from storage tanks due to incremental throughput of oil for Central Rock 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 these terminals 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 365 barrels during the assumed 22-year project life and 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 Central Rock 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 2.2 percent (1 chance in 45 or a recurrence interval of 1000 years). During the life of the project, spills greater than 2000 barrels have a probability of 0.0213 (1 chance in 47) of occurring from the pipeline, and less than 0.0002 (1 chance in 5000) at each terminal.

Fume and Vent Control

There is a slight risk of toxic gas (H_2S) escaping during cavern filling. The amount of hydrogen sulfide gas remaining after shipment of a sour crude should, however, be negligible. Combustion of the vented gas out of the cavern through the piloted flare, as planned, will eliminate this remote hazard.

Diking

Petroleum facilities frequently use a peripheral berm or dike around the facility to contain spills. The use of a berm presents additional problems, however, since the dike can collect rainwater as well as spilled oil. Sometimes this rainwater must be released to avoid overflow of the berm. This overflow may be surcharged with oil residue and require treatment to prevent deterioration of the water quality in receiving streams. A sump for storm waters, or shielding of berm areas, can help to control storm water buildup.

Pipeline routes generally are not diked because these dikes would disrupt the drainage pattern of the area.

Fire Losses

The risk of a major fire due to oil storage in the Central Rock system lies almost entirely at the pipeline terminal at Tates Creek because this is the only point of surface oil storage in the system. In the cavern, the oil in storage is virtually insulated from major loss by fire. At the cavern 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 by fire in the national petroleum system is rare (especially for crude oil), but not unknown. The exposure at Tates Creek (240,000 barrels) constitutes less than 2 percent of the storage capacity of the mine cavern. Furthermore, the Tates Creek storage tanks would be in use only one-third of the time during the program and oil released during fire would be contained within the dike system (designed to contain four tanks of oil).

Storage of crude oil in the Central Rock Mine increases the oil handling steps compared to normal petroleum procedures. To this extent, there is a potential incremental increase in risk of injury to the facility personnel. However, these steps (i.e., operating remote control or low pressure valves, and oiling pumps) involve the least risk of operations 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 prevent migration of the oil. If this barrier is broken, gravity or pressure forces provide a mechanism for migration of the oil onto the surface or into the surrounding soil. In cone roof tanks, the roof forms an imperfect barrier, and evaporation provides a mechanism for migration of the oil 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 basic factors: loss of impermeability in the confining walls, and a mechanism for oil migration. In a cavern, however, the impermeability of the storage vessel is provided either by solid rock, or by external water that seals the fine cracks in the rock. Generally, one relies on the integrity of the rock structure to contain the oil. In the case where a shaft has been cut into the cavern for access, gravity forces (as a mechanism for migration) may be replaced by upward displacement (i.e., density flow) of the oil by a heavy fluid such as ground or surface water.

Features of the Central Rock Mine Affecting Oil Spill Risk

The Central Rock Mine has been excavated from massive limestone formations between elevations of 640 and 670 feet MSL by the room and pillar method. Ground level of the rock overburden is about 945 feet MSL. A vertical shaft extends into the mine from the surface, and a sloping shaft extends into the mine from an old quarry, the bottom of the quarry being about 795 feet MSL (Figure 2.2-3).

The limestone rock in the caverns is stable, relatively impermeable, and has very little rockfall. Three faults and several large voids must be sealed before storing any oil. Except for a very small inflow of water, mainly by drainage through the existing shafts, the mine is dry. There is a zone of karst formation in the limestone in the upper 100 feet nearest the surface. Water inflow to the deep mine caverns from this cavernous zone is a potential risk. The location of the site is at the highest point along the local watershed, which prevents significant surface flooding of the site. Surrounding areas are urbanized (light industrial and some residential). In this area, surface water flow could be produced by broken water mains and/or storm drains.

Risk of Catastrophic Spills from Storage Cavern

The intended oil storage caverns are 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 downhill and/or float on the surface water. If it reaches ground water levels, it may not have a significant pressure gradient for lateral migration, other than local diffusion into aquifer sands.

In order to prevent water from entering the storage cavern, the existing vertical and inclined shafts will be sealed. The inclined access tunnel will be completely sealed from the quarry floor. The pump shaft will be sealed by grouting and by seals in and around the pump casing.

Surface Water - With shaft seals, there is very little surface water exposure for the cavern. Catastrophic spills from flooding of local streams cannot occur (see section 3.3). The most serious condition would be due to a major surface water spill -- such as a storm drain break -- that might run into the quarry, filling that depression. The sealed access tunnel will be designed to prevent water from flowing into the mine.

Ground Water Inflow - Small amounts of water flow into the mine cavity through the existing shafts. It is expected that sealing of the shafts will eliminate all water inflow. If this does not occur, provision will be made to withdraw this water from the cavern sump. The water withdrawn would have to be treated to reduce oil content and other impurities before discharge.

Ground water inflow through a broken pump shaft casing would not displace much oil from the cavern. Upon entering the casing, the water would flow down the pipe and fill the sump to the level of the pipes. At that point, a water seal would be formed (one may already exist, preventing any oil outflow). The small amount of oil displaced would rise in the pipe until its hydraulic head was balanced by the ground water hydrostatic pressure. A small amount of oil could migrate into the surrounding soils, but there would be little lateral pressure gradient to facilitate movement.

The key to the shaft seals is the integrity of the grout along the shaft. If fluids cannot migrate up the outside of the pipe through the grout or the grout-rock interface, it does not matter if the pipe should rupture at a single point. A special inspection will be necessary to detect leaks in the casing wall since it cannot be inspected on the outside. During construction, such special inspections for casing and grout integrity can consist of hydraulic pressure testing and nondestructive wire line probe methods.

Overfilling of the cavern with oil can be a danger to the cavern seals, particularly if there is a great inflow of ground water. When all voids in the cavern are filled, ground water pressure could be impressed on the cavern and the seals will have to support this pressure. Standard designs avoid this problem by utilizing a gas space in the cavern over the oil surface.

The present design utilizes six separate, small-diameter shafts instead of a single, large-diameter pump shaft. This design prevents shaft collapse and the accompanying massive rock fall and possible displacement of oil to the surface or aquifers. Thus, a massive shaft plug is not required to prevent catastrophic oil loss.

Lateral Cavern Failure - Since the limestone rock is not considered to be absolutely impermeable, but derives its barrier properties from the water seal within the bedding planes, a very small amount of lateral oil migration could occur. The quantities which might escape the cavern would not be great enough to constitute a significant loss of storage capacity or a source of pollution to ground water aquifers. If the new limestone mine were excavated very close to the existing mine, or below it, migration of the oil could create hazardous working conditions in the new mine. Small amounts of oil seeping into the new mine would create a fume and gas hazard. This potential would require a routine inspection of the new workings. The planned separation distance between mines will eliminate this hazard. MESA is presently preparing separation criteria which must be followed.

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 would be no obvious flame ignition sources in the mine, but potential sources can be hypothesized: static electricity (rock being an insulator), 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. None of these sources seems likely for the Central Rock Mine, although they cannot be ruled out entirely. The alternatives for safe storage conditions are either to inert the atmosphere before filling and after withdrawal, 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 gas explosions are caused by the enormous total forces generated over large areas, in contrast to an explosive device that creates a sudden high overpressure over a localized area.

It has been estimated that maximum overpressure from petroleum vapor explosions may be as high as 150 psi (Macreagh, 1976). European practice is to design shaft plugs and seals to withstand 10 atmospheres. Lithostatic pressures of the rock over Central Rock Mine range from a minimum of 160 psi to over 250 psi. Rock structures in the cavern should 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). Pressures greater than 160 psi could affect cavern structural integrity (see section 4.3.1).

Transport and Storage of Mining Explosives - There is potential for some risk to aboveground workers and facilities at the Central Rock storage terminal as a result of the transport of explosives used in mining limestone rock. Up to 20 tons of ammonium nitrate explosives (amphoprill) are used monthly. 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 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 peek overpressure one-half 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 one-half mile of the detonation may be injured or damaged.

Based on historical data, the accident rate for truck shipments of hazardous cargo is about 1.7 incidents per million vehicle miles (Brobst, 1972). However, ammonium nitrate is difficult to detonate accidentally; at most, no more than 2 percent of the transport accidents at Central Rock Mine are projected to result in a detonation, and even this estimate may be high. (1.5 percent of all accidents in the data base resulted in cargo fire damage.) Thus, assuming that each delivery involves one-half mile of travel exposure to the site and that there are 12 deliveries per year, the probability of a detonation of the truck within damage range can be estimated at 2×10^{-7} per year, or a recurrence frequency of once every 5 million years (i.e., 1 chance in 227,000 during the life of the project).

The incremental risk to personnel and facilities (above that calculated elsewhere in section 4.3.8) is negligible. A detonation near the terminal can be assumed to create oil spill potential through penetration of pump casings, piping, etc., by shrapnel, or cracking of piping and connections by blast shock. For a detonation in the quarry bed, very little damage to the storage program facilities may in fact occur. The walls of the quarry may deflect shock and fragments. The shaft seal in the quarry could be cracked, but it would be unlikely that any hazard exposure to the stored oil, such as fire, could be generated. There would be no loss of oil to the environment through the quarry shaft seal.

Personnel exposure to explosives-related risk (other than the present risk to mine personnel) is limited to the few workers present during project operations (8 to 10 during pumping, 2 or 3 during standby) and the construction work force (as many as 180) during project construction. If the decision is made to shut down the mine for a 20-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 limestone mine, the mechanisms of oil release would have to be equivalent, differing only in time frame. However, oil in storage can, under adverse conditions, deteriorate.

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 on 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 offer some habitat for bacteria.

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 is constructed at the sump to reduce sludge intake. Loss of stored oil due to sludge buildup can be considered a very minor hazard to the stored oil. The shelf life of the stored oil, even with sludge buildup, is considered to exceed the expected lifetime of the project.

4.3.8.6 Movement and Dispersion of Spilled Oil

Spills at the Site

Spills at the Central Rock site could result from rupture of the piping system between the pipeline manifold and pump shaft, such as in the metering units or the booster pump manifolds. The main lifting pumps will be submerged in the cavern and any failure in these units would be confined to the cavern. The oil transport system is composed of lines of various sizes, up to the mainline diameter of 16 inches. The maximum oil volume in the piping system at the site will 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 1000 barrels. Larger amounts of oil could be spilled through small chronic leaks; routine inspection of the system and site will prevent these leaks. Since the main 16-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 2500 barrels.

If a 2500-barrel spill breached the containment berms, the spilled oil could flow rapidly through the storm sewer system and into area drainage streams. In the sewer system, there would be a fire hazard that would require monitoring of the area by the local fire department. Oil spill damage would be confined to the receiving streams of the watershed, which constitute the most ecologically sensitive targets of these spills.

Pipeline Spills

The ultimate receiving waters for spills along the pipeline route between Central Rock Mine and Tates Creek would be the Kentucky River. In evaluating spills for these areas, a maximum credible pipeline spill of 2500 barrels has been used. A 2500-barrel spill has the potential of spreading and polluting up to 25 miles of a stream, assuming a nominal channel width of 80 feet. The most damaging impacts (oil densities of over 8 barrels per acre) could occur along 12.5 miles of the stream channel. Removal of the oil at "cleanup strike points" along the stream would reduce this damage potential (see Appendix G).

The ultimate receiving waters for spills from the Capline or Ashland pipelines depends on the location of the spill. Major crossings include the Kentucky, Ohio and Mississippi Rivers. However, oil would most likely be spread over the ground or dispersed in small streams or lakes without reaching these rivers as an identifiable spill. Areas exposed to oil spills would be the same as are currently exposed by oil pumping and handling operations.

The presence of karst areas along the pipeline route presents a risk to the pipeline itself. Exposure of the Central Rock pipeline to karst areas presumably increases the risk above the national average, but there are no data to quantify the additional risk. However, spills due to karst collapse should not present an undue environmental hazard to the surface because a break in the line should result in most oil being confined within the karst cavity and local shallow aquifer, which is not a primary source of water in the area.

The high seismic risk areas crossed by the Capline and Ashland pipelines (Figure 3.2-6) also present an additional hazard to transport of oil through this region. However, damaging earthquakes have not occurred with any great frequency and there is no data to base an estimate of additional oil spill risk exposure. The assignment of high seismic risk is primarily due to the New Madrid earthquakes of 1811-1812.

Tanker Spills

Most of the Mississippi River has a pronounced spoil bank, which would contain the spilled oil until a natural drainage path is intersected. Such drainage paths are numerous in the lower delta (below Venice) and the movement of water along them is generally toward the Gulf. 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 45 MDWT capacity. Total loss from a tanker casualty is very unlikely, especially in the Mississippi River, 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 Mississippi 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 the Gulf of Mexico, the pill would be carried by surface currents and winds. In the vicinity of the probable VLCC-tanker transfer station, surface currents are predominantly toward offshore as a result of the strong flow of the Mississippi River.

A spill of up to 60,000 barrels as a result of a tanker accident in the lower Mississippi River or in the Gulf of Mexico would be rather quickly carried into the Gulf through one of the passes. From there, currents could carry the oil in almost any direction, though little of it would be expected to be transported directly to shore.

If a spill should occur above the Head of Passes, oil could reach Main Pass, Pass a Loutre, South Pass, or any of several smaller distributaries of the Mississippi River. From these passes, the currents are not very strong, and the chance of immediate landfall in the valuable wildlife refuges and management areas is higher. The 1680 acres of marsh that could be lost represent 1.5 percent of the area of the Delta and Pass a Loutre reserves.

Spills of up to 500 barrels could occur during oil transfer operations at St. James, and up to 1000 barrels in the open waters in the Gulf of Mexico. If the oil should reach the marshes of the Delta, as much as 40 acres of vegetation could be destroyed. These fresh marshes are prime habitat for waterfowl, especially the Delta National Wildlife Refuge and the Pass a Loutre State Waterfowl Management Area on the east side of the delta. The water column and substrate offshore are not highly productive areas because of heavy sediment loads and fluctuating river flow conditions; impacts of oil spilled during transfer operations should not be significant in these locations.

It is impossible to accurately predict actual bird and mammal mortality within the project area without quantification of wildlife populations and monitoring of indirect effects created by an actual spill. The greatest impact to wildlife populations will result from habitat loss. Loss of food sources and other indirect effects, such as subjection to predation where organisms are forced to occupy marginal habitats and competition resulting from forced immigration into already occupied habitats, will adversely affect wildlife populations.

The magnitude of effects of a spill on cropland or pasture habitat is dependent on the season of the year in which the spill occurs. Effects on resident wildlife are greater during the nesting season (the spring and summer months) for such species as ground-nesting birds (quail, meadowlark, and killdeer). Affected mammals include small rodents such as voles and shrews. Species which utilize the habitat for travel lanes or as a food source are also affected; such species include grackles, blackbirds, sparrows, rabbit, opossum and red fox.

Resident woodland wildlife species likely to be most directly affected by a spill causing habitat loss include the short-tailed shrew and white-footed mouse. Bird species which utilize the wooded habitat for food and roosts include cardinals, robins, crows, blackbirds, and starlings. Mammal species affected would include squirrels and opossum.

Seasonal factors will determine whether eggs and larvae of fish and larger invertebrates are present, and the degree of loss related to the aquatic biota. Loss of any biota in the 80 acres of habitat will be insignificant when one considers the overall amount of productive area present and the infrequency expected for such large spills. Repeated occurrences of spills would be a serious threat to the local environment, but statistics indicate that there is only a 1.0 percent chance that even one such incident would occur during the project lifetime. Repetition of such an event, especially at the same location, is extremely unlikely.

4.3.8.7 Oil Spill Impact on Surface Waters

During the operation of the project, the most significant impact on the surface waters of the Central Rock area would be caused by an oil spill. A spill could occur at the storage site, at any point along the pipeline, or at the Tates Creek Terminal (Table 4.3-2). An average size spill (along the pipeline) is estimated to be 1000 barrels; the maximum spill size is estimated to be 2500 barrels.

If a large spill should occur at the mine site or along the pipeline sections crossing Town Branch, Wolf's Run, Steeles Run, Manchester Branch, Cave Creek and the upper reaches of South Elkhorn Creek, the oil would eventually flow into Elkhorn Creek and subsequently into the Kentucky River (see Figure 3.3-2). A relatively small spill could be contained at the Old Grand Dad Distillery impoundment on Elkhorn Creek near Frankfort. Average flow conditions in these creeks are about 0.6 to 0.8 feet per second.

A spill that occurs at Tates Creek Terminal or in the pipeline sections that cross West Hickman Creek would flow into Hickman Creek and then into the Kentucky River. West Hickman Creek also has average flow velocities of about 0.8 feet per second.

The distance along the stream bed from the headwaters of both South Elkhorn and West Hickman Creeks to the Kentucky River is about 30 miles. Therefore, during periods of normal stream flow, it would take an oil spill about 55 hours to travel this distance. During high flood flows, when stream velocities reach 3 to 4 feet per second, a spill could cover this distance in about 11 hours. Thus, the worst case condition would be a maximum spill (2500 barrels) during a high flood period. This spill would be quickly carried downstream by the high flow velocities and could affect the entire water course, including the Kentucky River.

It is assumed that the "cleanup" strike force could be ready to commence cleanup and recovery action within 8 hours from the initial detection of a spill. During this mobilization time the spill could travel approximately 5 miles during normal flow periods and more than 20 miles during high flows. Locations of major cleanup activities would be planned accordingly.

In addition to ecological impacts (see section 4.3.8.8), an oil spill reaching surface waters around the Central Rock site would affect the downstream water uses. A major impact could occur to the Old Grand Dad Distillery impoundment on Elkhorn Creek and to the domestic and municipal water systems along the Kentucky River. Municipal water systems would have to provide additional charcoal 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 treat or to shut down the source of supply. Factors such as time, extent and degree of contamination, and the type of oil are important. The period of time over which the contamination occurs and the duration of pollution after the spill are very important. When a slug of oil moves quickly downstream, the problem of downstream water supply is important, but the degree of contamination may be less because of dispersion and "dilution" of the spill and the reduction in the amount of oil at any one point in the water body. The degree of solubility of the oil and taste and odor problems may lead to difficulties in treatment for small municipal or industrial systems. The river intake may be shut down for a short period of time, or water may be withdrawn from below the surface for use. If alternative water supplies are available, the river intake could be closed for several days to allow the oily water to move further downstream.

Oil may also reach surface waters as a result of a spill from the Capline or Ashland pipelines or from marine transport in the gulf of Mexico or Mississippi River (Figure 2.3-8). The diversity of stream types and flow conditions prevent any detailed 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.

Low molecular-weight hydrocarbons and aromatics are the most immediately toxic components of crude oil. 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. Also, 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. As a result, this portion of crude oil will sink and may physically and chemically affect bottom organisms.

Dissolution in the water column is selective for low molecular-weight hydrocarbons and aromatics as well as for some of the non-hydrocarbon components that are more polar. Most of the soluble materials go into solution in a relatively short time, but additional soluble material is produced later from biological and chemical oxidation. The solubility of the normal alkanes ranges from 40 ppm for C_6 molecules to 0.01 ppm for C_{12} molecules. For aromatics, solubility ranges from 1800 ppm for C_6 (benzene) to 0.075 ppm for C_{14} (amtracene).

Emulsifications, which are crude oil globules in water columns, are dispersed easily by currents and, it is believed, eventually dissolve or sink to the sediments after contact with suspended solids.

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 storm weather, which disturb 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 first and aromatics last. A supply of nitrogen, phosphorus, and oxygen is needed. In areas where oxygen concentrations are low, biodegradation is a very slow, gradual process.

4.3.8.8 Ecological Impacts of Oil Spills

An oil spill from the Central Rock oil transport system will affect the terrestrial and aquatic resources of the area by direct oiling of the soil, vegetation, and individual organisms. The most significant terrestrial impacts are likely to occur to vegetation, mammals, and 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 Central Rock storage system, the terrestrial environment 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 Kentucky, Ohio or Mississippi, or which flow into lakes and reservoirs, the potential impact of oil spills on the aquatic environment cannot be disregarded. Each of these systems is discussed below with respect to vulnerability, oil toxicity, biological recovery, and effects of chronic and maximum credible

Relative Vulnerability of Organisms

Vegetation - Plants can be very susceptible to oil damage; the actual impact depends on several factors, such as: 1) species and age of plants; 2) time of year and whether the plant is in a dormant or active-growth stage; 3) amount and type of oil; and 4) degree of weathering of the oil. Vegetation is damaged primarily by direct toxic effects of dissolved oil fractions entering the plant and by physical coating of the plant. The growing season for the Lexington area is relatively long, averaging 200 days. While the most active period of growth probably occurs during the spring and summer months, it appears that plants are vulnerable to some degree during a large portion of the year.

The main vegetative communities that are likely to be impacted by an oil spill consist of a large variety of small, low-lying crops, grasses, herbs and shrubs which grow in abundance in close proximity to the oil storage area and pipeline. Emergent aquatic plants in the shallow waters of the streams could also be coated with oil, but an oil slick might not be stationary long enough for significant amounts of oil to accumulate on these plants. Forested areas, because of the height of trees and deeper roots, would be affected to a much lesser extent than would croplands, grasses, herbs, and shrubs. Only minor damage would be likely to occur to vegetation; more damage is normally attributable to the clean-up procedures than to the direct impact of the spilled oil.

Terrestrial Wildlife - The direct effects of oil spills upon land mammals are generally limited, since most land mammals are highly mobile and can easily escape spills. Those animals that cannot readily escape may be killed by direct contact of oil products with the skin, by suffering chemical burns from being coated, or because of ingestion of contaminated foods (Texas A & M University, 1972).

Indirect effects are not easily avoided. Large spills on land may adversely affect a variety of habitats, making it necessary for animals to leave the area. Although it may appear that there is other suitable habitat for the animals to occupy, this is not always true. All habitats have a carrying capacity that limits the number of organisms which can be supported without placing stress on individuals living in that area. Forced, abrupt shifts of populations may cause adverse effects on both the migrant mammals moving into the area and those already inhabiting the site. Deaths may possibly occur from overcrowding, starvation, predation, competition, and disease.

The mammals most likely to be affected by an oil spill in the woodland areas near the project are the opossum, raccoon, gray and red squirrel, and skunk. Field and pasture mammals affected would include rabbits, groundhogs and foxes. Wetland mammals in habitat along the stream banks include the muskrat and mink. Upon being fouled with oil, these furbearing mammals would experience loss of insulation. Because mammals depend more on fatty deposits than on fur for insulation, this loss would not be as serious as with birds. However, any loss of food or habitat due to oil effects would be detrimental.

Crude oil spills can affect reptiles and amphibians in many ways. For example, direct contact of oil with the skin of some species of frogs and toads that breathe through their skins may affect respiration and result in death. Large land spills adjacent to aquatic habitats are likely to spread rapidly across wetland areas and may kill much of the vegetative cover that serves as habitat for many species. An oil spill may also kill insect species that are aquatic during reproductive cycles and which provide food for other species.

The direct effect of oil on birds frequenting the storage area, pipeline corridor, and terminal facility is likely to be small. These birds are highly mobile, and can avoid the contaminated land. Waterfowl are relatively scarce in the vicinity of Central Rock Mine (Durrel, 1976); however, the fresh and brackish marshes of the lower Mississippi River delta are habitat for large numbers of waterfowl in winter months. Ground-nesting and ground-inhabiting species of birds could be seriously affected by an oil spill, particularly if it were to occur during the nesting season. Large spills on land would also indirectly affect all birds that utilize the area for foraging purposes. Bird species that would be affected by an oil spill at Central Rock include the mockingbird, bluejay, redbird, blackbird and swallow, martin, robin, owl, crow, dove, quail and starling.

Domestic Livestock - Oil spills from the pipeline would have little direct effect upon livestock. Destruction of food would be the greatest effect, and grazing would have to be suspended until food grasses were reestablished. The relative acreage of pasture grasses affected would be insignificant, however.

Aquatic Organisms - Vulnerability of aquatic organisms to oil spills is largely a function of their proximity to the source of the spill and their ability to escape contaminated areas. Extent and duration of the spill are, therefore, important variables in their vulnerability. It is probable that, in the smaller streams, most aquatic organisms could not avoid contact with oil released in an accidental spill. Sessile organisms would be somewhat more susceptible to prolonged contact than would the more mobile forms. However, given the relatively high gradient (current velocity) of the smaller streams, even the most mobile fish would have little time to avoid contact with oil contaminants from any sizable spill. Only those fish able to enter unaffected tributary streams would escape.

If oil were accidentally released into one of the local streams, plankton would be killed quickly (particularly those species that inhabit the surface layer). Fish would die off over a period of several days, since most toxic fractions of the oil are retained for 48 to 96 hours (McKee and Wolf, 1963). In large streams, the benthic invertebrates would be least vulnerable to oil spills because they are furthest from the surface. However, if the spill were large enough, various oil fractions would contaminate the sediments and kill many of the organisms because they are not highly mobile and are less able to avoid contaminated areas. Also, if soluble hydrocarbon fractions dissolved into the water, the vulnerability of benthic organisms would be increased significantly.

Fish species in the Kentucky River expected to be impacted by an oil spill include suckers, crappies, white perch, and catfish. Some of the small private lakes in the area contain other game fish.

Relative Toxicity of Oil and Petroleum Products

Terrestrial Vegetation - The effect of oil pollution on vegetation can be either acute or chronic. Acute pollution would result from a major pipeline break, an accidental spill at the storage facility, or a spill from the terminal. Cowell (1970) described two possible forms of chronic pollution: 1) that resulting from successive spills occurring at a frequency which does not allow complete recovery; or 2) that resulting from a continuous discharge of low levels of oil and effluents, such as those from refinery outfalls. Baker (1971a) has concluded that a single oil spill does not cause long-term damage to marsh vegetation. However, successive spills result in a rapid decline of vegetation vigor and productivity (Baker, 1971b). Vegetative species vary considerably in their tolerance to successive spillage, with annuals being the most susceptible and perennials more tolerant.

The primary effect of an oil spill on vegetation is formation of a film which is difficult to wash off. The film forms on the plant, causing the leaves to turn yellow. Seedlings and annuals seldom recover from oil spillage, but perennials are capable of producing new shoots from the base, some within 3 weeks after contamination (Cowell, 1971). Seed germination of marsh species is reduced and flowering is inhibited when oiling of vegetation occurs during floral induction (Baker, 1971c).

Aquatic Biota - Toxicity of oil and petroleum products to aquatic biota is dependent in large part upon the amount of oil that dissolves into the water. Oil that is in solution is in direct contact with the organisms. Also, the most toxic fractions of the oil (aromatic fractions) are the most soluble. Once the oil is in the water, toxicity is a function of the quantity and characteristics of the oil, the quality of the stream water, and the sensitivity of the target organisms.

The harmful effects of oil substances on aquatic life may result from any of the following actions (McKee and Wolf, 1963):

1. Free oil and emulsions acting on the epithelial surfaces of fish, i.e., adhering to the gills and interfering with respiration. Within limits, fish have a defensive mechanism to combat such action; they can secrete a mucuous film to wash away irritants. If the concentration of oil is too heavy, oil will accumulate on the gills and cause asphyxia (Cole, 1941).

2. Free oil and emulsions coating and destroying algae and other plankton, thereby removing a source of fish food. The coated organisms may agglomerate with suspended solids and settle to the bottom of the stream.

3. Settleable oil substances coating the bottom, destroying benthic organisms, and interfering with spawning areas.

4. Soluble and emulsified material, ingested by fish, tainting the flavor of the flesh.

5. Organic materials deoxygenating the waters sufficiently to kill fish.

6. Heavy coatings of free oil on the surface interfering with the natural processes of reaeration and photosynthesis. Very light coatings would not be detrimental in this respect, however, because currents and other turbulence would maintain adequate rates of reaeration.

7. Water-soluble fractions acting directly and toxically with fish or fishfood organisms.

Biological Recovery

Terrestrial Vegetation - Information pertaining to recovery of vegetation after an oil spill is limited. Biological degradation of crude oil appears to be an important factor in vegetational recovery after a spill. Degradation is related to crude type, ambient temperature, and soil microflora; therefore, recovery rate would be influenced by temperature and climate. It must be assumed that factors influencing damage would be similar for the two major vegetation types (pasture grasses and hardwoods) associated with the proposed facility.

Aquatic Organisms - Because of the relatively high reproductive rate of algae and macroinvertebrates, recolonization of plankton and periphyton communities will usually begin as soon as the oil dissipates, as long as toxic materials do not remain. Fish communities are somewhat slower to recover, depending on the extent of damage and the availability of nearby populations that could recolonize the area. In most cases, it is likely to take at least several months for a fish community to recover.

The recovery rate of benthic communities may be slower than that for other components of the aquatic ecosystem. Studies by Shultz and Tebo (1974) and the National Academy of Sciences and National Academy of Engineering (1972) indicate that it is reasonable to predict that 6 or more months will be required for benthic communities to recover from a damaging spill.

Seasonal Factors Influencing Oil Spill Damage

An oil spill in any season would directly affect the terrestrial species using the area during that season, and would indirectly affect those species that would be prevented from using the area during a different season because of habitat destruction.

Damage to aquatic biota from an oil spill will vary seasonally to some extent. During dry periods, concentration of oil in the stream would be inversely related to stream flow, as would the resultant toxic effects. During high flow, there would be greater dilution, and toxic effects of the spill would be decreased. Damage could also be expected to be greatest in the spring and summer, when biological productivity is high. Larval and juvenile fish would be more susceptible to toxic effects of the oil, and less likely to escape, than adults. Also, spawning behavior could be inhibited. Other seasonal effects on the toxicity of an oil spill would be related to synergistic action of the oil with other compounds in the water as they relate to temperature. Generally, the higher the water temperature, the more toxic a compound will become.

Effects of Chronic Oil Pollution

Terrestrial Ecosystem - Little information is available regarding the predicted action of chronic oil spills on the terrestrial environment. Such a prediction would require information regarding a number of the parameters involved, such as soil texture, soil density, ambient moisture conditions of the soil, type of crude involved, age and amount of crude, and type and amount of vegetation present.

Duration of an oil spill along the pipeline corridor would be dependent upon the nature of the break. Release of oil from the pipeline as a result of a small leak would result in oil seeping slowly along the path of least resistance. Detection of subsoil or subterranean oil might be somewhat difficult, and location of the break even more difficult.

If a major pipeline break occurred, a surge of oil would be readily apparent and oil would spread over a much larger land surface than it would in a small spill. Duration effects of a larger spill might be considerably longer than for a small, well-contained spill. The point of break would be extremely critical in regard to the spreading of oil in the terrestrial ecosystem. Once oil enters the ecosystem, its spread would be dependent upon the amount and chemical nature of the crude, as influenced by such factors as oil viscosity, temperature, pipeline pressure, gradient, and vegetative cover.

Aquatic Ecosystem - The accumulation of hydrocarbons in organisms over a long time is probably one of the most serious chronic effects of oil pollution. In many cases, the effects on the organisms are obscure; however, the tainting of flesh is a common result that is easily noticed. Less noticeable may be changes in behavior, fecundity, activity, or resistance to disease. Another possible effect of chronic oil pollution that has not been conclusively substantiated is its carcinogenic effect. Known carcinogens exist in crude oil; in several cases, carcinogens have been found in the tissues of barnacles and oysters associated with oily wastes. Furthermore, fish with lesions, possibly cancerous, have been observed in areas exposed to oil pollution (Murphy, 1971). The possibility, therefore, exists that carcinogens or other hazardous compounds from oil pollution could be transferred through the food web to man.

Effects of a Maximum Credible Spill

A maximum credible spill resulting from pipeline failure (between Central Rock Mine and Tates Creek) or terminal accident is expected to be 2,500 barrels. For estimation of impacts, it is assumed that 10 percent, or 250 barrels, would evaporate and another 10 percent would dissolve in water bodies or sink to the stream bottoms.

A review of the literature reveals that no study presently predicts 100 percent damage to the terrestrial environment at concentrations of less than 25 barrels per acre. Much higher concentrations are normally needed to cause 100 percent loss of productivity. In order to be conservative, however, we can assume that 25 barrels per acre of fresh crude oil will result in total loss of vegetation within the affected area for periods varying from

2 to 5 years. With this assumption, therefore, it would appear that 2000 barrels could effectively destroy vegetation on 80 acres of pasture. It is unlikely, however, that the oil would spread across 80 acres, unless soils were saturated and slopes were high. A more typical coverage would be 80 to 160 barrels per acre, or coverage of 12 to 25 acres.

A maximum credible spill from either the Ashland or Capline pipelines 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 vegetation cover.

A maximum credible spill resulting from the sinking or heavy damage to a 45,000-DWT tanker while in transit between St. James and the Gulf of Mexico is expected to be 60,000 barrels. Because of the generally strong currents in this area, much of this oil could reach the passes and Gulf of Mexico before effective spill control equipment could be developed. Assuming that 20 percent evaporates and 10 percent dissolves or sinks, a potential 42,000 barrels of oil might remain at the surface within the delta 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 fresh marshes of the lower delta are prime water fowl habitat, especially to the east in Delta National Wildlife Refuge and the Pass a Loutre Management Area. Also exposed to an oil spill in this vicinity is the Breton National Wildlife Refuge on the Chandeleur Islands to the north.

An oil spill that reaches Southwest Pass of the Mississippi River would be carried strongly offshore to the southwest. From there, it should take several days before landfall might occur, and the chances are that the oil would follow the westward-trending current offshore. This is the most likely fate of a tanker spill.

Effects of Rehabilitation and Disposal of Oil Spill Debris

Indiscriminate clearing of vegetation or earth clearing (moving) has been found to make final efforts for rehabilitation of the land a larger problem compared to the small amounts of spilled oil recovered. Removing oil soaked soil and replacing it with clean soil is satisfactory only when it involves small areas and is not a reasonable alternative if a spill occurs over a large area or on forested lands; the problem of transporting and disposing of oil soaked soil in areas such as sanitary landfill still remains. It has been found that it is not necessary to completely remove grasses, trees or shrubs from a spill area. Vegetation should first be checked to determine the extent of the damage before the land is cleared, since some or most of the vegetation may recover later on in the growing season or during the next year if the root systems have not been extensively damaged. The rehabilitation and revegetation programs needed to revitalize an area affected by a spill would be designed to reestablish the natural vegetation and productivity of the area affected. These programs would be based on expert evaluation of the vegetative damage and would use proven techniques to rehabilitate the area with endemic species.

Basically, four types of techniques are used for the land disposal of spilled oil, in addition to the actual reclamation of at least part of the oil. These techniques include burning, land filling, burial, and land spreading of the oil.

The burning of oil in the near surface soil layers has been found to be relatively successful as a cleanup technique. Burning of spilled oil before landfilling has been practiced in some areas, but this method should not be used unless an evaluation has shown that all of the affected vegetation (trees, grasses, herbs, etc.) has been killed. Areas that have been burned off following a land spill must be recultivated to break up the resultant hard surface crust which forms on the soil and additional plant nutrients (such as nitrogen and phosphates) and other soil conditioners (such as pH balance) must be used to rehabilitate the soil so that new vegetation can be quickly established.

Spreading hay and straw on the oil contaminated surface area has also been successful in some cases to help establish new plant growth. It has been observed that the root stems of vegetation have grown through the oil-soil interface if this interface is not too thick.

Sanitary landfilling or burial of oil spill debris may also be used to dispose of the contaminated material. This technique requires the availability of sanitary landfill areas and also the use of large machinery and manpower to transport the oil debris to the landfill in the event of a spill that covers a wide area. Possible problems associated with landfilling include the leaching of the oil into the ground water, the displacement of the oil to the surface by rainwater, or fire hazard by ignition of the oil debris in the landfill.

The burial of oil in surface soil layers is similar to sanitary landfilling, but the burial of oil has not been found to be very successful as a cleanup method in very wet areas such as marshland or in areas with water tables very close to the surface. Crude oil does not appear to be readily absorbed into the soil in these areas and the oil can sometimes rise back up to the surface through capillary action or float to the surface if rainwater percolates through the soil.

Landspreading of the spilled oil can be utilized at the site of the spill or in other land areas where the soil is at least eight inches deep and where land slopes are not greater than 6 percent (Farrow, Ross and Landreth, 1977). Bacteria can decompose the oil when the oil is mixed with soil where oxygen, nutrient, pH, and moisture conditions are satisfactory. It has been reported that landspreading should not be used in areas subject to erosion or flooding since the oil pollution may then contaminate additional areas.

Landfarming studies reported by Cresswell (1977) have shown that biodegradation rates for oil in soil are comparable to those for water environments, but degradation is a relatively slow process. Oil mixed into the upper six inches of topsoil to a concentration of 5 percent will degrade at a rate of about 60 barrels (2520 gallons) of oil per acre per year; ashaltic oils have longer degradation rates than paraffinic oils. Oil tends to stay tightly bound to the soil during degradation and the basic physical-chemical properties of the soil are not altered appreciably by the oil, and normal crops can be grown in soil containing oil concentrations of about 5-10 percent. Many questions, such as the final extent of degradation, nutrient requirements, and effects on producing, however, remain unanswered.

TABLE 4.3-1

Estimated hydrocarbon emissions accompanying transport of oil from Gulf of Mexico to Central Rock 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 $\mu g/m^3$) Distance Downwind (miles)	Total Emissions (tons) [b]
Gulf of Mexico	16	25	9.6	400
Mississippi River	0.8	25	(c)	20
St. James, Louisiana	11.2	25	7.5	280
Tank Farm Terminals:				
St. James	0.15	15	0.45	2.3
Patoka, Illinois	0.15	40	0.45	6.0
Owensboro, Kentucky	0.15	30	0.45	4.5
Tates Creek, Ky.	0.04	500	0.25	21.3

(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. Emissions rates from tank farms are time-dependent; thus fewer tanks at Tates Creek release more total hydrocarbons than at other terminals because of much longer storage times.

(b) Expressed in terms of equivalent weight of oil. One ton equals 6.65 barrels.

(c) Non-point source. Transient concentrations exceeding 160 $\mu g/m^3$ approximately 1.2 miles downwind of tanker location.

Table 4.3-2 Summary of oil spill accident potential, Central Rock storage facilities

	Mode	Expected Number of Spill Incidents per Single Fill Cycle	Expected Number of Spill Incidents During Lifetime of Project	Average Spill Volume Per Incident (bbl)	Volume of Oil Release Expected During Project Lifetime (bbl)	**Maximum Credible Spill (bbl)**
Transportation Between Central Rock and Tates Creek	**Pipeline**	**0.009**	**0.15**	**1083**	**161**	**2500**
	Terminal at Central Rock	**0.007**	**0.07**	**300**	**21**	**2500**
	Terminal at Tates Creek	**0.007**	**0.07**	**300**	**21**	**2500**
	Subtotal	**0.023**	**0.29**	**700**	**203**	**2500**
Transportation Between Gulf of Mexico and Tates Creek	**Pipeline**	**.030**	**0.15**	**1083**	**162**	**10,000**
	Tanker Transport	**.050**	**0.25**	**428**	**107**	**60,000**
	Tanker Transfer:					
	Gulf	**2.6**	**13.0**	**16.2**	**210**	**1,000**
	St. James	**0.52**	**2.6**	**27**	**70**	**500**
	Subtotal	**3.2**	**16.0**	**34.3**	**549**	**-**
						-
	Total	**3.223**	**16.29**	**46.2**	**752**	**-**

TABLE 4.3-3 Probable spill size distribution for pipeline, tanker, and terminal accidents, assuming the occurrence of an oil release

Pipeline Transport
Central Rock to Tates Creek
(Average Size 1083 bbl)

Size Range (bbl)	%Probability
0 - 500	19
500 - 1500	58
1500 - 2500	23

Pipeline Transport
St. James to Tates Creek
(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	47.6
200 - 500	39.4
500 - 1000	10.1
1000 - 2000	2.6
2000 - 2500	0.3

VLCC/45 MDWT Tanker Transfer in Gulf
(Average Size 16.2 bbl)

Size Range (bbl)	%Probability
0	83.9
20 - 50	12.0
50 - 100	3.16
100 - 200	0.75
200 - 500	0.16
500 - 1000	0.03

45 MDWT Tanker Transport
(Average Size 428 bbl)

Size Range (bbl)	%Probability
0 - 200	45.8
200 - 500	35.0
500 - 1000	13.1
1000 - 2000	4.3
2000 - 5000	1.3
5000 - 10,000	0.39
10,000 - 20,000	0.09
20,000 - 50,000	0.017
50,000 - 60,000	0.007

Tanker Transfer at St. James
(Average Size 27 bbl)

Size Range (bbl)	%Probability
0 - 2	3.0
2 - 5	10.8
5 - 10	19.6
10 - 20	26.0
20 - 50	28.2
50 - 100	9.5
100 - 200	2.4
200 - 500	0.5

TABLE 4.3-4 Percent chance of pipeline spills by watershed during the life of the project

	Number of spills during project (by percent)		
	0	1	2
Town Branch	99.697	0.283	0.02
Wolf Run	97.92	1.94	0.14
Steeles Run	98.44	1.46	0.10
Manchester Branch	99.38	0.58	0.04
Cave Creek	98.08	1.79	0.13
South Elkhorn Creek	95.59	4.12	0.29
West Hickman Creek	97.11	2.70	0.19

TABLE 4.3-5 Target species indicating hydrocarbon toxicity

Chemical	PPM	Effect	Species
Aniline	379	None	*Daphnia magna*
Benzene	31	96 hr LC50	*Pimephales promelas*
	22	96 hr LC50	*Lepomis macrochirus*
	32	96 hr LC50	*Carassius auratus*
Cresol	10	96 hr LC50	*Lepomus macrochirus*
Cyclohexane	30	96 hr LC50	*Pimephales promelas*
	31	96 hr LC50	*Lepomis macrochirus*
	33	96 hr LC50	*Carassius auratus*
	48	96 hr LC50	*Poecilia reticulatus*
Ethylbenzene	40	96 hr LC50	*Pimephales promelas*
	29	96 hr LC50	*Lepomis macrochirus*
	73	96 hr LC50	*Carassius auratus*
	78	96 hr LC50	*Poecilia reticulatus*
Heptane	4924	48 hr LC50	*Gambusia affinis*
Isoprene	75	96 hr LC50	*Pimephales promelas*
	39	96 hr LC50	*Lepomis macrochirus*
	180	96 hr LC50	*Carassius auratus*
	140	96 hr LC50	*Poecilia reticulatus*
Nephenic acid	5.6	96 hr LC50	*Lepomis macrochirus*
	6.6-7.5	96 hr LC50	*Physa heterostropha*
Naphthalene	165	48 hr LC50	*Gambusia affinis*
Toluene	1260	48 hr LC50	*Gambusia affinis*
	44	96 hr LC50	*Pimephales promelas*
	24	96 hr LC50	*Lepomis macrochirus*
	62	96 hr LC50	*Carassius auratus*
	66	96 hr LC50	*Poecilia reticulatus*
Gasoline	91	48 hr LC50	*Alosa sapidissima*
	40	96 hr LC50	*Salmo gairdneri*
Cutting oil #2	14,500	96 hr LC50	*Salmo gairdneri*
Diesel fuel	167	48 hr LC50	*Alosa sapidissima*
Bunker oil	2417	48 hr LC50	*Alosa sapidissima*
Bunker C oil	1700	163 hr LC50	*Salmo salar*

Source: National Academy of Sciences and National Academy of Engineering, 1972.

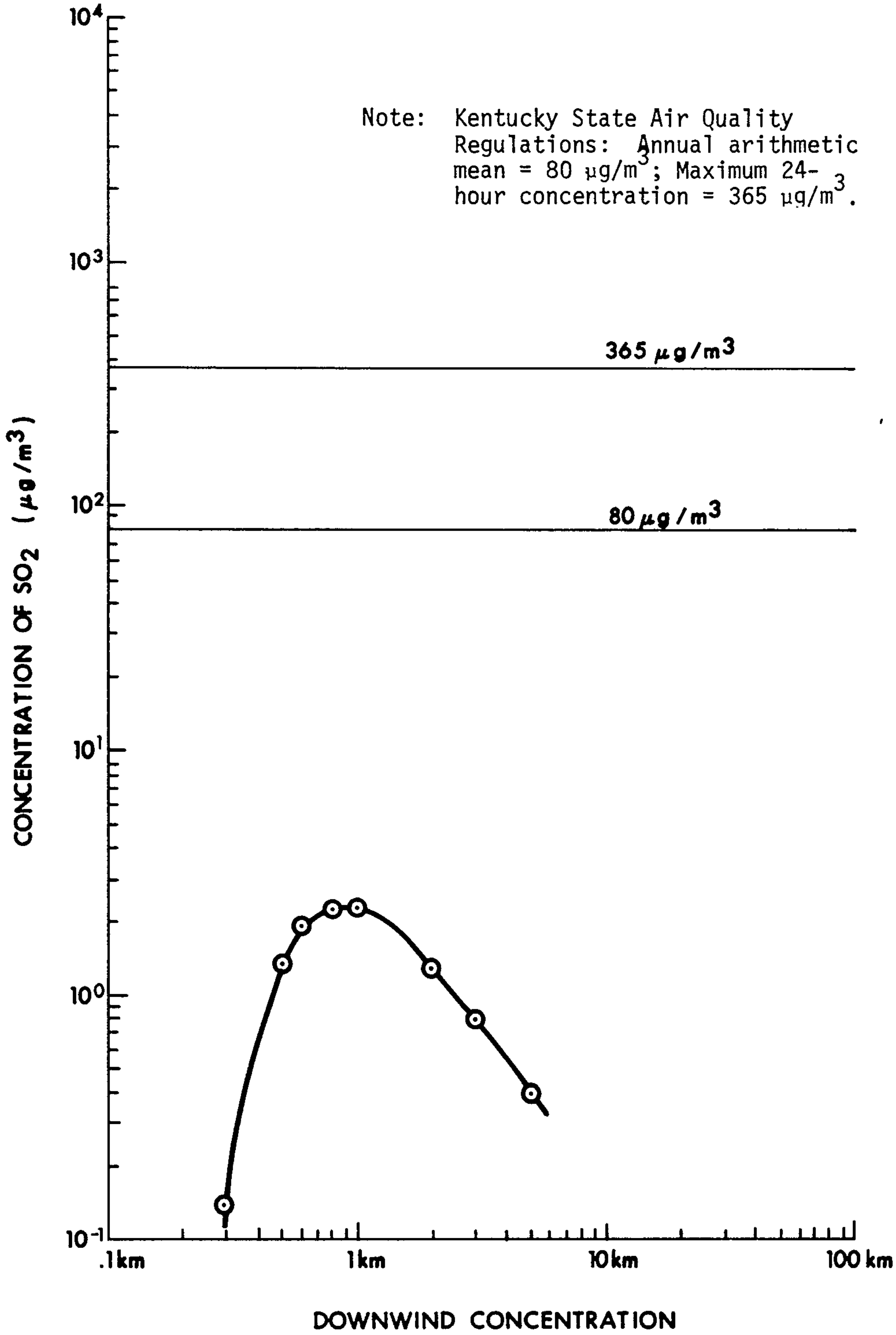


FIGURE 4.3-1 Downwind concentration of SO_2 ($\mu g/m^3$) resulting from flaring (assuming 0.15 gm/sec release SO_2 and 28,000 bbl/day pumping)

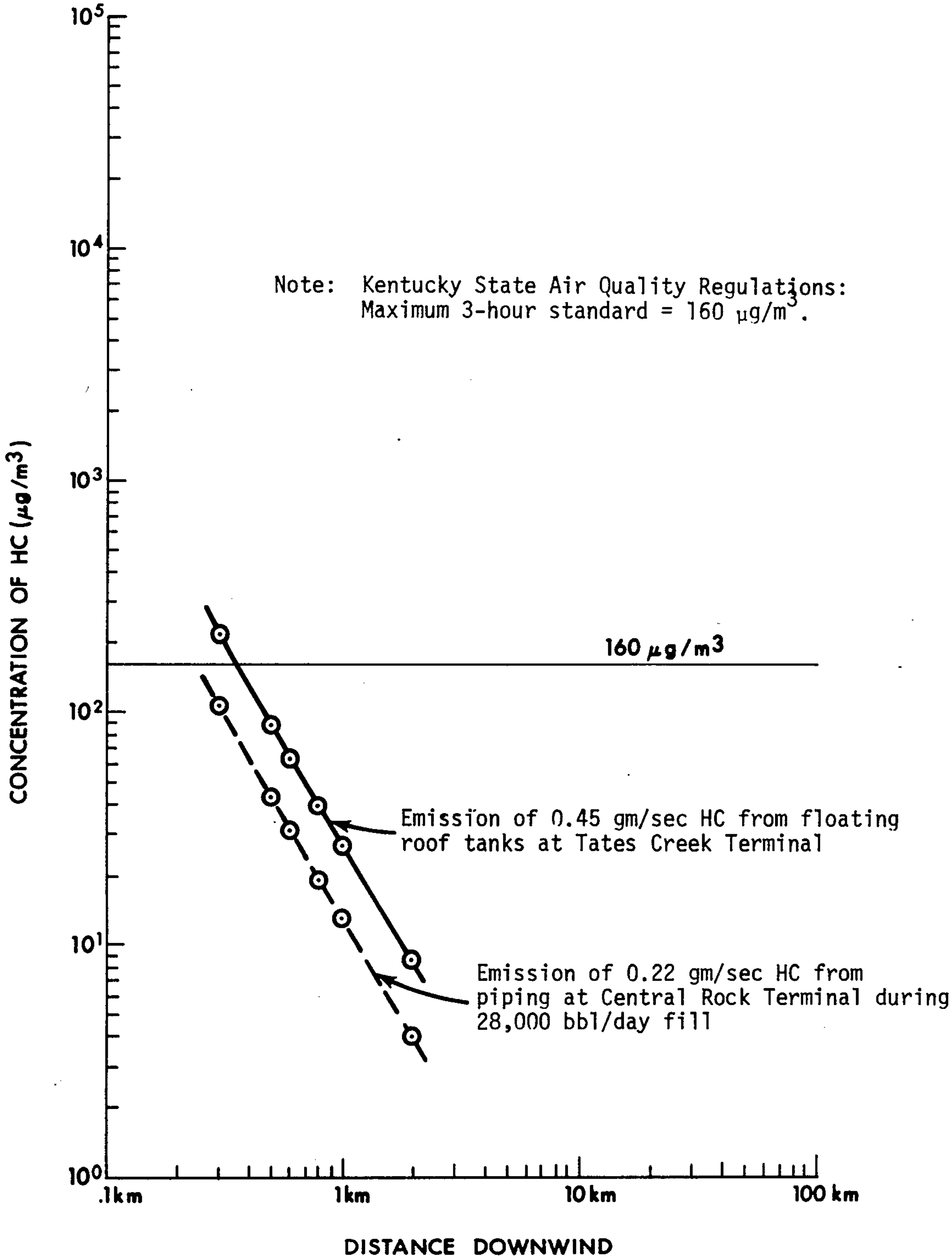


FIGURE 4.3-2 Downwind concentration of HC from leakage

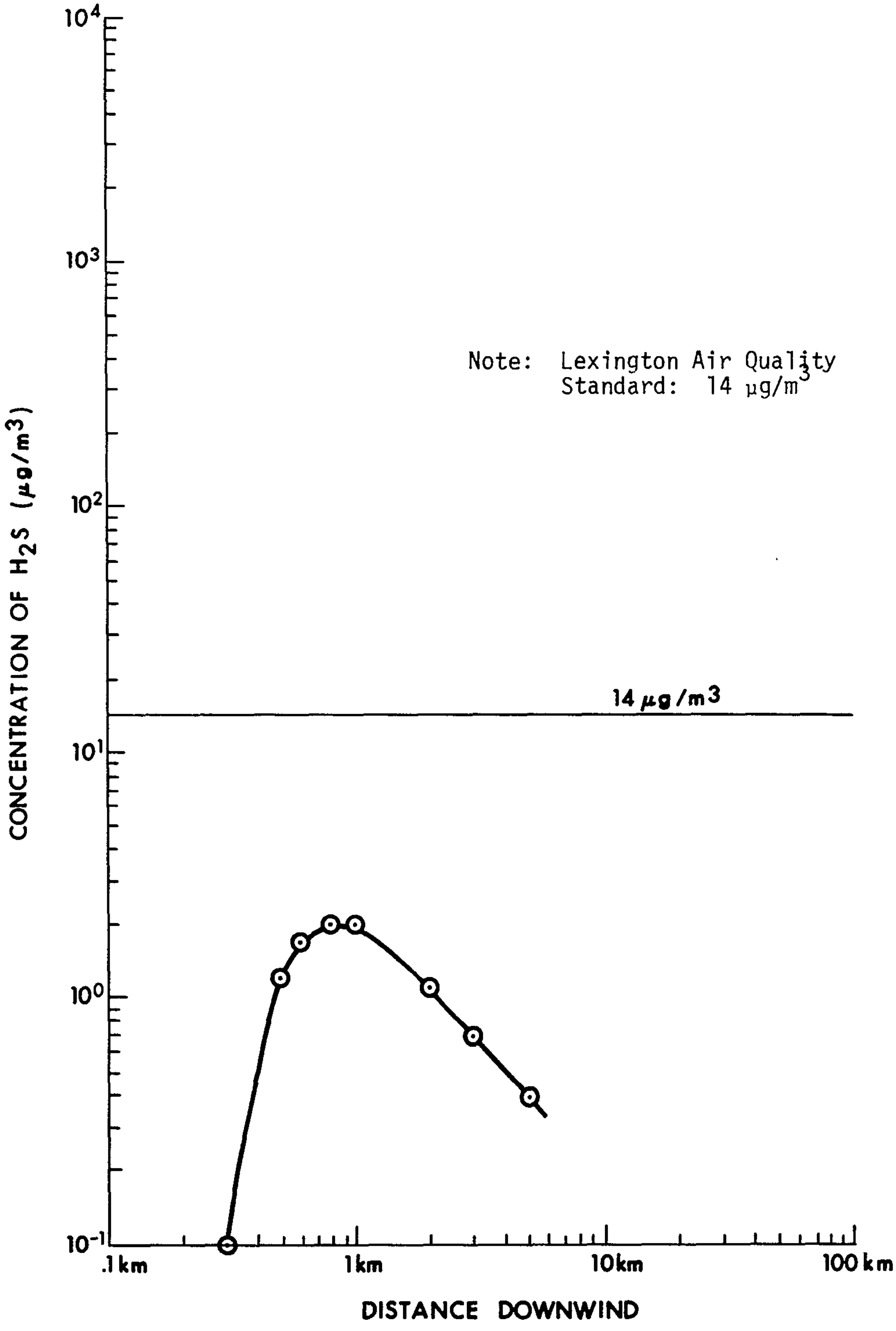


FIGURE 4.3-3 Downwind concentration of H_2S (assuming no flaring) for 28,000 bbl/day fill rate and 0.08 gm/sec release of H_2S

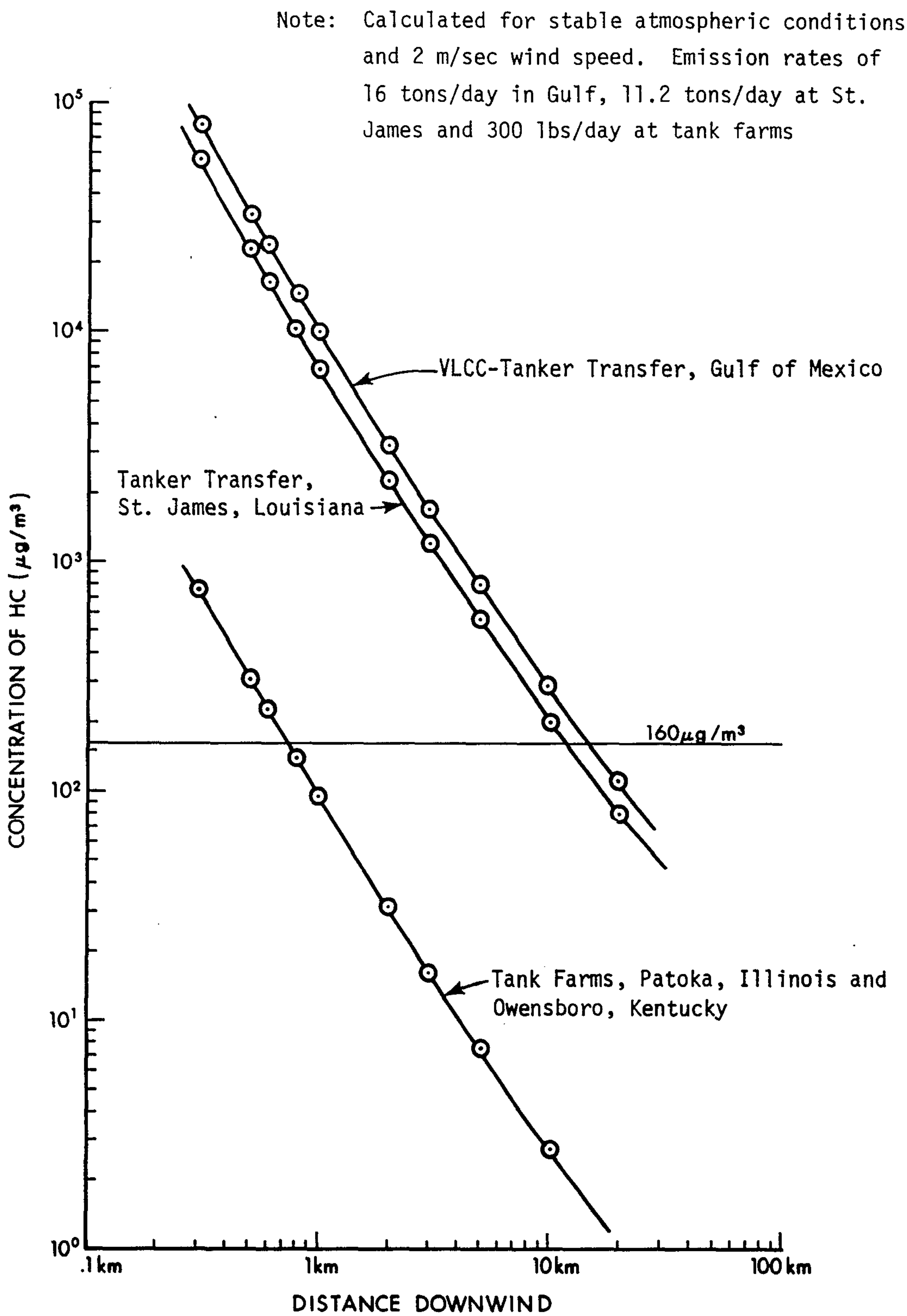


FIGURE 4.3-4 Downwind ground level concentration of HC (with no vapor control system) released during VLCC-tanker transfer operations in the Gulf of Mexico, tanker transfer at St. James, and tank farm storage at Patoka and Owensboro

4.4 TERMINATION AND ABANDONMENT

No specific plan for termination and abandonment of the Central Rock oil storage site has been established. However, the FEA will be required to develop such a plan 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. However, various feasible plans are available.

Present plans for the mine include putting it to some beneficial use after project termination, such as disposal of dredge 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 federal plans, policies, or controls in Fayette County, but local zoning ordinances will be affected by the project. At the Central Rock and Tates Creek Terminals, lands to be used by the project are currently zoned industrial and will require no zone changes. However, land crossed by the pipeline near both terminals is presently zoned residential (Lexington-Fayette County Planning Commission, 1973), so zoning variances will be required for pipeline construction in these areas. Most other land along the pipeline route is zoned for agriculture or extraction land use. The project will have only a short-term effect on these lands during construction, and no effect during project operation.

The Lexington-Fayette County Planning Commission (1973) has developed a basic framework plan that applies to the entire county. This plan includes consideration of areas in need of rehabilitation, and is intended as a guide to better the quality of new development. There is no apparent major conflict between the proposed action and these land-use plans and controls.

A plan has been submitted to the Lexington-Fayette County Historic Commission for development of the Cahill Farm and historic preservation of the McConnell Springs area located just to the west on the Central Rock property (Figure 2.2-1). Because of the existing light industrial buffer zone located west of Forbes Road, no conflict between the proposed oil storage facilities and the Cahill Farm are envisioned. The Cahill Farm is surrounded by existing industrial, storage or public service type institutional uses. The existing mine facilities are located about 140 feet below the surface of the Cahill Farm. No conflict exists between the surface use of the Cahill Farm and the underground operations.

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 Central Rock 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 14 million barrels to be stored at Central Rock represent about 3 percent of the total planned Strategic Petroleum Reserve, and 9 percent of the Early Storage Reserve.

4.6.2 Overall Project Appraisal

Conversion of the Central Rock limestone 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 Tates Creek Terminal and tank farms at Patoka, Illinois, Owensboro, Kentucky, and St. James, Louisiana, and the release of locally significant quantities of hydrocarbons due to marine transport of oil from the Gulf of Mexico up the Mississippi River to St. James. The fact that the mine site, Tates Creek Terminal and the entire transportation route from the Gulf to Tates Creek have long been used for industrial purposes and that the project locations are not a unique resource or habitat for significant flora of fauna minimizes the scope of impacts resulting from construction and operation activities. Also, the area affected by construction is only 75 acres. Although the pipeline crosses some agricultural land, horse pasture, and some lands zoned for residential use, these are not unique or especially significant to the area, and the pipeline will be underground. Sedimentation may be a problem in the Old Grand Dad Distilling Company impoundment on Elkhorn Creek, but the impact is not irreversible. Construction noise may cause some annoyance to residents within a half mile of the Central Rock Mine 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 (20 weeks) adverse social and economic impact to segments of the local population. Probably only the workers directly involved in mining operations (approximately 30) would be affected.

Operation of the Central Rock facility will have negligible socioeconomic impacts since its employment requirements (in addition to the limestone mining operation at the relocated mine) are very small. Continuation of mining activities is of some 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 limestone production 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 catastrophic 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 Tates Creek 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 tank farms at Patoka, Owensboro, and St. James will total an estimated 300 pounds per day for shorter periods. Marine transport operations will release much greater quantities of hydrocarbon vapors to the atmosphere: an estimated 16 tons/day in the Gulf of Mexico, 0.8 tons/day in the lower Mississippi River, and 11.2 tons/day at St. James, all for a period of about 25 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 Tates Creek, up to 1/2 mile from Patoka and Owensboro, up to 9.6 miles from the tanker transfer point in the Gulf of Mexico, and up to 7.5 miles from transfer operations at St. James. The effect on regional air quality should not be significant with the possible exception of emissions at St. James, Louisiana.

TABLE 4.6-1 Summary tabulations of adverse and beneficial project impacts*

Subject Areas and Environmental Impact	Summary Characterization of Impact	
	Adverse	Beneficial
Geology		
1. Land subsidence	No impact	None
2. Seismic stability	No impact	None
3. Engineering stability	Remote chance of cavern collapse in case of extraordinarily severe hydrocarbon explosion.	None
4. Cavern integrity	No impact	None
5. Disposal of mine water	No change from present operation.	None
6. Loss of mineral resource	Negligible oil absorption; slight loss of recoverable limestone.	Expanded accessibility to limestone deposits (with relocation of present mine).
Hydrology		
1. Surface water pollution	From mine: negligible. From oil spill: small risk of large spill; temporary adverse impact. From pipeline construction: slight increase in erosion during construction periods.	None
2. Ground water pollution	Possible local contamination of shallow aquifers due to oil spills or other wastes entering from surface through karst solution channels; none of the engineering modifications of the mine interrelate with the groundwater system.	None

TABLE 4.6-1 Continued

Subject Areas and Environmental Impact	Summary Characterization of Impact	
	Adverse	Beneficial
3. Water supply	Temporary adverse impact in the case of an oil release to Elkhorn Creek or Kentucky River. Potential sedimentation in Old Grand Dad Distillery Company impoundment.	None
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 Tates Creek Terminal, and tank farms at Patoka, Illinois, Owensboro, Kentucky, and St. James, Louisiana; locally significant amounts of HC vapors released during transport of oil from VLCC's in the Gulf of Mexico to the tank farm at St. James.	None
Noise		
1. Construction equipment	Moderate: increase in nighttime ambient sound levels at nearby undeveloped areas will be less than 6 dB; increase at nearby Lexington will be 4 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 Impact: Adverse	Summary Characterization of Impact: Beneficial
Terrestrial Ecology		
1. Wildlife habitat	Removal of approximately 75 acres for site preparation and pipeline structures.	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
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
Historical and Archaeological Assets		
1. Cultural resources	Cahill Farm, of local importance, is located on Central Rock property. No known site will be affected by construction or operation; a survey of potential sites within the proposed development area will be conducted by the state when final route is selected.	Survey will add to archaeological knowledge of area.

TABLE 4.6-1 Continued

Subject Areas and Environmental Impact	Summary Characterization of Impact: Adverse	Summary Characterization of Impact: Beneficial
Socioeconomic Characteristics		
1. Land use		
a) Construction phase	Removal of approximately 75 acres of pasture and forest land for mine relocation and oil pipeline handling equipment. Rezoning of some land presently intended for residential use.	Increased economic utilization of land and expansion of local property tax base (if privately developed).
b) Operation phase	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
2. Transportation		
a) Construction phase	Negligible impact on local traffic; temporary increase in vehicular traffic at terminal and pipeline construction sites.	Temporary increase in transportation employment judged to be of minor significance.
b) Operation phase	Minor increase in tanker traffic in Mississippi River.	Fuller utilization of existing Pipeline capacity.
3. Population and Housing		
a) Construction phase	Extremely small temporary increase in transient population for approximately 1 year; maximum of 50 nonlocal construction workers plus some dependents.	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.

TABLE 4.6-1 Continued

Subject Areas and Environmental Impact	Summary Characterization of Impact: Adverse	Summary Characterization of Impact: Beneficial
4. Economic Changes		
a) Construction phase	Possible slight 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 limestone production dependent on decision to close mine. Maximum of 20 weeks of output loss locally significant to region.	Estimated $2.9 million of regional construction labor income during mine conversion and other relocation activities (net of only $2.2 million if mine is shut down and 180 workers are put out of work). Increased demand for local supplies of construction services (materials, fuels, 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 area income and employment in Lexington area. Slight temporary increase in tanker and pipeline employment and in shipyard construction employment.
5. Government sector		
a) Construction phase	Construction traffic near Central Rock may necessitate controls. No increase in education and public welfare costs anticipated. Possible temporary decline in tax revenues on limestone production if new mine output does not exactly offset decline in present mine production or if mine is temporarily shut down.	None

TABLE 4.6-1 Continued

Subject Areas and Environmental Impact	Summary Characterization of Impact	
	Adverse	Beneficial
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 $84,700 per year).
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.
7. Mine Safety	Very slight risk of cavern collapse. Under worst case conditions oil might be displaced to the quarry and into the new mine, endangering the Central Rock miners.	None

*For further details on project impacts, especially quantification of effects, see the appropriate subsections of 4.2 (SITE PREPARATION AND CONSTRUCTION) and 4.3 (ENVIRONMENTAL IMPACTS OF OPERATION AND OIL STORAGE).

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.

Central Rock 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 Central Rock Mine for oil storage (sections 4.1 through 4.6). The importance of the site in providing a potential 9 percent of the established Early Storage Reserve capacity is a factor that substantially offsets the expected adverse environmental effects.

SECTION 5.0

UNAVOIDABLE ADVERSE IMPACTS AND AVAILABLE MITIGATIVE MEASURES

5.1 UNAVOIDABLE IMPACTS*

5.1.1 Geology and Soils

During the construction phase, minor disruption will unavoidably occur to the weathered bedrock surface as a result of the shallow excavation and blasting that will be required to provide foundations for the storage and terminal surface structures and for adequate burial depth of the pipeline. These impacts on the environment will affect only the immediate construction zone of the projects.

The principal unavoidable adverse impacts on the physical environment as a result of construction are erosion and subsequent sedimentation due to runoff. Soil in most of the construction area is clayey; topography of the region is flat to gently rolling. These factors greatly minimize erosion potential. However, there will be a period of time before plant growth when the uncovered ground will be susceptible to erosion.

The only permanent impact on soils will be the inversion of soil profiles as a result of excavation and backfilling.

5.1.2 Hydrology

During construction, some siltation of small streams will occur despite efforts to prevent erosion. Temporary reduction in water quality will include increased turbidity and suspended solids during site excavation and grading. Temporary causeways required in soft-bottom streams for movement of construction equipment will also cause some siltation and increased turbidity in the streams.

Construction of the pipeline will probably require temporary diversion or damming of streams which it will cross. Trenching, pipelaying, and backfilling will have to be done while the waterflow

* Please see section 4 for a thorough discussion of project impacts. Only summaries of significant unavoidable adverse impacts are in this section.

continues, and will therefore cause soil and bottom sediments to be carried downstream.

Mine modification and new mine conversion will require a maximum of 35 gallons per minute more water than is used for the mine now.

It is possible that some portion of the shallow aquifer will be exposed to the surface through bedrock and thereby experience local contamination from runoff at some time during the project. In addition, small pipeline leaks could cause minor contamination; a major pipeline break due to sinkhole collapse would cause major contamination.

During operation, a remote possibility of shaft lining failure would result in minor oil intrusion into the local aquifers.

5.1.3 Air Quality

Dust typical of mining construction activities will be created, particularly during the site preparation activities, explosive blasting, and shaft sinking operations. Emissions and fugitive dust will be produced from open burning and the new limestone mine facilities. Heavy mobile equipment will exhaust diesel fumes and produce fugitive dust.

Oil leakage during filling operations will release a total of approximately 42 lb/day of hydrocarbons into the local atmosphere at Central Rock, 85 lb/day at Tates Creek Terminal, 300 lb/day at Patoka, Owensboro and St. James tank farms, 16 tons/day in the Gulf of Mexico, 0.8 tons/day dispersed along the Mississippi River, and 11.2 tons/day at St. James dock facilities. Air quality standards for hydrocarbons are presently exceeded at most of these locations.

5.1.4 Noise

Construction noise may cause some annoyance to residents within 1/2 mile of the mine site and within 2000 feet of the pipeline route.

5.1.5 Ecology

Disruption of the terrestrial food chain is an unavoidable adverse consequence of construction. Localized increases in stream turbidity and siltation due to pipeline construction are also unavoidable. The following specific impacts are likely to result from project construction and operation:

1. Temporary loss of 65 acres of oldfield-pasture habitat during construction of the pipeline corridor.
2. Reduction in grazing area and forage quality for domestic livestock as a result of construction of the pipeline corridor and terminal facilities.
3. Potential disruption of wildlife activity at the pump station and terminal as a result of noise during the filling and withdrawal periods.
4. Permanent loss of approximately 10 acres of oldfield-pasture habitat at the mine site and Tates Creek Terminal.
5. Disruption and possible loss of wildlife species inhabiting oldfield-pasture that cannot successfully relocate in adjacent habitats (e.g., rabbits and small rodents).
6. Potential loss of as much as 100 acres of wildlife habitat if a maximum credible oil spill should occur.

5.1.6 Socioeconomics

5.1.6.1 Land Use

The area in the immediate vicinity of the existing Central Rock Mine will be withdrawn from use for limestone production for the life of the Strategic Reserve Plan. Access to the site will be controlled by the FEA for reasons of safety and security of the stored oil.

Construction of the pipeline will affect 65 acres of land. While the pipeline is in operation, residential and other industrial uses of the land will not be possible. The terminals will require approximately 10 acres of industrial land.

5.1.6.2 Transportation

Circulation patterns will be modified temporarily along the pipeline route during construction and some new access roads could be required. New access roads could cause changes in land use patterns for these areas.

Trucking and other vehicular traffic will increase during construction. The level of traffic will depend on the provisions for transporting employees to the site.

There will be a temporary (25 days) increase in tanker traffic in the Mississippi River during each fill operation. The increase is equivalent to approximately two round trips per day.

5.1.6.3 Employment and Income

If the entire construction work force for the project is required to start work at the same time, there could be some local labor shortages as a result of suddenly having 150 to 170 more employees at the mine site. If the limestone mine is shut down for 20 weeks, 6 to 30 people would probably be out of work. If the related plants on the site also closed, as many as 180 people could be unemployed for 20 weeks. In the latter case, project construction would increase present employee income in the area by $2.2 million instead of $2.9 million.

5.1.6.4 Aesthetics

Vegetation aesthetics will be temporarily disrupted along the pipeline route. The terminal plant will be adversely affected by the addition of storage tanks. Flaring will be visible in the immediate vicinity and visible at night from nearby residential areas.

An oil spill, depending on its size, could affect areas in size up to a few tens of acres and it could take several months to a few years for complete biological recovery.

5.1.7 Oil Spills

The risks and impacts of oil spills from this project are discussed in section 4.3.8. Possible major impacts from a maximum credible oil spill are mentioned in the preceding subsections of section 5.

5.2 MITIGATIVE MEASURES

5.2.1 Geology and Soils

No feasible mitigative measures can be implemented to avoid disruption of the local bedrock from excavation and blasting.

Interceptor barriers in the trench, shallow drainage ditches, and temporary settling basins could serve to minimize erosion and sediment transport during the construction period. Exposed soils can be temporarily protected from erosion by the compaction of the backfill; they can be further protected by installation of temporary diversion berms, drains, flow barriers, or other types of barriers. By proper backfilling of the trench, especially in areas susceptible to erosion, and careful revegetation procedures, erosion can be kept to a minimum.

5.2.2 Hydrology

Causeways can be constructed of nonpolluting material with properly sized pipe flumes installed to minimize erosion. The causeways could be removed after construction is completed.

Flumes or conduits can be used to pass streams across the pipeline trench. Sand, gravel, or rock-bottom streams can be backfilled with excavated material, and with additional bankrun sand, gravel, or crushed stone, as necessary. A temporary cofferdam could be installed across main streams and the pipeline trench to minimize siltation during pipeline laying.

Erosion potential can be reduced by replanting vegetation along the pipeline corridor after the line is buried and covered with top soil. This measure could result in a decreased level of suspended sediments in the streams during periods of high water runoff.

In order to maintain the current water quality of the streams and the aquifer in the construction areas, all water pumped from the area could be collected and treated in small storage ponds or tank trucks and delivered to the municipal sewage system. Chemical toilets could be provided and maintained by a contractor. Liquid wastes such as chemicals, lubricants, and bitumens can be stored in tanks and removed from the site. Limestone excavated from construction and shaft sinking can be placed in the storage cavern for stabilization prior to filling if it is unsuitable for commercial use.

Aquifer pollution by oil resulting from shaft lining failure in the storage cavern can be prevented by adding a closure mechanism to the pipes below passage through the shaft plug.

5.2.3 Air Quality

The FEA is committed to minimizing dust and emissions due to construction activities. Local and state air quality regulations and standards will be met. Gases vented from the storage cavern during filling and withdrawal will be flared to eliminate release of odors, hydrocarbons, and combustible vapors. A description of possible vapor control systems for use in reducing hydrocarbon emissions from oil handling systems is provided in Section 5.2.10.

In order to reduce the volume of exhaust fumes, all internal combustion engines can be maintained with regard to high performance, efficiency, and operation. This maintenance should include routine adjustments to the carburetor fuel injection systems, supercharger inspections, routine replacement of fuel and air filters and PCV valves, and major engine overhaul when necessary.

In order to reduce the atmospheric loading from the shaft drilling and sinking operations, small amounts of water can be added to the drill airstream to reduce the fine cuttings liberated during drilling operations. If the rock material to be loosened by blasting is too dry and causes dust clouds during excavation, the rock can be sprayed with water to reduce emissions.

All mine roads and pipeline access roads can be sprayed with water periodically to reduce fugitive dust, especially during the dry summer months. Surfacing with gravel can also help reduce dust. Main roadways could be paved and maintained.

Dust emissions from the batch concrete plant can be controlled using modern engineering practices. Wherever practicable, shredding or mulching, rather than burning, can be used to dispose of vegetation.

5.2.4 Noise

Vehicles utilized at the construction site could be equipped with muffler systems to reduce their noise contribution to the existing ambient levels in the residential neighborhoods. This measure could be strictly enforced during the nighttime hours. Blasting of the shafts could be limited to daytime periods so as not to interfere with sleep in the residential areas. Blast mats or deep burial of the explosives can be used to reduce the noise and annoyance to nearby residents. Use of a rock saw for limestone removal could eliminate impulse noise and help reduce any annoyance caused by blasting. The U.S. Environmental Protection Agency is studying the regulation of all types of equipment noise, and it is anticipated that construction equipment, trucks, and mining equipment noise levels will be reduced by regulation in the near future.

5.2.5 Ecology

If proper mitigation measures are taken, most adverse construction effects on aquatic life can be minimized. These measures include erosion control, stream bank stabilization, and careful disposal or containment of dredged materials. Soil erosion during grading and excavation can be controlled by diverting surface runoff away from the construction and spoils areas. Buffer strips of natural vegetation can be preserved along forests and stream banks wherever possible in order to provide habitat and mimimize erosion. The stream banks can be protected against erosion by providing additional riprap. Vehicles should cross drainageways, to the extent possible, only where culverts are provided.

The loss of terrestrial habitat at the mine site and terminal facility are long-term impacts that cannot be readily mitigated. During all construction activities, movement of vehicles could be controlled to protect natural vegetation, seeded areas, and erosion control structures as much as possible. In clearing the transportation and pipeline rights-of-way, only small trees and shrubs could be removed; no growth retardants, chemicals, or herbicides should be used.

Revegetation can help return the oldfield-pasture areas disrupted during construction to useful production. The original topsoil removed can be replaced and reseeded. Grass and low shrub species could be selected for their rapid growth characteristics. (Trees and woody shrubs result in high maintenance costs and so are not recommended.)

5.2.6 Historical and Archaeological Resources

The possibility of adverse archaeological impacts can be minimized by a state survey of the proposed pipeline prior to construction and the availability of an archaeological consultant during construction. The archaeologist will inspect the site and make recommendations concerning any archaeological artifacts that are discovered.

5.2.7 Socioeconomics

Transportation for employees from nearby communities could minimize the local traffic generated during peak construction periods.

In order to stabilize the construction work force and reduce future employment peaks, work on the oil handling and distribution facilities, new mine, and surface facilities can all be initiated early in the period of construction.

Permanent fencing for the project could be limited to that necessary to maintain security of plant structures. Landscaping can also help improve the visual appearance of the facilities. After the pipeline is built, access roads could either be spaded and reseeded or added to the county road system. Stockpile areas, depending on their size, can also be revegetated.

5.2.8 Oil Spills

An oil spill contingency plan will be designed to minimize impacts from a spill and to speed recovery (see Appendix G). The plan will include 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. After cleanup, the affected area can be restored to its former level of productivity through soil additions and revegetation, as necessary.

The following measures could reduce the probability of oil spills:

1. Installation of a shutoff system in the oil fill pipes below the shaft seal.
2. Placement of a cover over the pump shaft to prevent entry of surface water.
3. Construction of dikes or channels to divert runoff away from the storage and terminal areas, and any oil spillage to the containment area.
4. Installation of a modern supervisory control system for observance of operations by dispatchers and shutdown by the dispatchers in case of any potentially dangerous deviation from normal operating conditions.
5. Incorporation of check and block valves at all major stream crossings.
6. Placement of automatic gate valves at the pump station.
7. Use of a cathodic protection system to prevent corrosion.
8. Regular surveillance of the entire pipeline system by air and/or surface methods every 2 weeks; surveillance of congested or potentially hazardous areas at least once a week.
9. Availability of well-equipped "strike force" crews at strategic locations along the pipeline route for prompt corrective action, if needed.
10. Installation and maintenance of warning signs and markers along roads, property lines, and other areas, as advisable.
11. To avoid third-party construction accidents affecting the pipeline, the distribution of informational literature and requests for notification of any planned construction in the vicinity so that the line could be precisely located and marked.
12. Periodic contact with city, county, state, and federal agencies to maintain awareness of the facilities and proper contacts in case of an emergency.

13. Purging pipelines of oil during standby storage, resulting in an estimated 60 percent reduction in the risk of total oil spill release.

14. Design and construction of vapor recovery system, resulting in elimination of hydrocarbons loss by flaring during cavern fill and positive control of vapor pressure within the cavern during storage.

5.2.9 Monitoring Programs

A comprehensive monitoring program has not been designed for this project. However, various considerations could be integrated into a monitoring program in order to provide optimum protection of personnel and the environment, and to meet industry standards and regulations of the various federal and state agencies.

Following is an outline of a monitoring program that would accomplish the above goals. It would consist of activities during project construction and operation to prevent harmful accidents or environmental degradation and, should an accident occur, a program which would measure the impact of the accident and the effectiveness of the cleanup procedures.

5.2.9.1 Construction Monitoring

The construction monitoring program would consider air quality, geology, hydrology, water quality, and both terrestrial and aquatic ecology. Particularly critical parameters to be measured during the construction monitoring program would include:

1. A complete geological survey of the mine cavern and pipeline route to define any possible fault systems or karst hazards along the route.
2. The hydrology associated with the present system design.
3. The ecology, surface water quality, and air quality at and surrounding the project storage site, oil distribution system, and Tates Creek Terminal.

The hydrology program would measure flow rate, water chemistry, sediment composition and depth, and bottom contours of the streams. These measurements would be taken downstream of the Central Rock site and pipeline crossings, with particular emphasis on measurements taken near existing public and industrial water supply intake stations. Data obtained from wells drilled at the site would determine the composition of the aquifer, various types of sands, water and mineral content, depth and area of the aquifer, and characteristics of isolating layers that might prevent oil from reaching the aquifers.

The ecology program would place special emphasis on vegetation, because the major impacts of construction and oil spill risk during operation will be on the floral community. The program would concentrate on measurements in the immediate vicinity of the project and a one-mile-wide strip along the proposed pipeline right-of-way. In addition, the aquatic ecology of the affected streams would be monitored, taking into consideration the wildlife species dependent on the streams.

5.2.9.2 Operation Monitoring

During oil storage, only minimal monitoring would be required, conducted in conjunction with normal operation and maintenance procedures. Observation wells could be set up to monitor any changes in the groundwater table or contamination of the aquifer. Visual monitoring of the storage system components for excessive emissions and leaks would be the main efforts. During withdrawal and/or refilling operations, the entire monitoring program could be reactivated, including an increase in monitoring along the entire pipeline route.

5.2.10 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 125,400 barrels (equivalent) for five fill/withdrawal cycles (section 7.5.2). Second, vapors which are not flared contribute a significant amount of hydrocarbons to the atmosphere, particularly in southern Louisiana where hydrocarbon concentrations are already high. The quantities of unflared hydrocarbon emissions contributed to the atmosphere from uncontrolled systems are estimated to be: 1) a maximum rate of 189 BPD; 2) a maximum annual emission of 4840 barrels; and 3) a total release of 24,630 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 St. James 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 St. James transfer terminal. It is also possible that a condensation system would be utilized in place in 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 St. James 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 Central Rock 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 Central Rock storage site, install a vapor condensation system with 60 percent efficiency; 2) at the St. James transfer terminal, install a vapor blowback system with 95 percent efficiency; 3) losses during transfer between VLCCs and tanker 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 Central Rock system. The reduction in estimated hydrocarbon release to the atmosphere may be summarized as follows: 1) maximum system daily emission rate reduced by 37 percent to 119 BPD; 2) maximum annual release to the atmosphere reduced by 37 percent to 3100 barrels of oil (equivalent); and 3) total release of hydrocarbons to the atmosphere during the project lifetime reduced by 37 percent to 15,600 barrels of oil. The reduction in total hydrocarbon loss from the Central Rock storage system would be approximately 55 percent to 55,900 barrels over the life of the project.

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 Central Rock 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 Central Rock Mine will be the underground storage of petroleum for use during a period of national emergency. This oil storage will contribute to the short-term availability of petroleum resources in case the nation's foreign supplies are reduced, thus providing an element of stability and security in our economy and our national well-being. The conversion of a producing limestone mine to oil storage will reduce the total recoverable supply of limestone at Central Rock. The effect on national, and local, mineral resources is miniscule, however.

The use of Central Rock for underground oil storage will add a potential reserve of 14 million barrels of oil for immediate use in the future. This amount will account for approximately 3 percent of the storage requirements as detailed in the Energy Policy and Conservation Act of 1975.

There is no current experience in the United States to indicate any stress to the environment that 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. With adequate safety and monitoring measures for fire prevention and the prevention of oil leakage into the ground water system or to the surface, harmful effects will be minimized.

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 Central Rock Mine is developed for storage, approximately 11 surface acres and all limestone within 150 feet of the existing mine caverns will be eliminated from future limestone production, 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 existing limestone mine will be relocated to an area adjacent to the oil storage cavern and available limestone resources, both at the mine and in the United States, are sufficient to allow continued mining during the foreseeable future.

Disturbance of the sites for construction of new project facilities at the mine and along the pipeline route will temporarily decrease productivity of these areas. The habitats to be affected at the mine site are already disturbed by industrial activities, however, and do not represent a unique or especially valuable resource. The habitats along the pipeline route, while not unique, are a valuable resource to Fayette County.

6.2 ENHANCEMENT OF NATIONAL ECONOMIC PRODUCTIVITY

The Central Rock oil storage facility will provide a potential reserve supply of about 14 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 limestone, agricultural, forestry, recreational, or other potential resource uses of the site. Increased payrolls and, possibly, increased property taxes will have a beneficial economic impact on the Fayette County area.

If temporary closing of the Central Rock Mine were 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 storage area will remove about 11 acres of land and a relatively small volume of limestone from other uses for the life of the storage site. Limestone is not the primary resource of Lexington or Fayette County. At the storage site, the surface area is utilized for existing mining activities.

Short-term impacts on resources caused by construction will include the temporary loss of 65 acres of oldfield-pasture habitat in the pipeline corridor and the resulting stress on terrestrial wildlife species inhabiting that component of the ecosystem. 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 16-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 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 permanent loss of 11 acres of oldfield-pasture habitat at the mine and terminal sites is the one significant effect the project will have on the long-term use of resources. During the lifetime of the project, the effect is likely to be severe for most species of flora and fauna on the site. However, considering the limited size and present urban location of the site, 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. 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 tanks at Central Rock (42 lbs/day), at Tates Creek (85 lbs/day), and at the Patoka, Owensboro, and St. James tank farms (300 lbs/day at each). 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 16 tons/day of hydrocarbons in the Gulf of Mexico, 0.8 tons/day along the Mississippi River south of St. James, and 11.2 tons/day at St. James. These releases will be of short duration (25 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.

7.2 COMMITMENTS CONSIDERED

The types of resources affected by the underground storage of oil can be described as: 1) renewable and nonrenewable resource materials consumed in construction and operation; and 2) natural resources, including any recognized beneficial uses of the environment. Resources that may be irreversibly committed are: 1) plants and animals destroyed at and around the site and along the pipeline; 2) construction materials and energy that cannot be recovered or recycled; 3) materials consumed or reduced to waste products; and 4) land areas removed from present uses.

7.3 LAND RESOURCES

Land areas that will be removed from present use for oil storage and pipeline transport total about 75 acres. Except for areas occupied by the pumphouse, pipelines, and other small structures, which will be situated on about 2 acres of the storage site, this land could easily be converted to other uses when the aboveground facilities are no longer needed. The 1 acre could also be cleared if future usage of these particular land areas were to justify the cost of removal (also see section 6.0).

7.4 WATER AND AIR RESOURCES

The expected small releases of emissions from the flaring processes are discussed in Appendix B. During plant operation, air resources must be used to receive these discharges. As planned, no effluent will be discharged to the water surrounding Central Rock during oil storage, filling, or withdrawal. Oil spill releases are expected to be minor, of local extent, and of temporary impact. No irreversible commitments of air or water resources in the region are necessary for the proposed project.

7.5 MATERIAL AND ENERGY RESOURCES

The primary resource irretrievably committed at Central Rock Mine is the energy required to create the reservoir, store and recover oil, and maintain limestone production at its present level. Some material resources, such as metals used structurally or in piping, concrete, rock that is no longer minable, and petroleum lost or abandoned, may also be irretrievably committed. However, unlike energy, which cannot be recycled, materials may be physically, if not economically, retrievable. Metals can be recycled. Both dirt-contaminated oil and oil-contaminated limestone can be refined to recover the physical materials. However, to be conservative, it is assumed that the oil storage caverns will never be reentered. After abandonment, all materials beyond the shaft seals will be considered economically irretrievable. The following estimates apply to both mine development options.

7.5.1 Material Resources

The rock around the contours of the mine up to the minimum safe distance between adjacent mine cavities will be excluded from future recovery. The minimum safe thickness is now considered to be 150 feet. This figure may eventually be set at anywhere between 100 and 300 feet. The contours enveloping Central Rock Mine have roughly rectangular dimensions of 3250 x 2070 x 30 feet. A layer of the Camp Nelson Formation 150 feet thick below the cavity contains about 1 billion cubic feet of material. A layer of the Oregon Formation 150 feet thick around the perimeter of the mine contains about 50 million cubic feet of material. Within the same Central Rock Mine envelope, about 60 percent of the Oregon Formation rock, or 123 million cubic feet, still remain. Therefore, a total of about 173 million cubic feet of Oregon Formation rock and 1 billion cubic feet of Camp Nelson Formation rock is excluded by the project from future recovery. About 300 million cubic feet of minable Camp Nelson Formation, down to elevation 451 feet MSL, still underlies the mine cavity and will be inaccessible until after project termination. (Another 1 billion cubic feet of limestone will be inaccessible above the caverns, but this rock is assumed to be of lower commercial quality or it would already have been extracted.)

The mined caverns have a volume of about 80 million cubic feet, with about 2.6 million square feet of floor area and 3.9 million square feet of wall area (estimated by using 40 feet as the average corridor width). Assuming the walls hold an oil residue of 0.1 inch, and the floor, a residue of 0.25 inch, then about 15,000 barrels of oil will be unrecoverable (0.1 percent of the storage volume). In time, with sludge buildup, the amount of unrecoverable oil on the mine floor could double, making about 25,000 barrels irretrievable (0.2 percent of storage volume).

Estimates of construction material irretrievably committed total about 500 tons of steel and 5000 tons of concrete.

7.5.2 Energy Resources

The energy consumed directly in construction is estimated at about 2 million horsepower-hours. In addition, energy is required to supply the 500 tons of steel and 5000 tons of concrete needed for construction. Energy expended in filling and emptying the cavern by pipeline averages 800 BTU per ton-mile, in addition to the lift pump power. Five filling cycles are assumed over the life of the project. Tabulated gross energy values include:

	Millions of BTU (includes energy lost in conversion)	Equivalent Barrels of Oil (5.5 MMBTU/barrel)
Direct Construction		
New access and shaft entries	67,000	12,000
Steel	20,000	3,600
Concrete	30,000	5,400
Total	117,000	21,000
Indirect Construction		
Labor Support	30,000	5,400
Steel (manufactured, 150 tons)	6,000	1,100
Total	36,000	6,500
Handling		
Tanker Pumping	500,000	90,900
Tanker Transport	650,000	118,200
Pipeline steel	150,000	27,200
Pipeline construction	32,000	5,800
Pipeline transport	7,220,000	1,312,700
Cavern lift	222,000	40,000
Total	8,774,000	1,595,200

These tabulations indicate that energy equivalent to 28,000 barrels of oil are consumed in converting the cavern and relocating the limestone mine. Approximately 33,000 barrels of oil are required to construct the pipeline facilities. Approximately 1,562,000 barrels of oil are expended in handling the oil during the assumed 5 storage cycles (not including delivery from Tates Creek Terminal to refineries). In terms of the total energy equivalent of the storage capacity of the facility (70 million barrels in 5 cycles), the energy commitments are:

	Percent of Potential Cavern Storage Capacity (70 million barrels)	Barrels of Oil
Construction	0.09	60,500
Handling (5 cycles)	2.232	1,562,200
Unrecovered oil	0.04	25,000
Oil released as vapor by leakage during transportation of oil	0.035	24,630
Oil released by flaring during cavern fill	0.144	100,800
Spill expectation	0.001	752
Maximum credible spill	0.086	60,000
Total (5 cycles) energy use	2.62	1,833,900

The energy used is irretrievable. It represents an investment of approximately 2.6 percent of the potential cavern storage capacity to help prevent future drastic reductions in energy availability as a result of arbitrary decisions made by foreign suppliers. Approximately 80 percent of this energy use is for oil transportation and handling between the Gulf Coast and Kentucky which would be necessary even without development of an oil storage facility at Central Park.

7.6 BIOTIC RESOURCES

Construction of the oil storage facilities and pipeline will result in habitat alterations of approximately 75 acres, causing the displacement and/or loss of some plants and animals. A temporary disruption of the benthic organisms in the area's streams will occur if erosion from construction areas is extensive. It is not expected that there will be any effect on horse or cattle grazing during the normal operating life of the oil storage program. No endangered, threatened, or unique wildlife or vegetation will be affected. None of these losses will be significant compared to the total expanse of these resources in the Lexington area.

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 Central Rock Mine. Alternatives to the proposed program available to the FEA 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) and include 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 Central Rock Mine; they address the larger question of optimum program policy. Two nonstructural alternatives involving the Central Rock Mine specifically, are the "no action" alternative and the permanent shutdown of the limestone mine.

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 Central Rock mine facility would result in the development of one of the other candidate sites to take its place. In such a case, the impacts described in section 4.0 would not occur and the existing environment of Central Rock (as described in section 3.0) would be maintained. However, the decision to develop another facility in lieu of Central Rock could result in similar impacts associated with this alternate facility. Since many of the candidate sites are located in the Gulf Coast region, it is not likely that many of the impacts resulting from development of the replacement site would be substantially identical to those for Central Rock. The range of impacts for any particular facility are very site specific and, therefore, would be discussed in the EIS for that site.

8.2.2 Permanent Shutdown of Central Rock Mine

The FEA intends to provide for development of a new limestone mine at Central Rock which is equivalent to the existing mine. The limestone resource in the area is capable of supporting such a mine at a location close enough to continue use of the existing surface facilities. The only effect on limestone production or mine employment would be a possible temporary shutdown for approximately 20 weeks if this development option is selected (section 2.3).

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 Central Rock the actual reasonable expenses associated with relocation. If market conditions are unfavorable for mine development at Lexington, Central Rock 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 180. It is estimated that 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 120 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 Central Rock workers, about one-half of the 150 construction workers required for the project are associated with development of the replacement limestone mine. Of the 75 new jobs that would be unavailable if a new mine were not built, 50 to 60 would have been filled by local residents.

The loss of 180 Central Rock jobs would, if uncompensated, lead indirectly to the loss of 200 or more service jobs in the area, assuming that each Central Rock job supported a minimum of one non-basic (service) job. Because Lexington and Fayette County have a substantial and diverse economic base, this loss would not affect the local economy significantly. However, until suitable alternative jobs were found, it would have serious economic and social effects on displaced workers and their families.

At an average annual wage of $11,000 for each Central Rock employee, the loss of 180 jobs would remove as much as $2 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 to $1.5 million per year. New construction earnings from mine conversion would total about $1.5 million--not enough to offset the $2 million in current wages that would be lost.

If only the limestone mine were shutdown, and the related cement and concrete block plants kept in operation, only 30 full-time employees would be unemployed. (Some seasonal and peak production period employees would also lose Central Rock job opportunities.) Of these 30, approximately

12 work underground and 13 aboveground on mining operations, and 5 work in administration. Secretarial and general labor represents 24 of the 30 positions. These employees would probably have little trouble finding alternative employment in the Lexington labor market. Administrators and skilled labor--6 employees--would have a more difficult time finding re-employment. Under these circumstances, the impact of mine shutdown on most current Central Rock employees as well as the local economy, would be minimal.

In summary, the socioeconomic impacts on the local economy from shutdown of the limestone mine would not be severe. Local residents and the area economy are not highly dependent on the mine for wages, and there are a variety of local employment opportunities that could avoid relocation of households. Depending on whether or not the related plants were closed, 6 to 180 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 limestone mine are estimated at $0.49 per barrel of oil stored, compared to $1.03 per barrel with relocation of the mine.

Environmental effects of the project without development of a new limestone mine would be slightly reduced, but not significantly changed, by permanently closing the Central Rock mining operations. A new access tunnel would not have to be sunk at the existing mine. This modification would reduce the use of energy and materials, and the volume of overburden to be placed in landfill. Essentially all other effects would be unchanged.

If a decision were made not to develop a new limestone 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 limestone mining operation would allow approximately 13 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 alternative storage methods, alternative mine sites, and alternative pipeline 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 Central Rock limestone mine is one of eight sites being studied as ESR candidates. Of these eight candidates 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 Móund salt dome (Brazoria County, Texas), The Cote Blanche salt mine (St. Mary Parish, Louisiana), and the Weeks Island salt mine (Iberia Parish, Louisiana). All except Cote Blanche have been selected for the ESR. Bayou Choctaw, Bryan Mound, and West Hackberry have been acquired and site development and geotechnical testing is about to begin at Weeks Island.

The remaining three sites,Central Rock limestone mine (Fayette County, Kentucky), Ironton limestone mine (Lawrence County, Ohio), and Kleer salt mine (Van Zandt County, Texas), 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. Central Rock and Ironton would supply that part of the inland market area served by the Capline pipeline while Kleer would supply the Texoma pipeline market area.

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 five 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 involves choosing sites to satisfy the ESR requirement for the inland refineries. Cote Blanche, one of the five (5) candidates sites which was considered in the first step of site selection, but was not selected in that process, is considered again as an alternative during the second step in the site selection process because of its ability to supply the inland market. For supplying the Capline market area, Central Rock, Ironton, and Cote Blanche are possible sites in this group. The Kleer mine would serve the Texoma pipeline and is therefore not an alternative for the Capline market.

The impacts that could result from the development of the four Gulf Coast sites which have already been selected for the ESR, as well as Cote Blanche and Central Rock mines, which are alternatives to the Ironton site, are set out in Sections 8.3.2.1 through 8.3.2.6. The impacts from the use of sites already selected are included for information purposes, so that this final EIS will parallel the draft EIS for this site, which was published before any of the sites were selected or acquired. The individual statements should be consulted for detailed assessment of these impacts.

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 8.3-1 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 8.3-2 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 8.3-3 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 repopulation 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 Texas 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 8.3-4 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 would 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 8.3-5 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.

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 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.

8.3.2.6 Ironton

Conversion of the Ironton limestone mine into a 21-million barrel oil storage facility would require construction of two new vent shafts; pumping out and chemically treating seepage water currently in mine; sealing two existing shafts with double concrete bulkheads upon completion of the installation of the pumping equipment; installing oil pipelines, pumps manifolds and metering equipment between the new pump station and pump shaft; installing an electrical power substation; constructing a 13-mile pipeline connection between the site and Ashland Refinery system and constructing pipeline terminal facilities at or near Ashlands Catlettsburg Terminal. Construction of this facility is not expected to have long term adverse environmental impact. Except for the remote possibility of a large oil spill, any negative impact is expected to be short term and minor in nature.

Storage Site Conversion and Construction

Conversion of the Ironton limestone mine to an oil storage facility requires removal and treatment of seepage water, removal of existing shaft equipment, sinking of two new vent shafts, conversion of one of the existing shafts to accommodate pumping equipment, sealing of the second shaft after underground construction is complete, construction of underground drainage channels and a provision for a sump below the pump shaft. During construction activity there would be increases in fugitive dust levels, emissions from construction vehicles and ambient noise levels. These effects would be localized and temporary.

Development of the storage facility would provide 3600 man-weeks of labor for a 55-week period and a total earnings of about $1.5 million. Mine conversion would cost an estimated $1.0 million and oil handling equipment and distribution facilities an estimated $6.7 million. The total project development cost would be more than $7.7 million or $0.37 per barrel of oil stored.

Pipeline Construction

An 18-inch diameter, 13.1-mile long pipeline would be required to connect Ironton storage facility with the Catlettsburg Terminal located at Ashland Refinery. The 40-foot wide right-of-way corridor of the pipeline would affect 64 acres of industrial, low-income residential and forested lands. Construction activity, including blasting and using trucks and heavy equipment, would cause increased noise levels, fugitive dust levels, and vehicle emissions. During excavation and back filling of the pipeline trench, the soil profile would be inverted and disturbed, leaving the soil vulnerable to runoff - erosion process. Because of the blasting of limestone located close to the land surface, restoration would be required.

Pipeline Terminal Facilities Construction

The construction of the piping, instrumentation and electrical systems located at or near the Catlettsburg terminal will disturb about 2 acres of land. Construction activity would cause increased noise levels, fugitive dust levels and vehicle emissions. These effects would be localized and temporary.

Facility Operations

The storage facility would be filled by a pipeline through the Catlettsburg terminal at a rate of about 28,000 BPD over approximately 750 days. Oil would be withdrawn at a rate of 140,000 BPD over a 150 day withdrawal period. Approximately 42 pounds of hydrocarbons per day would be omitted from the storage cavern during fill perids; a temporary flare system would be used as a safety precaution to reduce concentrations of combustible gases and SO_2 in the mine area.

Eight to ten skilled employees would be required during the 150 day withdrawal and the 750 day refill period. Two or three employees would be sufficient to carry out routine maintenance, equipment monitoring, and security procedures at the storage site during standby storage periods.

Oil Spills

The potential for oil spillage at both the Ironton facility and the Catlettsburg terminal has been projected to be 0.0105 spill incidents per single fill cycle, and 0.105 spill incidents over tne project lifetime. The average spill volume per incident is calculated to be 300 barrels, with a maximum credible spill being 3000 barrels. The projected volume of oil released during project lifetime is 30 barrels.

The expected number of spill incidents of the pipeline from the Ironton storage site to the Catlettsburg terminal is .013 incidents per single filling cycle and .14 over the project lifetime. The average spill volume is estimated at 1083 barrels, with a maximum credible spill of 3000 barrels. The projected volume of oil released during the project lifetime is 156.

Transportation of Crude Oil from the Gulf of Mexico and Catlettsburg Terminal

All facilities required for the transfer of crude oil from the Gulf of Mexico and Catlettsburg Terminal are presently in operation. No new construction would be required, therefore, there would be no construction related impacts.

Significant hydrocarbon emissions would occur during each fill operation at the facility locations: 600 tons in the Gulf of Mexico south of the Mississippi River; 30 tons in transport up the river to St. James, Louisiana; 420 tons at

St. James Terminal; 13.5 tons at the tank farms in Patoka, Illinois and Owensboro, Kentucky. During the life of the project an equivalent of approximately 35,930 barrels of oil would be emitted to the atmosphere. Maximum credible spill for the Gulf is 60,000 barrels which could render 840 to 1,680 acres of marsh unproductive for two years. The maximum credible spill size for pipeline accidents is 10,000 barrels.

In transporting crude oil from the Gulf of Mexico to Catlettsburg, the expected total volume of oil spilled during the project lifetime would be 790 barrels. Of this total, 570 barrels would be released in the Gulf of Mexico or Mississippi River below St. James, Louisiana and the remainder would be released accidently from the Capline or Ashland pipelines. The VLCC to tanker transfers of crude oil in the Gulf and tanker to storage tank transfers at St. James would cause emissions at maximum annual rates of 600 tons/year and 420 tons/year, respectively. Transfers at St. James, under worst case conditions would cause hydrocarbon concentrations in excess of the 3-hour Federal standard of 160 $\mu g/m^3$ as far as 7.5 miles downwind.

8.3.3 Alternative Pipeline Systems

8.3.3.1 Systems from Tates Creek to Alternative Refineries

The Central Rock facility could fill or withdraw oil from either of two pipeline systems passing through Tates Creek Terminal (Figure 8.3-2):

1. The Ashland 24-inch oil pipeline system runs from Owensboro, Kentucky to the Ashland Refinery at Catlettsburg, Kentucky. It passes through the Tates Creek Terminal and delivers 50 to 70 percent foreign crude to the Ashland Refinery.
2. The Mid-Valley 22-inch oil pipeline system carries predominantly domestic crude oil from Louisiana and Texas into Ohio.

The selection of a distribution system depends to a very large extent on whether another nearby strategic storage facility is constructed and operated at the same time as Central Rock. The design mode of operation includes delivery from Central Rock to the Ashland Refinery at Catlettsburg. However, for purposes of this analysis, another storage facility has been considered (Figure 8.3-2). The Ashland Refinery's capacity could be met adequately by either one of the two facilities. Therefore, Central Rock would probably tie in with a different refinery in order to more efficiently meet the total needs of the SPR Program. The Mid-Valley pipeline system could be used for this purpose.

In actual operation, oil from the Central Rock storage facility could be directed through Tates Creek Terminal to the Lebanon Junction Station of the Mid-Valley system. This would require no additional pipeline construction, but would require the reversing of the Ashland 24-inch pipeline between Tates Creek Terminal and the Lebanon Junction Station to accommodate the required withdrawal demand. This modification accomplished, oil from Central Rock would flow via Tates Creek Terminal to the west through the Ashland 24-inch pipeline to the Lebanon Junction Station, from which the oil would be distributed to another refinery for processing.

The combined interrelationship of the two strategic storage facilities could be accomplished simply, with addition of pump units at Tates Creek Terminal, Owensboro, and the Lebanon Junction Station. Reversal of the section of Ashland's 24-inch line would require check valves, modifications to distribution equipment and physical changes which could be accomplished at station and terminal facilities. Costs for completing the pump modifications in 20 months are estimated to be $560,000. Line reversal of the Ashland 24-inch section between terminal and station (also in 20 months) would cost an estimated $690,000. The combined additional cost (over the design alternative) for modification of the distribution system is estimated to be $1,250,000 (excluding costs associated with delivery from the Mid-Valley pipeline to another refinery). The advantage would be greater flexibility in case the other storage facility were developed.

Filling of the Central Rock storage facility would be accomplished by transporting oil through Mid-Valley to Lebanon Junction, and then to Tates Creek through the Ashland pipeline, as for the primary design.

Two pipeline routes from the Central Rock storage facility to the Tates Creek Terminal have been analyzed. The first, presented as the proposed pipeline alignment in this EIS, is approximately 13 miles long. The second, identified herein as the alternative pipeline alignment, is about 12 miles long. Either of the pipeline alignments would satisfy the fill/withdrawal rate requirements of the SPR program. A comparison of these pipeline routes is presented below.

8.3.3.2 Comparison of the Alternative Pipeline Rights-of-Way

The alignment of both the proposed pipeline and the alternative pipeline is shown on Figure 8.3-3. A comparison of these two alternate rights-of-way indicating the number of stream and road crossings, and structures within 1500 feet of the alignment is given in Table 8.3-7. A brief comparison of both the originally proposed pipeline and the alternative alignment follows with emphasis placed on the alternative right-of-way.

Referring to Figure 8.3-3, the original proposed pipeline follows the Southern Railroad right-of-way corridor from the Central Rock Mine for about three miles in a westerly direction through an area of industrial land use and, after crossing New Circle Road, through an area used for horse farms. It then turns to the southwest and, in a long arc, transitions to the south and then to the southeast, terminating at the Tates Creek Terminal. In the course of this 10.3-mile distance, the proposed pipeline traverses terrain that is gently rolling to steep in gradient and is predominantly in a crop and pasture usage. This alignment was selected to avoid the populated areas of Lexington, Kentucky.

The alternative route (ABC...L) also follows the Southern Railroad right-of-way through an industrial area but, at New Circle Road, makes a transition to the south. From this point to the Tates Creek Terminal (about 12.1 miles) the alternative alignment follows highway rights-of-way for much of its length. Both pipelines would connect with the Tates Creek Terminal for distribution to either the Ashland 24-inch pipeline system or to the Lebanon Junction Station of the Mid-Valley 22-inch pipeline system. Filling of the Central Rock Mine would be accomplished by transporting the oil through the Mid-Valley to Lebanon Junction, and then to Tates Creek through the Ashland pipeline. Distribution of oil from the Tates Creek Terminal depends on allocation decisions which have not been made; therefore, the oil spill analysis for withdrawal terminates at the Tates Creek Terminal. The oil spill analysis for the fill cycle will assume the use of the Tates Creek Terminal facilities as the starting point.

Existing Environment

Physical Setting - Except for a small segment (Central Rock Mine to A) along the Southern Railroad right-of-way (Figure 8.3-3), two different pipeline routes would transport the oil between the mine and Tates Creek Terminal.

Most of the length of the alternative alignment is located adjacent to highway rights-of-way, through areas in residential and agricultural uses. The originally proposed pipeline crosses terrain that is high (about 900 to 950 feet MSL) and that has much steeper slopes than the terrain traversed by the alternative pipeline. Between segments D and L, both pipelines have parallel routes traversing similar terrain.

Ecological Characteristics - The major ecosystems encountered along the pipeline routes are horse farms, forest, crop, pasture, streams, residential, railroad, highway, and industrial land use areas.

Horse farms and other agricultural areas are the dominant land use activities along the originally proposed pipeline corridor, while highway rights-of-way and residential uses are encountered by the alternative pipeline, in addition to those uses. Much of the agricultural lands in the area are characterized by oldfield-pasture vegetation that is composed entirely of ground cover species with no overstory development. Some understory development is evident along the field borders. The dominant species is meadow fescue, followed by Kentucky bluegrass and red top. The upland areas (about 910 to 940 feet) are characterized by mesophytic-wooded slope vegetation. The most dominant of the overstory components is the slippery elm, followed closely by hackberry, blue ash, and bur oak. Other supportive species of the overstory include the American hornbeam, black walnut, sweet gum, sycamore, and black locust. Wildlife expected to be present along the pipeline rights-of-way is discussed on pages 3.6-4 to 3.6-22.

Land and Water Uses - The predominant land uses affected by either pipeline right-of-way are crop and pasturelands and transportation rights-of-way. Most of the roads in the area are secondary roads providing access to the farms and residences in the area. Descriptions of the surface watersheds in the area of the pipeline alignments, water uses, and ground water are discussed on pages 3.3-1 to 3.3-11.

Description of the Pipeline System

The Central Rock storage facility is planned to be filled by pipeline through the Tates Creek Terminal at a minimum rate of 28,000 barrels per day. Withdrawal during an oil supply interruption would utilize the same pipeline system, delivering approximately 93,000 barrels per day to the Ashland pipeline over a 150-day period. Construction of both pipelines would utilize the same size crew and the same type of equipment and laying methodology.

Construction Methods - The basic technique of pipeline construction would be by the conventional dry land method. With the conventional dry land method, a right-of-way width of approximately 20 to 50 feet (average 40 feet) is cleared. Excavation equipment then travels along the right-of-way, digging the pipe ditch to a depth of approximately 6 feet so that the pipeline will have a minimum cover of 3 feet. The pipe joints are then strung out along the pipe ditch and welded together. The required corrosion protection is applied, and the pipe is lowered into the ditch. Pipeline backfill equipment then travels along the right-of-way, backfilling the open ditch with the spoil removed in excavation. Restoration of the right-of-way is made to permit continued use of the land and to allow maintenance access to the line.

Several measures are normally taken to minimize the environmental effects of pipeline laying. All lines are hydrostatically tested to 150 percent of the maximum working pressure, buried and the route marked for protection from mechanical injury. A wire-mesh reinforced concrete coating is placed on the lines both for mechanical and corrosion protection. Sacrificial anodes are used in harsh environments to further prevent corrosion. Culverts, or breaks in temporary spoil banks, are provided to facilitate normal surface water flows. Bulkheads are constructed where pipelines cross, or on either side of major drainage crossings to prevent flow diversion and erosion. All areas are backfilled as soon as possible to restore the terrain to near previous topographical conditions. Finally, remote-controlled shut-offs or block valves are installed on either side of major waterways and in key locations along the route to isolate pipeline segments in case of a possible line rupture.

Operation - The pipeline from Central Rock to the Tates Creek Terminal would be used for both filling and withdrawal of the storage cavern. Actual construction of the pipeline should take less than 6 months. However, surveying the route, obtaining property rights, letting contracts, and obtaining materials might require another year or longer. When the pipeline is completed, however, fill rates would probably be limited only by oil supply, since the pipeline capacity would be sufficient to fill the storage cavern in 71 weeks.

It is not expected that a pumping station would be required to boost line pressure or to achieve full flowrate capacities along the pipeline rights-of-way because of the relatively short length of either the proposed or alternative lines.

Impacts of Pipeline Transportation System

In order to compare the effects of construction and operation for both of the proposed and alternative pipeline oil transportation systems, the two routes shown on Figure 8.3-3 must be considered in some detail. The alternative alignment was developed to incorporate additional engineering considerations and to more fully utilize existing railroad and highway rights-of-way and thus help to avoid extensive clearing and grading of undeveloped lands. For the purpose of route analysis of impact sensitivity within the areas traversed, the routes have been divided into approximately 5000 foot segments A through L, as shown on Figure 8.3-3. Utilizing the most recent available aerial photography, topographic maps and area experience, each segment was then systematically analyzed for a 1500 foot corridor (750 feet on each side of the alignment). Table 8.3-7 provides a summary of impact characteristics for each route.

Storage Site to A - From the Central Rock storage facility to A, both the proposed and alternative pipeline alignments lie within the same corridor which extends northwest from the storage facility to

New Circle Road, adjoining the Southern Railroad right-of-way. The predominant land uses in the area surrounding the corridor are low-density residential, industrial, and trade uses. Elevations in this segment range from about 900 feet to 950 feet. Both pipeline alignments would cross one stream, Wolf Run; one primary highway, new Circle Road; and would involve 11 residences or other structures within 750 feet of either side of the alignment. The only difference between the proposed and alternative alignments is that the alternative alignment crosses the Southern Railroad and travels to the south of its right-of-way, while the proposed alignment is to the north of the railroad right-of-way.

Segment A to B - In segment A to B, the proposed pipeline alignment continues to travel in a westerly direction. It is generally adjacent to the northern side of the Southern Railroad right-of-way, but crosses the railroad twice. The area traversed is gently rolling land, with elevations ranging from 900 to 950 feet and the surrounding areas are generally used for horse farms. The proposed alignment crosses two intermittent tributaries of Wolf Run, and crosses Viley Road, a secondary highway. There are 13 residences and other structures within 750 feet of this alignment that would be affected.

The alternative alignment changes to a southerly direction at point A and generally follows the western right-of-way of New Circle Road. The alternative alignment, within this segment, would involve no stream crossings. This alignment would cross Viley Road, a secondary highway, and would cross an unimproved road in two locations. The area traversed by the alternative is generally flat, with elevations ranging from 950 to 970 feet. Land use in the area to the west of the alignment is agricultural, while to the east, across New Circle Road, it is in low-density residential use, comprising the Holiday Hills area of Lexington. There are 31 residences and other structures within 750 feet of the alignment.

Segment B to C - Near point B, the proposed pipeline alignment crosses the Southern Railroad right-of-way as it changes to a southwesterly direction. After leaving the railroad right-of-way, the proposed alignment traverses hilly terrain with elevations ranging from 900 to 960 feet. The alignment crosses Van Meter Road, a secondary highway, and two unimproved roads which appear to be farm access roads; it also crosses U.S. 60, a four-lane, primary highway, where the alignment turns southeast. After this change in direction, the proposed alignment crosses a pipeline and an unimproved, farm access road. No streams are crossed by the proposed alignment in this segment. The predominant land use affected in the segment is agricultural, and there are 15 residences and other structures within 750 feet of the alignment.

The alternative pipeline alignment continues to parallel the western side of the New Circle Road right-of-way, in a southwesterly direction. This alignment crosses no streams, but involves the crossing of the New Circle Road - U.S. 60 interchange. The land traversed in this segment is generally flat, with elevations ranging from 970 feet to 980 feet. At least seven residences and other structures would be affected. Land use in this area is generally agricultural.

Segment C to D - In segment C to D, the proposed pipeline alignment continues to travel in a southeasterly direction through an area of predominantly agricultural usage. This alignment crosses two intermittent tributaries of Cave Creek. The proposed alignment crosses an unimproved farm road and Parkers Mill Road, a secondary highway. One residence is within 750 feet of the proposed alignment. The area traversed is hilly, with elevations ranging from 910 to 960 feet.

The alternative pipeline alignment travels in a southeasterly direction and parallels New Circle Road to the west of the road's right-of-way. To the north of the intersection of New Circle Road and Parkers Mill Road, the alternative alignment shifts to a westerly direction along the north side of Parkers Mill Road. East of the intersection of Parkers Mill Road and Mill Road, the alignment shifts direction again, this time to the southwest. For the remainder of this segment, the alternative alignment parallels Mill Road, a light-duty road, to the west of the road. The area traversed is principally agricultural and consists of hilly terrain, with elevations ranging from 960 to 1000 feet. One additional road is crossed, Fallon Road, a private road. No streams are crossed within this segment of the alternative alignment. There are nine residences and other structures within 750 feet of the alternative pipeline alignment.

Segment D to E - In segment D to E, the proposed pipeline alignment continues to travel in a southeasterly direction through agricultural land. The area traversed is hilly, open terrain, having elevations ranging from 900 to about 1000 feet. The proposed alignment crosses two roads, Mint Lane, a private road, and an unimproved farm access road. The alignment crosses Cave Creek at the confluence of two intermittent tributaries. This stream crossing is at a point where the streams form a valley with steep banks, the slopes climbing 40 feet within 250 feet of the stream. There are four residences and other structures within 750 feet of the proposed alignment.

The alternative pipeline alignment continues to travel in a southwesterly direction through agricultural land. The pipeline crosses an intermittent tributary of Cave Creek and the intermittent upper reach of that stream. It also crosses Hoffman Road, a private, light-duty, access road, and Cave Hill Road, a light-duty road. In the vicinity of Cave Hill Road, the alternative alignment passes through an area of depressed elevations, although elevations for this segment range from 970 to 980 feet. There is one residence within 750 feet of the alignment in this segment.

Segment E to F - In segment E to F, the proposed pipeline alignment travels in a generally southeasterly direction through an agricultural area. The alignment traverses hilly, open land with elevations ranging from about 900 to 990 feet. This alignment crosses two intermittent tributaries of South Elkhorn Creek which have broad, flat valleys. The proposed alignment also passes just to the west of a farm pond. One unimproved access road is crossed and six residences and other structures are within 750 feet of either side of the alignment.

The alternative pipeline alignment travels in a southwesterly direction from point E for about 1750 feet, where it changes to a southeasterly direction to point F. In this segment, the alignment crosses two intermittent tributaries of South Elkhorn Creek. These crossings will occur in areas where the stream valleys are wooded. The alignment traverses hilly land having elevations ranging from 940 to 990 feet, in an area used for agricultural purposes. The alignment crosses one road, U.S. 68, a four-lane primary highway. There are nine residences and other structures within 750 feet of either side of the pipeline alignment.

<u>Segment F to G</u> - In segment F to G, the proposed pipeline alignment continues in a southeasterly direction in an agricultural area. This alignment crosses a primary highway, U.S. 68, a secondary highway, Higbee Mill Road, and one unimproved access road. It passes approximately 750 feet to the east of the village of South Elkhorn. The alignment also passes about 750 feet to the west of a sewage disposal plant. The terrain traversed by this alignment is hilly with elevations ranging from about 900 feet to 980 feet. The proposed alignment crosses South Elkhorn Creek, the south bank of which is steep, climbing 30 feet in elevation within 125 feet of the stream. There are 12 residences and other structures within 750 feet of either side of the alignment.

The alternative pipeline alignment travels south from point F, then shifts to a southeasterly direction to point G. The alignment crosses three roads: an unimproved farm access road; Higbee Mill Road, a secondary highway; and an unimproved access road to the sewage disposal plant on South Elkhorn Creek. The alignment is generally located south of Higbee Mill Road after its crossing. The alignment crosses South Elkhorn Creek in three places and passes within 250 feet to the west of the sewage disposal plant. These stream crossings are in areas where the stream banks are wooded. The terrain traversed is gently rolling with elevations ranging from 913 to 950 feet. There are three residences and other structures within 750 feet of either side of the alternative pipeline alignment.

<u>Segment G to H</u> - In segment G to H, the proposed pipeline alignment travels in a southeasterly direction in an agricultural area. One road is crossed, Clays Mill Road, a secondary highway. One stream is crossed, an intermittent tributary of South Elkhorn Creek. The proposed alignment passes about 750 feet south of a quarry located near Clays Mill Road. The terrain is hilly with elevations ranging from 950 feet to 990 feet. There is one residence within 750 feet of either side of the alignment.

The alternative pipeline alignment continues in a southeasterly direction, to the south of Higbee Mill Road, in an agricultural area. This alignment crosses South Elkhorn Creek near the confluence of an intermittent tributary. One road, Clays Mill Road, is crossed. The alignment passes approximately 375 feet north of a quarry located near Clays Mill Road. The terrain traversed by the alternative alignment is hilly, with elevations ranging from 920 feet to 980 feet. There are eight residences and other structures located within 750 feet of either side of the alternative pipeline alignment.

Segment H to I - The proposed pipeline alignment, in segment H to I, continues in a southeasterly direction in an agricultural area. The alignment crosses no streams. Three roads are crossed, two unimproved roads and one light-duty, private road. The alignment is located south of Higbee Mill Road and north of the Jessamine County line. The terrain traversed is hilly with elevations ranging from 960 feet to 1010 feet. There are three residences and other structures within 750 feet of either side of the proposed pipeline alignment.

The alternative pipeline alignment continues to travel in a southeasterly direction in an agricultural area. The alignment crosses one stream, an intermittent reach of South Elkhorn Creek. Four road crossings are involved with the alternative alignment: two unimproved farm access roads; one light-duty, private road; and Higbee Mill Road, a secondary highway. After crossing Higbee Mill Road the alignment parallels that road to the north. There are two residences or other structures within 750 feet of either side of the alternative pipeline alignment.

Segment I to J - The proposed pipeline alignment, in segment I to J, continues in a southeasterly direction crossing an agricultural area. No streams are crossed in this segment. Shortly after leaving point I, the proposed alignment passes near the southwest corner of a power substation and crosses five powerline corridors. This alignment also crosses the Southern Railroad tracks and Nicholasville Road, a primary highway. The terrain traversed is gently rolling with elevations ranging from 990 feet to 1020 feet. There are 11 residences and other structures within 750 feet of either side of the proposed pipeline alignment.

The alternative pipeline alignment continues in a southeasterly direction, paralleling Higbee Mill Road to the north of its right-of-way. Near the intersection of Higbee Mill Road and the Southern Railroad tracks, the alignment crosses Higbee Mill Road to the south and then crosses the Southern Railroad tracks. In the vicinity of this intersection, the alignment passes about 375 feet north of the power substation and crosses one powerline corridor. The alignment then transitions back to the northern side of the Higbee Mill Road right-of-way, and continues to parallel it. The alignment passes about 125 feet to the south of the Waveland Museum. One other road is crossed in this segment, Nicholasville Road, a primary highway. No streams are crossed. There are about 55 residences within 750 feet of either side of the alignment, the majority of which are located in a subdivision to the north of the alignment near point J.

Segment J to K - The proposed pipeline alignment, in segment J to K, continues in a southeasterly direction in an agricultural area. No roads are crossed in this segment. Four stream crossings are involved: one intermittent tributary of Hickman Creek is crossed twice, and the alignment crosses the confluence of two intermittent tributaries of Hickman Creek. The terrain traversed in this segment is very hilly with elevations ranging from 930 feet to 1010 feet. There are no residences or other structures in the vicinity of the alignment.

The alternative pipeline alignment continues to travel in a southeasterly direction, traversing steep terrain with elevations ranging from 940 feet to 1000 feet. No roads are crossed. The alternative alignment crosses two intermittent tributaries to Hickman Creek. There are nine residences and other structures within 750 feet of either side of the alternative alignment.

Segment K to L - The proposed pipeline alignment, in segment K to L, continues in a southeasterly direction through agricultural lands. No roads are crossed in this segment. At point K, the alignment leaves the stream valley formed by an intermittent tributary of Hickman Creek, climbs the steep terrain and crosses the same tributary at a point downstream. Elevations within this segment, range from 900 to 1000 feet. The alignment also crosses a small farm pond and a powerline corridor. There is one residence within 750 feet of the proposed pipeline alignment.

The alternative pipeline alignment continues, within this segment, to travel in a southeasterly direction. There are no road crossings involved, although one powerline corridor is crossed. There are three stream crossings in this segment: one intermittent tributary of Hickman Creek is crossed twice, another is crossed once. There is one residence within 750 feet of the alternative pipeline alignment.

Segment L to Tates Creek Terminal - At point L, the beginning of this segment, the proposed and alternative pipeline alignments transition into a common corridor. There are no roads crossed by either, nor are any residences involved. The one stream crossing is that of Hickman Creek in a broad, flat valley.

Summary

A summary comparison of the environmental impacts expected to occur for the proposed and the alternative pipeline route alignments is given in Table 8.3-8. The alternative route appears to be preferable from the point of view of shortest distance and thus construction costs, but differences in potential for environmental damage between the two routes is not very significant. The shorter distance traversed by the alternative alignment (12.12 miles as opposed to 13.30 miles for the proposed alignment) also results in less excavation, which would reduce the amount of sediment that would be transported to surface waterways. On the other hand, the alternative alignment involves more stream crossings than would the proposed alignment.

The alternative route follows existing railroad and highway rights-of-way, as much as possible, to avoid further encroachment upon the natural environment, especially the horse farms in the area. The use of these existing transportation corridors would also reduce the impact of construction noise and would tend to avoid noise sensitive areas. The alternative route also is reduced in total length compared to the originally proposed route, and thus should reflect a reduction in pipeline costs and minimize ecological impacts. The alternative route has also been relocated to avoid proximity to a highly developed subdivision.

Both pipeline alignments will require the clearing of some timber along their rights-of-way. Based on an initial construction impact right-of-way on the average of 40 feet (assuming the right-of-way would range from 20 to 60 feet depending upon the area traversed, for example residential or railroad areas compared to open lands) required to lay the pipelines, the acreage impacted along each of the routes has been estimated for each of the major land uses which would be preempted by the alignments, as follows:

Land Use	Proposed Alignment	Alternative Alignment
Horse Farm	8.24 Acres	0 Acres
Industrial	0.58 Acres	0.58 Acres
Railroad Right-of-Way	12.27 Acres	4.59 Acres
Forest	0.73 Acres	2.75 Acres
Residential	2.42 Acres	1.47 Acres
Crop and Pasture	40.24 Acres	24.58 Acres
Highway Right-of-Way	0 Acres	24.79 Acres
Total	64.48 Acres	58.76 Acres

Comparison of the data shows that the proposed pipeline would affect a total of about 64 acres consisting mostly of crop and pastureland (62 percent); the alternative route would impact on 59 acres distributed among crop and pastureland (42 percent), highway rights-of-way (42 percent), and railroad rights-of-way (eight percent). The notable difference between the proposed and alternative pipeline routes, is that the former would require a greater use of agricultural land than does the latter.

Because of the similarity in estimated lengths for both the alternative (12.1 miles) and the proposed (13.3 miles) pipeline, the frequency of a spill for either of the lines would be about the same. Thus, the estimated spill risk (Appendix F) per year for the alternative route would be 0.00605 compared to 0.00675 for the proposed pipeline. If the pipelines were kept full of oil during the standby or storage period, the frequency of a spill in this mode is estimated to be 0.14 events (1 chance in 7) for a spill over the 22-year life (1978-2000) of the project. Assuming the average spill size of 1083 barrels (U.S. pipeline average), the total spill expectation would be 156 barrels (6552 gallons) over the life of the project. Expected spill frequencies during the 22-year project life are:

None - 86.16 percent
One - 12.88 percent
Two or More - 0.92 percent

The maximum credible spill for either the alternative or the proposed route is estimated to be 2500 barrels (105,000 gallons). Appendix F contains a more detailed treatment of oil spill risks for the storage and terminal facilities which are the same for both the proposed and the alternative pipeline routes.

Physical Impacts

A. Construction - The primary physical impact of either the proposed or alternative pipeline system is caused during construction by excavation along the pipeline route. Acreages of each land use/habitat type affected by an assumed 40-foot wide construction right-of-way has been described above. Assuming that dry land excavation will be used throughout the entire length of either pipeline, an estimate of total sediment volumes excavated can be made. For dry land excavation (estimated at 10,000 cubic yards per mile), the total volume is 133,000 cubic yards for the proposed route and 121,000 cubic yards for the alternative route.

This excavated material must be placed in temporary spoil banks along the pipeline route until the line is installed and pressure-checked. During this period of time, an insignificant amount of interstitial water would be released to surrounding areas. Leaching and erosion are also likely to occur from runoff and normal surface water flow during the 4 to 6-month period of pipeline construction.

To prevent damming, low water quality, and stagnation in streams adjacent to the pipeline route, spoil banks should be carefully placed to avoid disruption or blockage of normal surface water flow patterns. This would allow for dilution of spoil leachate and the movement of aquatic organisms in the streams. If several construction crews worked simultaneously, completed segments of the pipeline could be pressure-checked and backfilled immediately without waiting for completion of the entire line. Bulkheads could be constructed immediately after pipeline installation at various locations to reduce the impact on major streams.

Without backfilling and bulkheading, surface and ground water flow patterns could be disrupted along the entire pipeline route. Flow stagnation and other possible effects could alter habitat over a wide area through the streams and wetland areas affected. Current practice is to minimize this disruption by proper restoration measures such as described above.

Backfilling will not necessarily restore areas to natural conditions in all cases. For example, in the floodplain and streambeds erosion and compaction inevitably lead to a loss of some material. After backfilling, a shallow water canal could remain along the pipeline route. Assuming a 50-foot wide canal, this will represent a permanent loss of approximately 0.1 square miles of streambed for both routes. This canal will also affect the turbidity and local surface water flow patterns to some degree.

Backfilling in dry land and woodlands is usually successful. In dry land areas, prior topography of the terrain can be duplicated. In woodlands, there would be a small loss of both trees and material, but often not enough to significantly affect the final elevation or regrowth of other vegetation. It is assumed, however, for the present analysis that a 40-foot corridor through the forest areas is permanently lost as wooded habitat.

Ground water systems should not be affected by pipeline construction since all excavations are too shallow to disturb the local aquifers.

The impact of increased noise levels (see Section 4.2.4) during construction of the alternative pipeline route to residents along the right-of-way would be great. Trucks, hoes, air compressors, impact hammers, drills and detonation equipment will be required in areas where limestone rock is encountered. Pipeline construction activity noise (L_{eq}) 500 feet from construction through these limestone areas is estimated to be 72dB. Blasting would produce instantaneous sound levels of 91dB at 1000 feet. Since a major portion of the alternative route passes near residential areas, the noise increase in these areas would be high. This increase may cause public annoyance to residents within 1-mile of the construction activity. But according to EPA guidelines at 10 blasts per day and an overpressure of 113dB, public health and welfare would not be degraded.

B. Operation - Normal operation of the pipeline system should have no effect on physical conditions along the corridor. The entire route can be allowed to reseed and revegetate naturally or, in certain aesthetically or ecologically sensitive areas, vegetation can be intentionally transplanted. Permanent right of access must be retained for system repairs and maintenance.

Spills that occur on dry land or wetlands will probably not spread as far as in a waterway such as South Elkhorn Creek. Destruction of vegetation and wildlife would be great, and residual oil in the soil will affect recovery of the area. Nearly all fractions of crude oil are attacked by bacteria and eventually decompose; thus, a single heavy oil spill of 156 barrels does not represent a permanent stress on the environment.

Transportation of oil by pipeline minimizes the problem of hydrocarbon vapor emissions which occur with barge or tank truck transportation, particularly since the pipeline would be left full of oil during standby storage. Filling of the cavern would displace vapors from the system. These vapors would either be flared, as presently proposed, or passed through a vapor condensation system. In either case, no appreciable amount of hydrocarbons would be released. With a vapor condensation system, a minimal amount of oil would be lost from the storage system.

The presence of karst areas along the pipeline routes presents a risk to the pipeline itself. Exposure of the routes to karst areas presumably increases the risk above the national average, but there are no data to quantify the additional risk. However, spills due to karst collapse should not present an undue environmental hazard to the surface because a break in the line should result in most oil being confined within the karst cavity and local shallow aquifer.

Biological Impacts

A. Construction - Pipeline construction through the uplands, streams, and floodplain traversed by either the proposed or alternative route, can have several possible effects on biota. Excavation can directly destroy vegetation and sessile wildlife. Reduction in habitat can displace animal life and put stress on neighboring animal populations. Spoil banks can disrupt normal migration patterns for aquatic life. Spoil runoff can lower water quality, smother benthos, and stress populations in adjoining areas. Noise and the physical presence of construction crews can disturb wildlife. Greatly altered physical conditions can prevent regeneration of productive habitats after construction is complete. The extent and significance of these impacts can depend to a large degree on the success of restoration measures in mitigating potentially lasting construction effects.

An indication of potential direct effects of pipeline construction on the ecology of the area is presented in Sections 4.2.5.1 and 4.2.5.2. A worst case effect would occur if adjacent habitats were already at full carrying capacity and no further population increase could be absorbed. This would result in the death of individuals least able to compete for food and shelter in numbers equal to those displaced. This may be true for certain of the species present, but probably not for the less common species, which may be limited by factors other than habitat acreage. For the present analysis, dry land and wetland areas are assumed to recover fully in two years. Woodland is assumed to recover full productivity in 10 years (though regrowth may take 30 years or longer).

The agricultural areas traversed by the proposed pipeline amount to 75 percent of the total acreage affected, and represent an area that has been modified but has habitat value. The alternative alignment traverses 24.6 acres of agricultural land which represent 41.8 percent of the total area traversed. Much of this land, however, is close to more urban uses and to transportation corridors which might limit its value as wildlife habitat.

The total loss of vegetation and wildlife along the pipeline routes is not a significant portion of the vast resources of similar kind still existent. Offsite effects caused by spoil disposal and surface water disruption may increase the temporary effects for a period of a week to several months, but should not increase the permanent effects if construction is carried out properly.

A significant advantage to the alternative route in terms of biological impact is the fact that it parallels existing rights-of-way for much of the entire length. Thus, the habitat directly impacted should be of generally lower wildlife value and productivity than that along the proposed route, especially in the wooded areas. However a pipeline does add to the incremental construction impacts occurring throughout the streambeds affected. By following an existing right-of-way no previously undisturbed areas are directly affected. Widening of streambeds or laying pipeline parallel to the streams increases the risk of flow disruption and creates a pipeline corridor likely to be used again in the future.

B. Operation - Operation of either the proposed or alternative pipeline affects biota only in the case of an oil spill. Because of the presence of many streams along the pipeline routes, oil spills from buried pipelines can have significant impacts on large areas and affect the vegetation and wildlife unless the spill occurs in the vicinity of a, small enclosed or isolated water body or in heavy terrestrial vegetation where the effects are usually localized.

Existing pipeline technology, however, provides excellent supervisory control systems for monitoring oil transport. For example, a pipeline leak can be detected by meters; flow can be automatically shut down and block valves closed to isolate line segments. Oil spill recovery teams and cleanup equipment can then be quickly transported to the spill scene to rapidly cleanup the oil.

For the maximum credible spill treated in the previous section on physical impacts, an 80 acre area of riparian vegetation could be destroyed. Birds, mammals, and fish are the most likely fauna to be affected. The impact would be especially great on waterfowl if the spill occurred when many species are resting in the area. On land, however, oil spreading would be limited. Habitat recovery in all but the most heavily oiled areas would be expected to be complete in two to three years.

Expected oil spill (156 barrels) impacts would be much lower than those from a maximum credible spill (2500 barrels). A total of 2500 barrels spilled on land might destroy 80 acres over the life of the project. This is a small fraction of the available woodland and agricultural land in the region.

Block valves at major stream crossings, and sensitive leak detection and shut-down systems to be designed into either pipeline would generally limit spills to considerably less than the maximum credible oil spill.

Spills which would occur along South Elkhorn or Hickman Creeks could be carried downstream if not contained or recovered. Both of these streams have good water quality and both are tributaries of the Kentucky River, which could be the receiver of oil if a spill were not contained.

Socioeconomic impacts - Socioeconomic impacts of construction and operation of either the proposed or alternative pipeline primarily relate to land use, employment, income, and property tax revenues. Construction and operation of a pipeline to the Tates Creek Terminal would affect highway traffic at road crossings only for short periods. Domestic water supplies would not be affected by either route. Land use restrictions will be required for a 20 to 60-foot right-of-way, but these may alter current or potential usage only in areas already developed.

Assuming that the 12.1-mile alternative route is selected, construction will require the expenditure of an estimated $12.1 million in capital costs. Construction of the pipelines might require up to 1-year for either route and would employ 150 workers full time. Energy costs in constructing the pipelines and pumping the oil to and from storage 5 times over the life of the project would be the same for both lines.

Most pipeline construction workers are specialists who move from job to job. There is little requirement for common day laborers, so the pipeline installation is not likely to generate significant local employment along the route. Most of the pipeline crew will take temporary lodgings in communities near the right-of-way and relocate as work progresses. Few workers will bring dependents or spend significant amounts of their wages locally.

After completion, it is assumed that property taxes would be levied on the pipeline by the counties through which it passes. Alternatively, an in-lieu tax might be paid on the facility if it remained in public ownership. The incremental impact of such revenues on county or state finances would not be very significant.

Operation of the pipeline requires only a few personnel. Numbers increase during filling and withdrawal operations because of the need to tend valves and pumps. During standby, however, only maintenance and security personnel are required. Accordingly, operations will place no significant demand on the area labor force; for the same reasons, the pipeline will generate little local wage income.

8.3.4 Expansion of Ashland Pipeline Capacity

The present capacity of Ashland's 24-inch pipeline from Owensboro Station to the Catlettsburg Refinery (Figure 8.3-2) is 152,000 BPD. Presently 124,000 BPD are processed at the refinery, leaving a potential 28,000 BPD for filling the Central Rock Mine. However, it would be possible to expand the capacity of Ashland's pipeline to 185,000 BPD simply by using an existing standby pump at Owensboro and installing a new pump unit at Lebanon Junction. This would provide a potential 61,000 BPD for use in filling the Central Rock Mine.

As indicated in Section 8.3.3, another site in the vicinity of the Catlettsburg Refinery may be developed for the SPR program. If this occurs, it is expected that oil would be provided to both storage facilities through the Ashland 24-inch pipeline. In this case, it may be assumed that approximately half the available flow rate would go to each site, or 30,500 BPD. This is very nearly identical to the assumed fill rate of 28,000 BPD used in evaluating the environmental impacts of the Central Rock Mine storage site. This alternative therefore requires no further analysis of impacts, though it should be noted that in the absence of pipeline capacity expansion, development of the second oil storage facility would require an alternative oil delivery system or an extended period of fill for one or both of the storage sites.

If the storage site near Catlettsburg is not developed, the potential fill rate at Central Rock could be as high as 61,000 BPD. This would reduce the fill time from 500 days (71.4 weeks) to 230 days (32.8 weeks). It would also mean that the full 14 million barrel storage capacity would be available during the ESR period for either mine development option (Figures 2.3-1 and 2.3-2).

Other aspects of the site development plan and related impacts would be changed very little by the higher fill rate. Oil spill risk should be unaffected. The length of the 5 to 7 jobs created by the filling operation would be reduced by 55 percent, but this effect is not significant. The most significant change would be a reduction in hydrocarbon losses to the atmosphere from the Tates Creek Terminal storage tanks. Exposure to leakage would be reduced by 270 days, thereby lowering the hydrocarbon loss to an estimated 23,000 pounds (55 percent reduction) per fill period. In effect, this would shorten the duration of hydrocarbon emissions from 500 days to 230 days at Tates Creek.

8.3.5 Alternative Transportation System, Gulf Coast to Tates Creek

It is assumed in estimating impacts of transporting oil from the Gulf Coast to Tates Creek Terminal for storage in Central Rock 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 St. James, Louisiana, then existing pipelines to the oil to Tates Creek. However, another possibility would be to use the proposed Louisiana Offshore Oil Port (LOOP) facilities which would connect VLCCs in the Gulf directly to St. James; this alternative is contingent on issuance of construction and operating licenses to LOOP, 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 LOOP facilities will consider 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 20 miles to shore and 80 miles to St. James. A temporary storage facility will exist in an underground salt dome at Clovelly oil field in Lafourche Parish, 50 miles southeast of St. James. Impacts associated with VLCC transport of oil to the SPM buoy are not considered. Impacts associated with transport of oil from St. James to Tates Creek 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 LOOP EIS (U.S. Department of Transportation, 1976), transfer of 14 million barrels of oil from VLCCs to the LOOP pipeline would result in an estimated 0.12 spill incidents, totaling 22 barrels of oil (183 barrel average spill). Pipeline transport would require approximately 7 to 14 days of system use and an estimated 0.003 incidents, totaling 3 barrels of oil, per fill period. Thus, for 5 fill periods, there would be a total expectation of 0.615 spill incidents resulting in release of 125 barrels of oil into the environment; 88 percent of the oil would be released into the Gulf 18 miles from shore with negligible environmental impact. This is a 96 percent reduction in spill frequency and a 68 percent reduction in oil release compared to the primary alternative of using 45 MDWT tankers on the Mississippi River. Maximum credible spill size is estimated to be 2000 barrels for SPM operations and 10,000 barrels from the LOOP pipeline.

A second potentially significant impact is hydrocarbon emissions. Vapor emissions for this alternative would be limited to that caused by VLCC ballast uptake (except for a negligible 45 lbs/day estimated to leak from system piping at Clovelly for a period of 15 days). 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 112 tons per fill or 16 tons/day for 7 days. Thus for 5 fill periods, there would be a total release of 560 tons of hydrocarbon vapor, all of it 18 miles from the coast and primarily consisting of non-reactive methane and ethane fractions. This represents an 84 percent reduction from total vapor emissions associated with the primary alternative. Hydrocarbon concentrations may exceed 160 $\mu g/m^3$ for distances up to 9.6 miles downwind of the VLCC during the 7-day transfer period.

A third potentially significant impact is energy use. Handling and pipeline pumping to transport oil to St. James is estimated at approximately 100,000 MMBTU, or 18,000 barrels of oil equivalent, per fill. This is approximately 57 percent less energy than is required to transport the oil to St. James by 45 MDWT tanker (primary alternative).

There are other, less tangible, advantages associated with using the LOOP facilities to transport oil to St. James. All tanker traffic will be at least 18 miles from the coast rather than on the heavily travelled Mississippi River. Oil spills and hydrocarbon emissions will be further from coastal marshes and population centers. There is less likelihood of inducing tanker shortages or higher tanker transport rates. In summary, should the LOOP facilities be constructed and have sufficient capacity to transport oil for storage at Central Rock, associated environmental impacts should be smaller than for tanker transport up the Mississippi River. Impacts north of St. James 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 2 10,000 bbl surge tanks 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 (112 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 $32,000 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, 74 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 disruption of wildlife during drilling	Greater impact than proposal.
MARINE OPERATIONS	Small amount of erosion on channel bottom	No impact	Expected oil spill of 271 bbls with tankers, 1,087 bbls with barges	Barge hydrocarbon emissions of [illegible] lb/day during unloading, tanker emissions of 8,286 lb/day during unloading and 20,951 during loading. Concentrations in excess of 160 ug/m³ 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 ug/m³ 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	[illegible] people employed during operation, [illegible] employed during oil recovery, payroll during operation of $18,000 per month, payroll during recovery of $47,800 per month

(P) Proposed system design

(A) Alternative to the proposed system design

Bayou Choctaw

ENVIRONMENTAL IMPACT SUMMARY

Table 8.3-2

ACTIVITY	IMPACTS DUE TO ACTIVITIES						
	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.	118 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 $82,500 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 $43,000 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 $7,500 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 µg/m³ as far as 10 km downwind; maximum concentrations of 7500 µg/m³ 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 µg/m³ for considerable distance downwind (5-10 km); maximum concentration at 0.5 km of 6,125 µg/m³.	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

ACTIVITY	GEOLOGY AND SOILS	LAND USE	WATER QUALITY AND SUPPLY	AIR QUALITY	NOISE	ECOLOGY	SOCIOECONOMIC
	IMPACTS DUE TO ACTIVITIES						
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 of 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 5,560 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, 45 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.	Hydrorarbon 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 $160 \mu gm/m^3$ as far as 6.8 mi. downwind.	55 dB at 500 feet for one barge passby; frequency of occurence 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 37% 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 731 tons/yr, causing concentrations in excess of $160 \mu gm/m^3$ 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.	2-3 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

Weeks Island

ENVIRONMENTAL IMPACT SUMMARY

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 hydrocarbons, 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 undeveloped 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 severance 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 owns due to distance.	Temporary displacement of local aquatic life by enlargement of slip, approximate loss of 50 x 10^5 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 $160\mu gm/m^3$ 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 significantly 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 [illegible] 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 $160\mu gm/m^3$ 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

Ironton

TABLE 8.3-6

ENVIRONMENTAL IMPACT SUMMARY

ACTIVITY	IMPACTS DUE TO ACTIVITIES					
	GEOLOGY AND SOILS	LAND USE	WATER QUALITY AND SUPPLY	AIR QUALITY	NOISE	ECOLOGY	SOCIOECONOMIC
Storage Site and Terminal Facilities Construction	Slight erosion of bare ground; minimal re-grading of site.	2 acres for pump station on site; 2 acres for pipeline terminal facilities.	Little adverse impact to Ice Creek or Ohio River from 40 million gallons of treated mine seepage; no significant ground water contamination.	Small quantities of dust, NO_x, SO_2, CO and hydrocarbons due to construction vehicle activity; no violation of primary standards.	1 dB and 5 dB increase in daytime and nighttime ambient sound levels in the city of Ironton.	Site already highly disturbed; negligible loss of habitat.	No impact on any known archaeological or historic resource; no significant transportation impact; total gross payroll of $1.5 million; loss of $5500 in property taxes if federally owned.
Pipeline Construction (13-mile pipeline between Catlettsburg Terminal and site)	40 acre/feet of disturbed soil over route; 8 acre/feet of soil subject to runoff erosion.	63.52 acres for pipeline right-of-way corridors.	Slight increase in turbidity, suspended solids, and sediment loadings in Ice Creek; lowering of pH, increased heavy metal concentration, increased nutrients and BOD in Ohio River, significant adverse impact localized and temporary only.	Increased dust, NO_x, SO_2, CO and hydrocarbons due to construction activity; no violation of primary standards.	6 dB increase in ambient sound levels 1 mile from pipeline construction; 91 dB noise level at 1000 feet from blasting through surface limestone.	Loss of 2700 square feet of aquatic habitat from rights-of-way through 9 small streams; 20 acres of woodland habitat lost due to pipeline right-of-way.	Included in above impacts.
Pipeline Accidents (Between St. James Terminal and site)	Soil fouled in vicinity of pipeline.	Slight possibility of an oil spill reaching developed water recreation areas.	(Between Catlettsburg Terminal and site) Average expected spill size in surface waters is 1,000 barrels; maximum credible spill size-3000 barrels; slight chance of oil spill reaching Ohio River and affecting downstream water supplies. Expected total volume of oil spilled-205 barrels (between St. James and Catlettsburg Terminal); maximum credible spill 10,000 barrels.	Hydrocarbon vapor emissions from spilled oil.	Noise from clean up operations.	Significant impacts include: oiling of birds, mammals and aquatic organisms, loss of about 5-7 acres of vegetation and grasslands, (between Catlettsburg Terminal and site), loss of wildlife habitat and food supply, and contamination of soils.	No impact.
Facility Operation	No impact.	No impact.	Minimal impact expected; no discharge of wastes to surface water or ground water; very remote possibility of contamination resulting from accidents involving explosion from oil pressurization, seepage of oil from mine, or displacement of oil resulting from water inflow into mines.	42 lb/day hydrocarbons and .04 lb/day hydrogen sulfide expected from leakage of vapors from pipelines; 141 lb/day H_2S emitted if cavern unflared; 281 lb/day SO_2 emitted if vapors are flared, no violation of primary standards.	No anticipated increase in ambient sound level in city of Ironton; equivalent sound level contribution from pipeline facilities in the Catlettsburg Terminal would be about 55 dB at 500 feet.	No impact.	2-3 permanent employees needed to monitor equipment and provide security; 8-10 persons required for 107 weeks during fill and 21 weeks during withdrawal.
Marine Operation	Small amount of erosion on harbor bottom.	No impact.	Maximum credible spill in Gulf 60,000 barrels; total expected spillage of 585 barrels-105 at St. James, 480 in Mississippi River or in the Gulf.	"Breathing" losses from tankers and barges-maximum annual rate atmospheric loading rate of 30 tons/yr.; maximum annual hydrocarbon emission rates for tanker transfers in Gulf-600 tons/yr.; transfers at St. James would cause emissions in excess of 3-hour Federal standard of 160 $\mu gm/m^3$ as far as 7.5 miles downwind.	Slight impact.	Maximum credible oil spill for the Gulf could render 840 to 1,680 acres of marsh non-productive for 2 years.	Reduced marketability of fish fouled by oil; possible increase in demand for tankers may have positive effect on economy.

TABLE 8.3-7 Comparison of Central Rock pipeline alternatives for number of streams, roads, and structures affected by right-of-way

PIPELINE SEGMENT	STREAM CROSSINGS		ROAD CROSSINGS		STRUCTURES WITHIN 1500' ROW[a]	
	Proposed Alignment	Alternative Alignment	Proposed Alignment	Alternative Alignment	Proposed Alignment	Alternative Alignment
Central Rock to A	1	1	1	1	11	11
A - B	2	0	2	2	13	31
B - C	0	0	5	3	15	7
C - D	2	0	1	2	1	9
D - E	2	2	3	2	4	1
E - F	2	2	1	1	6	9
F - G	1	3	3	3	12	3
G - H	1	2	1	1	1	8
H - I	0	1	3	4	3	2
I - J	0	1	2	3	11	55
J - K	4	2	0	0	0	9
K - L	1	3	0	0	1	1
L to Tates Creek Terminal	1	1	0	0	0	0
TOTALS	17	18	22	22	78	145

[a]Structures Include: Residences, Churches, Schools, Office Buildings, and Farm Structures

TABLE 8.3-8 Summary comparison of proposed and alternative pipeline route alignments for the Central Rock Mine

Impact Area	Proposed Route	Alternative Route	Preferable Route
Geology/Soils	-133,000 cubic yards of excavation -Locally significant to surface topography, predominantly short-term -Some involvement of areas having karst geology	-121,000 cubic yards of excavation -Locally significant to surface topography, predominantly short-term -Some involvement of areas having karst geology	Alternative Route
Hydrology/ Water Quality	-17 waterway crossings -0.1 square mile of streambed loss -Locally significant during construction	-18 waterway crossings -0.1 square mile of streambed loss -Locally significant during construction	Proposed Route
Air Quality	-Significant at Central Rock Mine, Tates Creek Terminal, and along pipeline route	-Significant at Central Rock Mine, Tates Creek Terminal, and along pipeline route	No Significant Difference
Noise	-78 structures within 1500' noise impact radius -Areas traversed experience lower ambient noise levels - reflective of more natural setting	-145 structures within 1500 ' noise impact radius -Areas traversed presently experience higher ambient sound levels due to existing transportation corridors	Alternative Route
Species and Ecosystems	-64 acres of wildlife habitat traversed -Disruption of previously undisturbed areas	-25 acres of wildlife habitat traversed -Construction in areas previously disrupted by construction activities (i.e., along highway ROW)	Alternative Alignment

TABLE 8.3-8 Continued

Impact Area	Proposed Route	Alternative Route	Preferable Route
Socioeconomics	-Some short-term construction effects, both beneficial and adverse -Possible loss of property taxes -Estimated $13.3 million in capital costs	-Some short-term construction effects, both beneficial and adverse -Possible loss of property taxes -Estimated $12.1 million in capital costs	Alternative Route
Oil Spill Risks	-Estimated spill risk per year would be 0.00675	-Estimated spill risk per year would be 0.00605	No Significant Difference

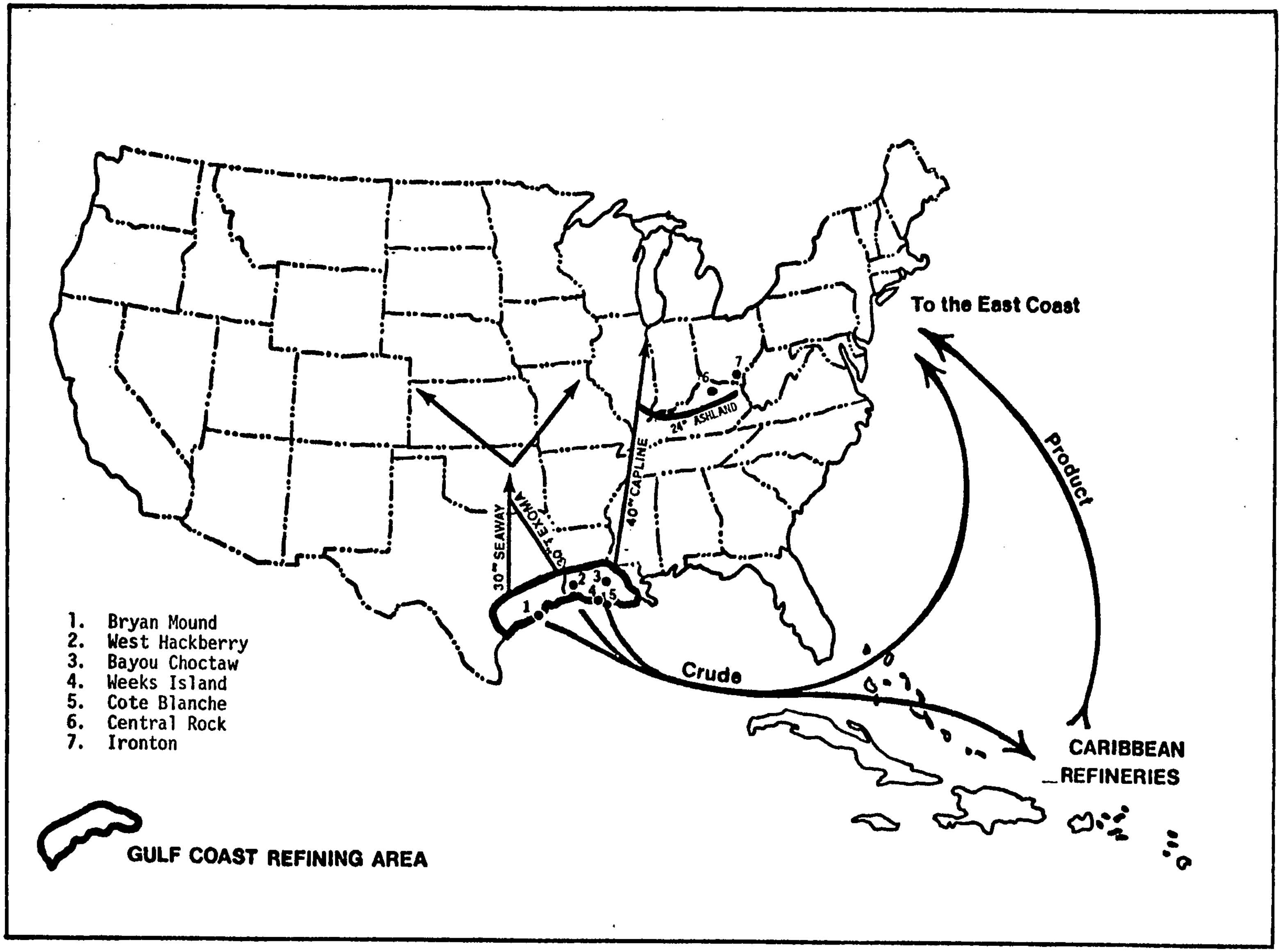


Figure 8.3-1 SPR Distribution Network

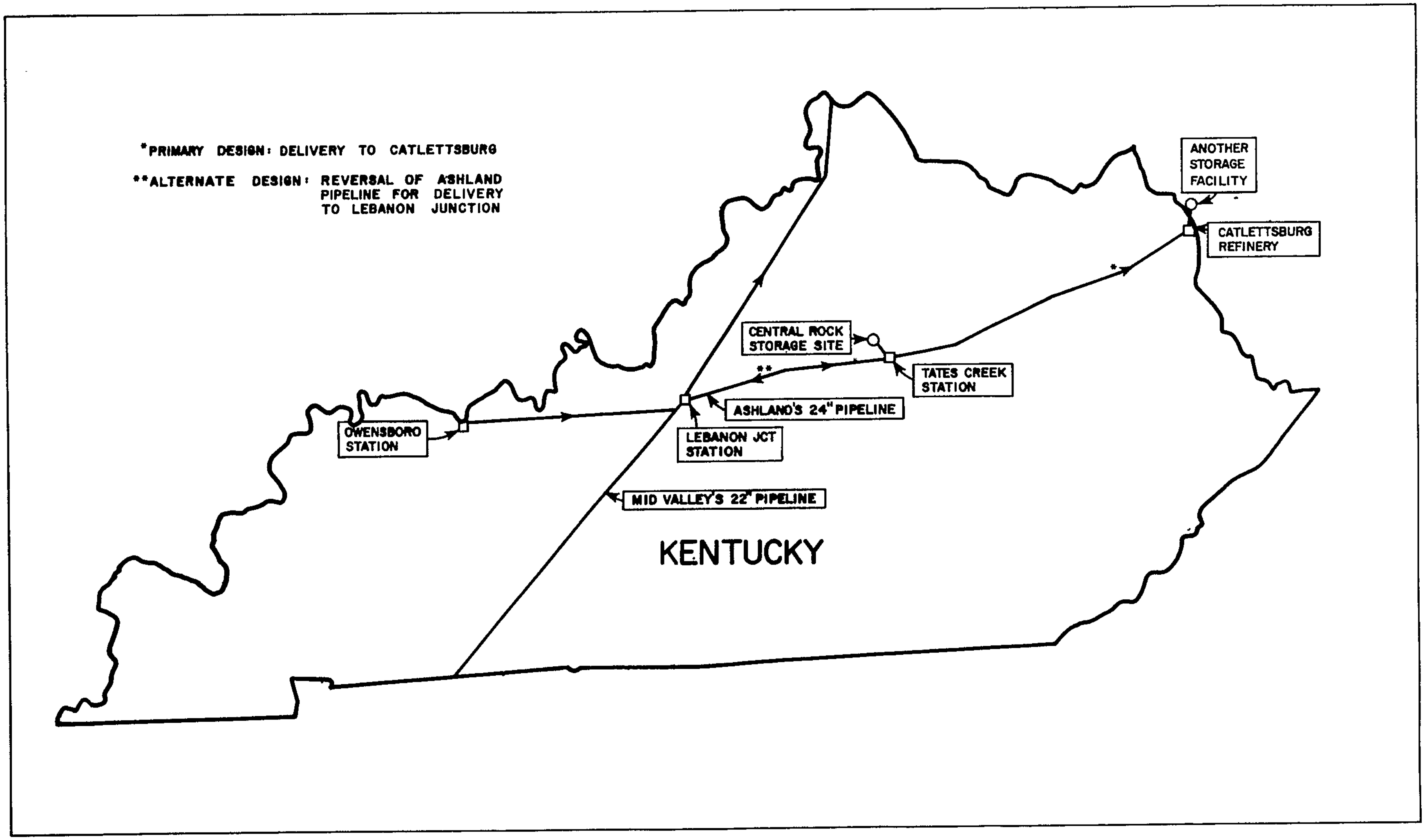


FIGURE 8.3-2 Alternative pipeline systems - Central Rock

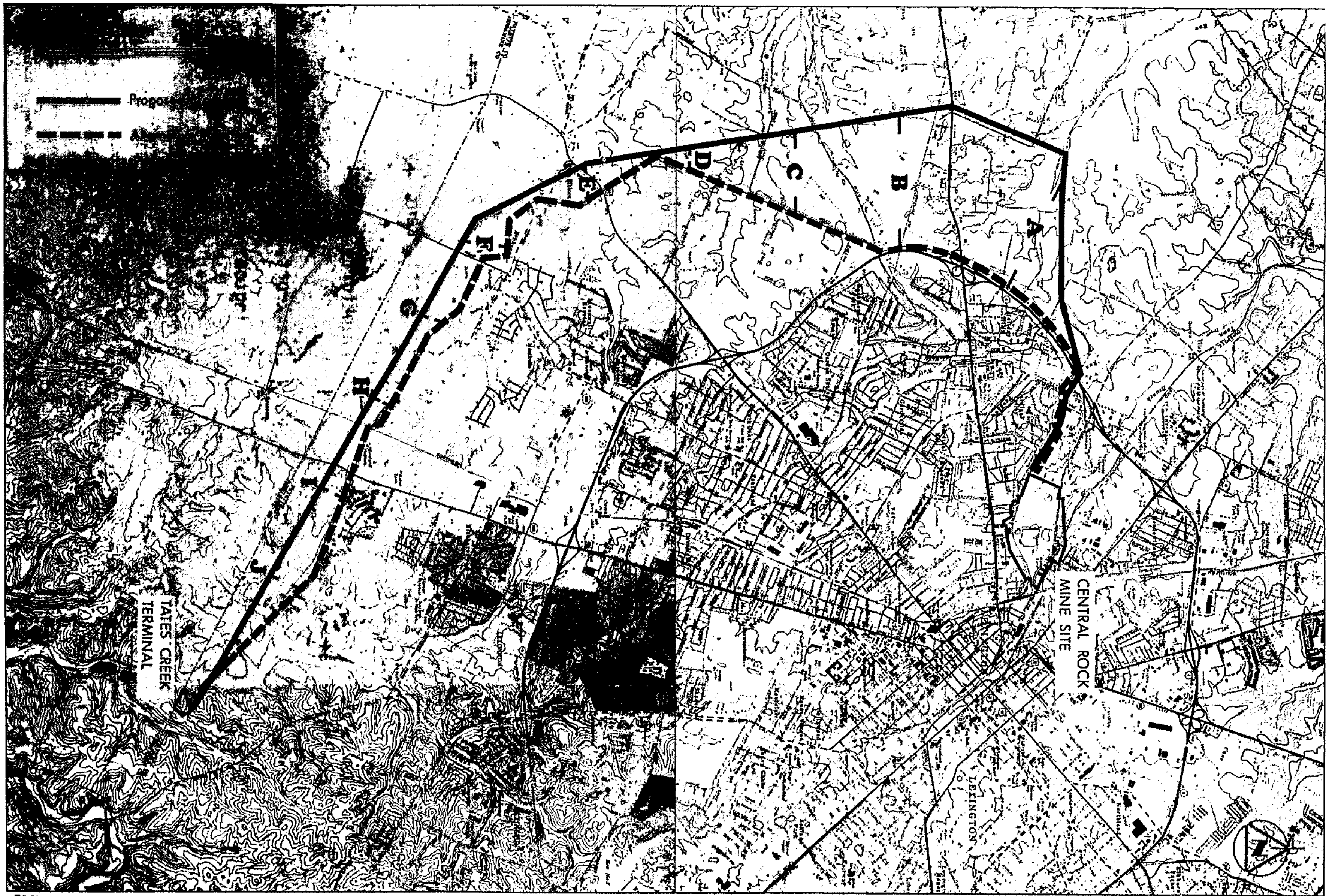


FIGURE 8.3.-3 Proposed and alternative pipeline routes between Central Rock Mine site and Tates Creek Terminal

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	Lexington, Kentucky
Department of the Army, Corps of Engineers, Louisville District	Louisville, Kentucky
Department of the Interior, Fish and Wildlife Service	Decatur, Alabama
United States Geological Survey, Water Resources Division	Louisville, Kentucky

AGENCY - STATE	LOCATION
Department for Natural Resources and Environmental Protection, Division of Reclamation, Underground Mines Department	Frankfort, Kentucky
Department for Natural Resources and Environmental Protection, Water Quality Division	Frankfort, Kentucky
Department of Fish and Wildlife Resources, Division of Game	Frankfort and Danville, Kentucky
Department of Mines and Minerals, Division of Oil and Gas	Frankfort, Kentucky
Department of Transportation, Environmental Systems	Frankfort, Kentucky
Fire Marshall	Frankfort, Kentucky
Geological Survey, Division of Water	Lexington, Kentucky
Public Service Commission	Frankfort, Kentucky

AGENCY OR COMPANY - LOCAL	LOCATION
Clyde E. Buckley Wildlife Sanctuary	Lexington, Kentucky
Division of Fire Prevention	Lexington, Kentucky
Gas Processors Association	Tulsa, Oklahoma
Kentucky Utilities Company, Inc.	Lexington, Kentucky
University of Kentucky, Museum of Anthropology, Department of Biology	Lexington, Kentucky

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 on or adjacent to the mine site facilities.

Local construction and blasting permits will be required from Lexington City Hall. A local zoning variance and storage permit may also be required. The Kentucky Highway Department will probably require issuance of an excavation permit for pipeline laying.

The Kentucky Division of Reclamation will review the project plans. Liaison with Fayette County engineers is encouraged, though no specific permit is applicable. The Kentucky Public Service Commission presently only regulates gas.

Although they do not have direct regulating authority over the strategic storage program, the following state agencies may be consulted by the regulatory agencies: Water Development Board, Water Right Commission, Water Well Drillers Board, State Department of Health's Division of Sanitary Engineers, and Soil Conservation Board.

TABLE 9.2-1 Environmentally oriented permits and licenses

Agency	Permit Type	References
U. S. Corps of Engineers, District Engineer (Louisville)	(a) Discharge of dredged material into navigable waters (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); 33 CFR 209, 130
U. S. Environmental Protection Agency, Region 4	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
Kentucky Stream Control Commission	(a) Certificate of Approval required for permission to discharge wastes into the public waters. (b) State must approve applications for NPDES permits before submission to U. S. Environmental Protection Agency.	Section IIIA; 40 CFR 123
Kentucky Air Control Commission (enforcement agency is the Kentucky Division of Air Control and Occupational Health) in Lexington.	Certificate of Approval for construction of sources of air pollution emissions. Applies to some petroleum handling equipment.	Kentucky Air Control Commission Regulations, Section 6.1

TABLE 9.2-1 Continued

Agency	Permit Type	References
Kentucky Division of Fire Prevention	State fire permit	Vol. 3; National Fire Prevention Act. Items 5 and 12 of Division of Fire Prevention
Kentucky Air Control Commission Division of Air Control and Occupational Health	Approval for open burning of land clearing debris is not specifically required at present so long as the guidelines stipulated in the air control regulations are met. However, it is advisable to notify the Division prior to such burning to determine that predicted ambient air quality and atmospheric conditions at the time of burning will be suitable and to alert the Division that burning is planned and will be properly conducted.	
Kentucky Air Control Commission Division of Air Control and Occupational Health	Regulations are now being considered for the establishment of ambient noise level standards. In final form, such regulations may require permits for the operation of specified industrial noise sources.	
Kentucky State Division of Health, Bureau of Environmental Services	Permit for installation of sewage treatment facilities and for disposal of solid and oily water wastes.	
Department of Commerce, Interstate Commerce Commission	Transportation of petroleum across state lines.	
Department of Transportation Highway Department	Excavation permit for pipeline trenching on interstate highways.	
Lexington Division of Fire Prevention	Local fire permit.	

TABLE 9.2-1 Continued

Agency	Permit Type	References
Kentucky Department of Natural Resources	Construction guidelines.	
Lexington City Hall	Construction and blasting permits. Maybe storage permit and zoning ordinance.	

9.3 REQUEST FOR COMMENTS

Comments on the Draft EIS for Central Rock 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 12 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 Commission
National Science Foundation
Nuclear Regulatory Commission
U.S. Army Corps of Engineers
Water Resources Council

States:

Kentucky
Ohio
Louisiana
West Virginia
Indiana

Local:

Fayette County
Lexington-Fayette County Planning Commission

Others:

American Petroleum Institute
Appalachian Regional Commission
Bluegrass Trust
Center for Law and Social Policy

Central Rock Company
Clyde E. Buckley Wildlife Sanctuary
Environmental Defense Fund
Environmental Policy Center
Friends of the Earth
Funds for Animals, Inc.
Gas Processors Association
Izaak Walton League
Kentucky Utilities Company
KYOVA Interstate Planning Commission
National Audubon Society
National Parks and Conservation Association
Natural Resources Defense Council
National Wildlife Federation
Sierra Club
University of Kentucky Museum of Anthropology

9.4 DISCUSSION OF COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

This 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 alloted comment period. Copies of the comment letters are included in Appendix H.

All of the review comments received by FEA have been considered in 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. Department of Agriculture; March 3, 1977

Comment 1: There appears to be no commitment to minimize erosion and adverse ground water and surface water effects due to pipeline construction or spills. There are statements of what could be done, but this gives the reader nothing to judge by. Other details of the planning are sufficient to allow development of a definite plan to minimize these effects.

Response: The FEA acknowledges and endorses the use of mitigative measures to minimize erosion and adverse ground water and surface water effects due to construction or spills. Measures for erosion and sediment control include stream bank stabilization and such techniques as cofferdams and the revegetation of disturbed areas. A Spill Prevention Control and Countermeasure (SPCC) Plan will be prepared within six months after commencement of operations in accordance with Environmental Protection Agency Regulations on Oil Pollution Prevention (40 CFR 112). Where proper mitigative measures are undertaken, most adverse impacts of construction or spills can be minimized.

Comment 2: It appears that the effects of potential oilspills and potential seepage into local aquifers may be understated. Bluegrass horse farms depend almost solely on surface water and ground water from streams for their livestock. Even a small spill could have catastrophic effects.

Response: Table 4.3-2 shows that the chances of a spill during the lifetime of the project are low. Also, the volume of any spill probably would be small. Furthermore, the following paragraphs demonstrate that the effects on surface and ground water would be temporary and areally isolated.

Any oil that is not locally absorbed in soil will either run off surficially or penetrate into underground karst channels in the bedrock. Since underground karst drainage is characteristically integrated into a few narrow channel ways which eventually emerge into surface streams (Sweeting, 1968), both surface and subsurface oil would move down gradient within discrete channels, eventually merging with stream waters.

Surface runoff would be contained within a narrow path by the concavity of the water table, beyond which the buoyant oil will not penetrate. In the underground karst channels, the oil will be laterally contained by the impermeability of its rock walls, and water inflow from tributaries. Such restriction should promote efficient downstream passage of spilled oil, as well as effective flushing by subsequent rain waters.

Because of the buoyancy of oil, groundwater in alluvial deposits adjacent to an affected stream would likely avoid contamination. Also, the odds of actual interception of a contaminated underground channel by a water well is remote. Therefore, the sole significant impact anticipated from an oil spill is temporary contamination of the specific stream into which the spill will eventually merge. The degree of contamination, in turn, will depend on dilution with surface and subsurface waters, which will depend on a variety of indeterminant factors. The specific streams that are prone to such contamination will depend on the point of spill along the pipeline (Figure 8.3-3).

Topographic maps show that all streams throughout the horse country north of Lexington would escape contamination. However, there are a few points between the storage site and the Tates Creek terminal where a spill could possibly affect one of the few small streams which flow into western rural areas.

In summary, the chance of spillage affecting source waters for horses is remote. If it happened, the effects would be temporary and isolated to a small area. Many of the various scenarios of such a spill would allow effective mitigation.

Comment 3: Though the statement seems to give good assurance that the petroleum can be adequately contained within man-made caverns, there is some reason for concern that escaping gases may find their way into the natural plumbing system, contaminating ground water and creating other hazards.

Response: The containment of the vapor phase of stored oil is comparable to that of ordinary underground gas storage. The gas is confined like a bubble, by the head of water which saturates all permeable fractures beneath the water table. As long as the head of water is equal to or larger than the cavern gas pressure, the pressure and skin tension of the water in the fractures prevents outward migration of gas.

The success of this concept is supported by the many underground gas storage facilities that operate world-wide without leakage. The rock quality c' many of these facilities is far inferior to that of the Central Rock Mine. Discernible leaks experienced by a few such storages typically have been associated with inadequate water heads, excessive cavern pressures, or porous zones or fractures that are sufficiently open to preclude an adequate skin tension of water. At Central Rock, the hundreds of feet of hydrostatic head, the low 1.5 atmospheric vapor pressures to be maintained, and the especially tight, impermeable nature of its rock fractures, assure that the chances of escape of significant oil vapors from the cavern are virtually nil.

B. Department of the Army; March 22, 1977

Comment 1: On page 3.3-5, the dates for the Kentucky water quality standards should be cited since these standards are periodically amended.

Response: The effective date, July 2, 1975, has been added to Appendix A, Kentucky Water Quality Standards, which is referenced on page 3.3-5.

Comment 2: On page 3.6-19, in the list of three birds species presently on the state list of endangered fauna, it is the southern bald eagle (Haliaeetus l. leucocephalus) which is endangered, not the northern bald eagle.

Response: The correction has been made to southern bald eagle.

Comment 3: On page 3.9-8 (3.9.2.3), under Highways, paragraph 2, the 1900 estimated population for Lexington-Fayette County, Kentucky is listed as 270,000. This seems to conflict with figures given in the text on page 3.9-11 under Housing (290,000) and page 3.9-32 under Table 3.9-15 (290,000).

Response: A correction has been made on page 3.9-8 to 290,000 which corresponds with the estimated population in 1990 listed elsewhere in the text.

Comment 4: Referring to page 4.1-2, the only known Old Grand Dad Distillery is approximately 15 miles away. It is presumed, therefore, the reference to its lake's siltation is for comparison only since it is doubtful if any pipeline construction at the Central Rock site would affect it.

Response: The reference indicated in the comment is included for comparison as a worst case condition. It is not expected that the volume of sediment from construction will significantly impact the lake's storage capacity.

Comment 5: It is suggested the proposed alignment for the 16-inch pipeline from the Tates Creek Terminal to the storage area should be re-examined and probably rerouted slightly to both shorten and reduce environmental impacts.

Response: Alternate pipeline routes have been and are being considered as part of this revision.

Comment 6: The pipeline crossing at West Hickman Creek will require a Department of the Army (DA) permit since the "normal" stream flow is greater than five cubic feet per second (cfs). We are enclosing two information documents to explain the Corps of Engineer's permit program.

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 application.

C. Department of Commerce; February 15, 1977

Comment 1: On p. 3.4-1 (2nd paragraph, 3rd sentence) it is stated that, "There are no bodies of water large enough or close enough to Lexington to exert any influence upon the climate." This is not really true, as both the Gulf of Mexico and the Atlantic are important sources of moisture for the air currents which traverse Kentucky, especially during the summer. The quoted sentence probably is referring to local climatic influences, in which case this should be made clear.

Response: The sentence indicated in the comment does in fact refer to local climatic influences at the Central Rock Mine site; therefore, the sentence has been revised to reflect a "local climate."

Comment 2: On p. 3.4-7 (3rd paragraph, 2nd sentence) it is noted that, "...strong insulation...are conducive to tornadic activity...". The word "insolation" should replace "insulation." Better yet, the term "surface heating" would be more understandable to most of the readers.

Response: The spelling of "insolation" has been corrected.

9.4.2 Comments Received from State Agencies

A. Kentucky Department for Natural Resources and Environmental Protection; February 21, 1977

Comment 1: In the event of a pipeline break or leak, considerable contamination of soil and vegetation could take place. While recovery of some of the oil from such contamination is usually possible, most of this contaminated material would require either landfilling techniques for disposal or land spreading over a wide area. These methods should be discussed as possibilities under Section 4.3.8.8.

Response: The FEA acknowledges that recovery and cleanup activities after an oil spill must be carefully carried out in order to minimize disturbance to the land and the terrestrial ecology of the spill area. The FEA believes that the most effective approach to oil spills is prevention of the spill and therefore the SPR program will have numerous engineering characteristics designed specifically to either prevent a spill or reduce the probability of an oil spill occurring along the Central Rock pipeline alignment. Indescriminant clearing of vegetation or earth clearing (moving) has been found to make final rehabilitation of the land a larger problem than the small amounts of spilled oil recovered warrent. Removing oil soaked soil and replacing it with clean soil is satisfactory only when it involves small areas, and is not a reasonable alternative if a spill occurs over a large area or in forested lands; the problem of transporting and disposing of oil soaked soil in sanitary landfill areas still remains. It has been found that it is not necessary to completely remove grasses, trees or shrubs from a spill area. Vegetation should first be checked to determine the extent of the damage before the land is cleared, since some or most of the vegetation may recover later on in the same growing season or during the next year if the root systems are not extensively damaged. The rehabilitation and revegetation programs would be designed to reestablish the natural vegetation and productivity of the area affected. These programs would be based on expert evaluation of vegetative damage and would use proven techniques for revegetation with endemic species.

Additional discussion on the disposal of oil spill contaminated soil and vegetation has been added to Section 4.3.8 of the text beginning on page 4.3-46.

Comment 2: Construction of such a pipeline as the one from the Tate's Creek Terminal to the Central Rock Company Site, in either a fee simple property R.O.W. or in a utility easement, presents some unique access problems. This depends on the wording of the easement or purchase agreement and can cause major problems in land subdivision along the route.

Response: The FEA acknowledges that problems may arise as a result of property agreements along the R.O.W. The final selection of the pipeline route will take these problems into consideration.

B. Kentucky Heritage Commission; March 1, 1977

Comment: It is indicated that the "state historic office" (see pages 4.2-15 and 4.2-16) will conduct the reconnaissance surveys to identify historic and/or archeological resources within the project area. Regrettably, it is not possible for this office to perform such survey work for all federal, federally funded and/or federally licensed projects in Kentucky.

Pursuant to the Procedures of the Advisory Council on Historic Preservation (36CFR, Part 800), identification of National Register properties within the area of potential environmental impact of a federal, federally funded or federally licensed undertaking is the responsibility of the federal "agency official" or his designee. Since this identification process must be accomplished in consultation with the State Historic Preservation Office it is recommended that a qualified historian and/or architectural historian and professional archeologist be employed to conduct the historical and archeological reconnaissance surveys of the project area. If any properties are identified during the surveys, the professional historian and archeologist should apply the National Register Criteria and indicate if any of the sites meet this criteria. Consultation with the State Historic Preservation Officer will have been accomplished when the reconnaissance survey reports have been reviewed and approved.

Response: The FEA acknowledges the authority of the State Historic Preservation Office under the Procedures of the Advisory Council on Historic Preservation. As soon as pipeline alternatives have been considered and final plans made, the FEA will arrange historical and archaeological reconnaissance surveys of the project area.

C. University of Kentucky, Department of Anthropology; February 18, 1977

Comment: With regard to the archaeological analysis of the proposed pipeline route, all undisturbed portions of this project area should be subjected to an on-site archaeological survey by a competent archaeologist. The area of the proposed pipeline in Kentucky is an archaeologicallv important one and there is a distinct possibility that archaeological sites, so far unrecorded in our State survey files will be encountered. It cannot be assumed that the proposed construction will have no adverse impact upon the archaeological resources. It will be the purpose of an archaeological survey to answer that question.

Where the pipeline, or other areas of the project occur on land owned by the Commonwealth or any municipal agency within it, a permit for an archaeological exploration will be required for this survey issued from the office of the State Archaeologist.

Response: The FEA acknowledges the responsibility of the Kentucky State Archaeologist with regard to the archaeological resources of the proposed construction area. As noted on page 4.2-16 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) before the proposed pipeline can be finalized.

No adverse impacts to the archaeological resources in the area are anticipated since one of the results of the planned investigation would be to determine if the proposed pipeline route would specifically cross any recorded or unrecorded archaeological sites. A second purpose of the investigation would be to help recommend an alternative pipeline route along which no archaeological resources would be impacted if the Central Rock Mine is selected as an SPR storage site.

The FEA also acknowledges the necessary permits which may be required for archaeological exploration on land owned by the Commonwealth of Kentucky or municipal agencies within it. This information has been added to Section 9.2 and to Table 9.2-1, Environmentally oriented permits and licenses.

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

No substantive comments were received from companies, groups or from the public.

SECTION 10.0

REFERENCES

American National Standards Institute, 1972, Building code requirements for minimum design loads in buildings and other structures: ANSI 58.1.

Arbib, R.S., Jr. (ed.), 1975, The seventy-fifth Christmas bird count, American Birds 29(2).

_____, 1974, The seventy-fourth Christmas bird count, American Birds 28(2).

Avants, J.B., 1974, What those ecological terms mean, Oil, Gas and Petrochem Equipment, September, 1974.

Baker, J.M., 1971a, The effects of a single oil spillage, E.B. Cowell (ed.), The ecological effects of oil pollution on littoral communities, Inst. Petro., London.

_____, 1971b, Successive spillages, E.B. Cowell (ed.), The ecological effects of oil pollution on littoral communities, Inst. Petro., London.

_____, 1971c, Oil and salt-marsh soil, E.B. Cowell (ed.), The ecological effects of oil pollution on littoral communities, Inst. Petro., London.

_____, 1970, Oil pollution in salt-marsh communities, Marine Poll. Bull. 1, 27-28.

_____, 1969, The effects of oil pollution and cleaning on salt-marsh ecology, Annual Report, Field Studies Council, Bert Edwards (Milford Haven) Ltd.

Baker, W.L., 1972, Eastern forest insects, U.S.D.A. Forest Service, Misc. Pub. No. 1175, U.S. Government Printing Office, Washington, D.C.

Barbour, R.W., 1971, Amphibians and reptiles of Kentucky, The University Press of Kentucky, Lexington, Kentucky.

Barbour, R.W., C.T. Peterson, D. Rust, H.E. Shadowan, and A.L. Whitt, Jr., 1973, Kentucky birds - A finding guide, The University Press of Kentucky, Lexington, Kentucky.

Barbour, R.W. and W.H. Davis, 1974, Mammals of Kentucky, The University Press of Kentucky, Lexington, Kentucky.

Bell Consulting Engineers, Inc., undated, Draft 208 report: Howard K. Bell Consulting Engineers, Inc., Lexington, Kentucky.

Black, D.F.B., E.R. Crissman, and W.C. MacQuown, Jr., 1965, The Lexington limestone (Middle Ordovician) of central Kentucky, U.S. Geological Survey Bulletin 1224-C.

Black, D.F.B., and W.C. MacQuown, Jr., 1965, Lithostratigraphy of the Ordovician Lexington limestone and Clays Ferry Formation of the central bluegrass area near Lexington, Kentucky, Geological Society of Kentucky, Field Trip Guidebook, Annual Spring Field Conference, 1965.

Brandt, H.W., 1972, Abandoned coal mine converted into man-made oil field, Oil and Gas Journal, December 25, 1972.

Braun, E. Lucy, 1950, Deciduous forests of eastern North America, Blakiston Company, Philadelphia, Pennsylvania.

_____, 1947, Development of the deciduous forests of eastern North America, Geological Monographs 17(2), 213-219.

_____, 1943, An annotated catalogue of the spermatophytes of Kentucky, The University of Cincinnati, Cincinnati, Ohio.

_____, 1921, Composition and source of the flora of the Cincinnati region, Ecology II (3), 162-178.

Brobst, W.A., 1972, The probability of transportation accidents, U.S. Atomic Energy Commission, Division of Waste Management and Transportation, presented at the 14th Annual Explosives Safety Seminar, Department of Defense, Explosives Safety Board, New Orleans (November 10).

Casey, William, 1974, Rare or endangered plants of the Inner Bluegrass Region of Kentucky, U.S.D.A. Soil Conservation Service.

Chipman, W.A. and P.S. Galtsoff, 1949, Effects of oil mixed with carbonized sand on aquatic animals, Department of the Interior, Special Science Report: Fish, No. 1.

Cowell, E.B., 1971, Some effects of oil pollution in Milford Haven, United Kingdom, Conf. Proc. on prevention and control of oil spills, Washington, D.C.

_____, 1970, Chronic oil pollution caused by refinery effluent water, P. Hepple (ed.), Water pollution by oil, Inst. Petro., London, Appendix, 380-381.

_____, 1969, The effects of oil pollution on salt marsh communities in Pembrokeshire and Cornwall, J. App. Ecol. 6, 133-142.

Cowell, E.B., and J.M. Baker, 1969, Recovery of a salt marsh in Pembrokeshire, S.W. Wales from pollution by crude oil, Conservationist 1, 291-292.

Cole, A.E., 1941, The effects of pollutional wastes on fish life, A Symposium on Hydrobiology, University of Wisconsin.

Cresswell, L.W., 1977, The fate of petroleum in a soil environment, presented at the 1977 Oil Spill Conference, March 8-10, 1977: New Orleans, Louisiana.

Crossley, D.A., Jr., 1963, Consumption of vegetation by insects, Radioecology, V. Schultz and A.W. Klement (eds.), Reinhold Publishing Company, New York.

Crossley, D.A., Jr., and H.T. Howden, 1961, Insect-vegetation relationships in a radioactive waste area, Ecology 42, 302-317.

Dames & Moore, 1976, Underground gas storage: Utilization of the subsurface environment.

_____, 1972, Preliminary safety analysis report for the St. Rosalie power plant site: Dames & Moore, Washington, D.C.

Davies, P.A., 1953, The status of floristic studies in Kentucky, Transactions of the Kentucky Academy of Science 14(2), 49-58.

Davis, D.H., 1927, Geography of the Bluegrass Region of Kentucky, First edition, Kentucky Geological Survey, Frankfort, Kentucky.

Durrel, J., 1976, Kentucky Department of Fish and Wildlife Resources, personal communication.

Engineer Agency for Resources Inventories, 1974, Environmental resources inventory of the Lexington, Kentucky urban area: U.S. Army Corps of Engineers, Louisville District, topographic laboratories (September).

Farlow, J.S., Ross, D.E., and Landreth, R., 1977, Practical recommendations for oil spill debris disposal, presented at the 1977 Oil Spill Conference, March 8-10, 1977: New Orleans, Louisiana.

Fayette County Planning Commission, 1971, Bluegrass Field air terminal feasibility study, Lexington, Kentucky.

FEA, 1976a, Phase 3 feasibility study: FEA, Washington, D.C. (March).

_____, 1976b, Programmatic environmental impact statement: FEA, Washington, D.C. (March).

_____, 1975, Federal Energy Administration underground oil storage program mine inspection report: FEA, Washington, D.C.

Federal Register, 1975, Fauna and flora - Interior FWS status of endangered and threatened plants 40(127):27823, U.S. Government Printing Office, Washington, D.C.

_____, 1971, 36 (158), U.S. Government Printing Office, Washington, D.C. (August 14).

Federal Water Pollution Control Agency, 1968, Water quality criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Washington, D.C.

Galloway, et. al., November 1973, Population distribution of the U.S. as a function of outdoor noise levels, DB&N Report #2592 to U.S. Environmental Protection Agency.

Gansner, D.A., 1968, The timber resources of Kentucky, U.S.D.A. Forest Service Resource Bulletin NE-9, Northeastern Forest Experiment Station, Upper Darby, Pennsylvania.

Gansner, D.A. and P.S. DeBald, 1966, Kentucky forests, Bluegrass unit, prepared in cooperation with the Division of Forestry, Kentucky Department of Natural Resources, U.S.D.A. Forest Resource Bulletin CS-7.

Gas Processors Association, 1975, GPA tentative method for the underground storage of natural gas liquids, GPA Publication 8175-75.

_____, 1975a, North American storage capacity for light hydrocarbons, GPA.

_____, 1970, pamphlet, Tentative standard for underground storage of liquified petroleum gas.

Gault, W.L., 1950, Mammals of the Inner Bluegrass and Jefferson County, Kentucky, M.S. thesis, University of Kentucky, Lexington, Kentucky.

Gibson, Dorothy, 1961, Life-forms of Kentucky flowering plants, The American Midland Naturalist 66(1), 1-60.

Gleason, H.A., and Arthur Cronquist, 1963 (reprinted 1968), Manual of vascular plants of northeastern United States and adjacent Canada, D. Van Nostrand Company, Inc., New Jersey.

Gutsell, W.A., 1921, Danger to fisheries from oil and tar pollution of waters, Bureau of Fisheries, Doc. 910, App. to Rep. of U.S. Comm. of Fisheries.

Hamilton, D.K., 1950, Areas and principles of ground water occurrence in the Inner Bluegrass Region, Kentucky, Kentucky Geological Survey Bull. 5.

Hartung, R., 1967, Energy metabolism in oil-covered ducks, J. Wildlife Management 31, 798-804.

Hartung, R., and G.W. Klingler, 1970, Concentration of DDI sedimented polluting oils, Environmental Science Technology 4(5), 407-410.

Hendrickson, G.E., and R.A. Krieger, 1964, Geochemistry of natural waters of the Bluegrass Region, Kentucky, U.S. Geological Survey Water Supply Paper 1700.

Holzworth, G.C., 1974, Meteorological episodes of slowest dillution in the contiguous United States: U.S. Research, Office of Research and Development, Triangle Park, North Carolina (February).

_____, 1972, Mixing heights, wind speeds, and potential for urban air pollution throughout the contiguous United States, EPA, Office of Air Programs, Research Triangle Park, North Carolina.

Hopkins, H.T., 1966, Fresh-saline water interface map of Kentucky, U.S. Geological Survey, Series X.

Hornsby, Robert, Joe Bruna, Robert Eversole, and Robert Kessler, 1962, Wildlife in Kentucky agricultural programs, Trans. North America Wildlife Conference 27, 202-212.

Horsbrugh, Patrick, 1974, Geospace: The concept and definition of subterranean accommodation, Symposium on Development and Utilization of Underground Space, 147-158.

Hosler, C.F., 1961, Low level inversion frequency in the contiguous United States, Monthly Weather Review 89(9).

Howard K. Bell Consulting Engineers, 1975, Development plan, McConnell Springs/Cahill Farms - Lexington, Kentucky, Lexington-Fayette County Historic Commission and Central Rock Co., Inc., Lexington, Kentucky.

Hunt, G.S., 1962, Water pollution and the ecology of some aquatic invertebrates in the lower Detroit River, in Proceedings of the Great Lakes Research Conference (Great Lakes Research Division Pub. No. 9). University of Michigan, Institute of Science and Technology, Ann Arbor.

_____, 1957, Causes of mortality among ducks wintering on the lower Detroit River (PhD. dissertation), University of Michigan, Ann Arbor.

Hynes, H.B.N., 1971, The biology of polluted waters, University of Toronto Press, Toronto.

Jansson, Gosta, 1974, Rock-cavern-type storage can be cheaper option, The Oil and Gas Journal, (October 28, 1974), 74-82.

Jillson, W.R., 1961, Agricultural perspective of Kentucky geology, Kentucky Geological Survey, Lexington, Kentucky.

Jones, A.R., 1973, Inventory and classification of streams in the Kentucky River drainage, Kentucky Department of Fish and Wildlife Resources, Frankfort, Kentucky.

_____, 1968, Changes in the black bass population of Elkhorn Creek following the establishment of a size limit, Kentucky Fisheries Bulletin No. 45, Kentucky Department of Fish and Wildlife Resources, Frankfort, Kentucky.

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

Kavernen Bau-und Betriebsgesellschaft mbH., 1975, KBB underground storage, 12 pages and maps, printed in Germany.

Keith, J.R., 1967, A study of vegetation in the Pleistocene drift region of northern Kentucky, Thesis, University of Kentucky, Lexington, Kentucky.

Kentucky Academy of Science, 1973, A preliminary list of rare and/or endangered species in Kentucky, Seven man ad hoc committee (unpublished).

Kentucky, Department of Commerce, 1976, Kentucky directory of manufacturers, 1976, Frankfort, Kentucky.

_____, 1975, Kentucky deskbook of economic statistics, Frankfort, Kentucky.

_____, 1974, Mineral resources and mineral industries map of Kentucky, Kentucky Geological Survey, University of Kentucky, Lexington, Kentucky.

_____, 1973, Transportation in Kentucky, Research and Planning Division.

_____, 1968, Water for industry, Research and Planning Division, Resources for Industry.

Kentucky Department of Highways, 1971, 1964-1990 urban transportation plan, Frankfort, Kentucky.

Kentucky Department of Natural Resources and Environmental Protection, Division of Air Pollution, April 1977, Kentucky ambient air quality, 1976 Annual Report.

_____, December 1976, Statistical report, Kentucky Aerometric Information System.

_____, December 1975, Statistical report, Kentucky Aerometric Information System.

_____, April 1975, Air pollution control regulations.

_____, April 1975, Kentucky ambient air quality, 1974 Annual Report.

_____, 1972, State implementation plan, Frankfort, Kentucky.

Kentucky Department of Natural Resources and Environmental Protection, Division of Water, 1971a, The Kentucky framework water plan: Commonwealth of Kentucky, Frankfort, Kentucky.

_____, 1971b, Kentucky water resources - 1971: Commonwealth of Kentucky, Frankfort, Kentucky.

_____, 1971c, Rainfall frequency values for Kentucky.

_____, 1965, Kentucky water resources - 1965: Commonwealth of Kentucky, Frankfort, Kentucky.

Kentucky Executive Department of Finance and Administration Office for Local Government, 1974, Kentucky developmental data series.

_____, 1973, Kentucky local debt report.

Kentucky Geological Survey, 1974, A symposium on the geology of fluorspar, Proceedings of the Ninth Forum on Geology of Industrial Minerals, Series X, Special Publication 22.

_____, 1971, Public and industrial water supplies of Kentucky 1968-69, University of Kentucky, Lexington, Kentucky, Series X, Information Circular 20.

_____, 1954, Geologic map of Kentucky, Series IX.

Kentucky Housing Corporation and Kentucky Executive Department of Finance and Administration Office for Local Government, 1974, Housing needs analysis, Commonwealth of Kentucky.

King, P.B., 1959, The evolution of North America, Princeton University Press, Princeton, New Jersey.

Korshover, 1967, Climatology of stagnating anticyclones east of the Rock Mountains, 1936-1963: Public Health Service, Publication No. 99-AP-34.

Krieger, R.A., R.V. Cushman, and N.O. Thomas, 1969, Water in Kentucky, U.S. Geological Survey Special Publication 16, University of Kentucky, Series X.

Küchler, A.W., 1964, Potential natural vegetation of the conterminous United States, American Geographical Society, New York.

Kulp, J.L., 1961, "Geologic time scale," Science 133, 1105-1114.

Laflin, B.D., 1970, Some effects of municipal sewage pollution upon the biota and water quality of Elkhorn Creek, Kentucky Fisheries Bulletin No. 55, Development of Fish and Wildlife Resources, Frankfort, Kentucky.

Lau, O.B., 1966, A comparative study of invertebrate communities in Hickman Creek, Kentucky, Master's thesis, University of Kentucky, Lexington, Kentucky.

Lessing, Peter, 1974, Earthquake history of West Virginia, Environmental Geology Bulletin No. 12, West Virginia Geological and Economic Survey.

Lexington-Fayette County Planning Commission, 1973, A growing community, Lexington, Kentucky.

Lonsdale, R.E., undated, Underground space as a locational consideration in industry, Separate paper.

Ludzack, F.J., W.M. Ingram, and M.B. Ettinger, 1957, Characteristics of a stream composed of oil refinery and activated sludge effluents, Sewage Indust. Wastes, 29, 1177-1189.

Macreagh, Dougall, 1976, Personal communication, Acres American, Buffalo, New York.

Martin, Alexander, H.S. Zim, and Arnold Nelson, 1951, American wildlife and plants: A guide to wildlife food habits, Dover Publications, Inc., New York.

McCarthy, D.F., 1972, Underground storage facilities for gaseous and liquid hydrocarbons, Pipeline and Gas Journal, March 1972.

McFarlan, A.C., 1958, Behind the scenery in Kentucky, Kentucky Geological Survey, Special Publication No. 10, Series IX.

_____, 1943, Geology of Kentucky, University of Kentucky, Lexington, Kentucky, The Waverly Press, Inc., Baltimore, Maryland.

McFarland, J.W., 1946, The vascular plants of Jessamine County, Kentucky, Master's thesis, University of Kentucky, Lexington, Kentucky.

McGrain, Preston, and T.J. Crawford, 1960, A physiographic and stratigraphic profile in Kentucky--Lexington to the Mammoth Cave region, Field trip for southeastern section, Geological Society of America, Kentucky Geological Survey, Lexington, Kentucky.

McGuire, W.H., and P. Howell, 1963, Oil and gas possibilities of the Cambrian and Lower Ordovician in Kentucky, Spindletop Research Center, Lexington, Kentucky, for the Kentucky Department of Commerce.

McInteer, R.B., 1947, Soil preference of some plants as seen in Kentucky, Castanea 12(1), 1-8.

_____, 1946, A change from grassland to forest vegetation in the "Big Barrens" of Kentucky, The American Midland Naturalist 35, 276-282.

McKee, J.E., and H.W. Wolf, 1963, Water quality criteria, Resources Agency of California, State Water Resources Control Board, Pub. 3-A.

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

Mengel, R.M., 1968, The birds of Kentucky, The American Ornithologist's Union.

Miller, R.D., 1967, Geologic map of the Lexington west quadrangle, Fayette and Scott Counties, Kentucky, U.S. Geological Society Map GQ-600.

Mull, D.S., 1968, The hydrology of the Lexington and Fayette County, Kentucky area, Lexington-Fayette County Planning Commission, Lexington, Kentucky.

Mull, D.S., R.V. Cushman, and T.W. Lambert, 1971, Public and industrial water supplies of Kentucky, 1968-69, U.S. Geological Survey, Information Circular 20, Series X.

Murphy, T.A., 1971, Environmental effects of oil pollution, Journal of the Sanitary Engineering Proceedings of the American Society of Civil Engineers, 361-371.

National Academy of Sciences and National Academy of Engineering, 1971, Water quality criteria 1972, Environmental Protection Agency, Washington, D.C.

Needham, J.G., J.R. Traver, and Yin-Chi Hsu, 1935, The biology of may-flies, Comstock Publishing Co., Inc., New York (republished by E.W. Classey, Ltd.).

Nelson, W.L., 1974, Cost of refineries - Part 4: Storage, environment, land, The Oil and Gas Journal, July 29, 1974, 160-162.

Nixon, J.W., 1954, Another choice . . . excavated caverns, Petroleum Refinery 33(7), 114-116.

Odum, E.P. and A.E. Smalley, 1959, Comparison of population energy flow of a herbivorous and a deposit-feeding invertebrate in a salt march ecosystem, Proceedings of the National Academy of Sciences 45, 617-622.

Oil and Gas Journal, 1975, Scottish plant would use underground storage, (September 8, 1974), 45.

_____, 1971, 1971 crude oil pipeline atlas of U.S. and Canada including refinery locations and capacities, (October 11, 1971).

_____, 1970, Products pipeline atlas of U.S. and Canada, (October 12, 1970).

_____, 1954, Latest idea in product storage--Esso finishes quarry facility, (September 6, 1954), 56-57.

Palmquist, W.N., Jr., and F.R. Hall, 1961, Reconnaissance of ground water resources in the Bluegrass Region, Kentucky, U.S. Geological Survey Water Supply Paper 1533.

_____, 1960, Availability of ground water in Bourbon, Fayette, Jessamine, and Scott Counties, Kentucky, Hydrologic Investigations Atlas HA-25, U.S. Geological Survey, Washington, D.C.

Patton, J.B., 1955, Underground storage of liquid hydrocarbons in Indiana, Indiana Department of Conservation, Geological Survey Report of Progress No. 9.

Pautz, M.E., undated, Severe local storm occurrences, 1955-1967: U.S. Department of Commerce, Office of Meteorological Operations, ESSA, Tech. Memorandum WBTM FCST 12.

Resource Planning Associates, 1975, Developing a strategic oil storage program, Resource Planning Associates, Inc., RPA No. RA-75-45, prepared for the Office of Strategic Energy Reserve, FEA, Washington, D.C.

Robinette, W.L., 1972, Browse and cover for wildlife, Wildlife Shrubs - Their Biology and Utilization, U.S.D.A. Forest Service General Technical Report Int-1, Intermountain Forest and Range Experiment Station, Ogden, Utah.

Riley, H.L., and Preston McGrain, 1965, The mineral industry of Kentucky, preprint from the 1965 Bureau of Mines Minerals Yearbook, Department of the Interior.

Ripley, S.D., 1974, Report on endangered and threatened plant species of the United States, presented to the Congress of the United States of America by the secretary, Smithsonian Institution, U.S. Government Printing Office, Washington, D.C.

Ryck, F., and R.M. Duchrow, 1974, The effects of an oil spill on the biota of the south fork of the Salt River, Missouri (Abstract), presented at the 22nd Annual Meeting of the Midwest Benthological Society, (March 27-29, 1974), Cincinnati, Ohio.

Schultz, D.A., and L.B. Tebo, 1974, Boone Creek oil spill (Abstract), presented at the 22nd Annual Meeting of the Midwest Benthological Society, (March 27-29, 1974), Cincinnati, Ohio.

Seattle University, 1970, The oxygen uptake demand of resuspended bottom sediments, U.S. Environmental Protection Agency, Water Quality Office, Washington, D.C.

Shaler, N.S. 1885, Kentucky: A pioneer commonwealth, Houghton, Mifflin, and Company, New York, New York.

Small, J.W., Jr., 1975, Energy dynamics of benthic fishes in a small Kentucky stream, Ecology 56(4), 827-840.

Smith, M.O., 1966, Geology and successful farm ponds in the Inner Bluegrass Region of Kentucky, Thesis Series I, Series X, Kentucky Geological Survey, Lexington, Kentucky.

Smith, Wilbur, 1963, 1980 Transportation study for Kentucky Department of Highways, Frankfort, Kentucky.

Stafford, T.F., 1962, Features of jointing in the Inner Bluegrass of Kentucky, Master's thesis, University of Kentucky, Lexington, Kentucky.

Stauffer, Truman, Sr., 1975, Kansas City: A model of underground development, presented at Symposium on the Development and Utilization of Underground Space.

_____, 1975, Subsurface uses in Sweden and France: A report, presented at Symposium on the Development and Utilization of Underground Space.

Stebbins, R.E., 1968, Torrey canyon oil pollution on salt marshes and a shingle beach in Brittany 16 months after, Nature Conservancy Furzebrook Research Station.

Texas A&M University, 1972, Environmental aspects of a supertanker port on the Texas Gulf Coast, Sea Grant Proj. 73-201.

Thom, H.C.S., July 1968, New distribution of extreme winds in the United States: American Society of Civil Engineers, Journal of the Structural Division, Proceedings, 1787-1801.

_____, 1963, Tornado probabilities, Monthly Weather Review 91 (10-12).

Transeau, E.N., 1935, Prairie peninsula, Ecology 16, 423-437.

Trewartha, G.T., 1966, The earth's problem climates: The University of Wisconsin Press.

Trotter, J.G., April 1975, 50 million bbls. crude stored in huge underground system, World Oil, 86-90.

Turner, D.B., 1969, Workbook of atmospheric dispersion estimates: NOAA, U.S. Air Resources Field Research Office.

U.S. Army, June 1969, Structures to resist the effect of accidental explosions, Technical Manual, 5-1300.

U.S. Army Corps of Engineers, Louisville District, 1974a Assessment of surface water quality in the Lexington, Kentucky metropolitan region: U.S. Army Corps of Engineers, Contract No. DACW27-74-C-0230, Louisville, Kentucky (October).

_____, 1974b, Environmental resources inventory of the Lexington, Kentucky urban area, Prepared for Corps of Engineers by Engineer Agency for Resources Inventories, topographic laboratories, (September).

_____, 1974c, Flood plain information - Kentucky River vicinity of Frankfort, Kentucky: U.S. Army Corps of Engineers, Louisville District, Louisville, Kentucky.

U. S. Coast Guard, 1973, Polluting accidents in and around the United States waters, Department of Transportation, Washington, D. C.

U.S. Department of Agriculture, Soil Conservation Service, 1968, Soil Survey of Fayette County.

U.S. Department of Commerce, 1973, Earthquake history of the United States, J.L. Coffman and C.A. Von Hake, eds., Publication 41-1, Revised edition.

_____, 1972, Climates of the states, The climate of Kentucky.

_____, Climatography of the United States No. 82-15, 1963, Summary of hourly observations, 1956-1960, Lexington, Kentucky.

_____, Bureau of the Census, 1970 Census of population, Washington, D.C.

_____, 1960 and 1970, General housing characteristics - Kentucky, Washington, D.C.

_____, National Oceanic and Atmospheric Administration, 1975, STAR data, 1970-1974, Miami International Airport, Asheville, North Carolina.

_____, 1974, Climatological data, Kentucky Annual Summary.

_____, 1974, Local climatological data, Asheville, North Carolina.

_____, 1968, Climatic atlas of the United States, Environmental Data Service, Washington, D.C. (June).

U.S. Department of the Interior, 1975, Endangered and threatened wildlife and plants, Federal Register.

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

U.S. Environmental Protection Agnecy, 1976, National emissions data system (February 7).

_____, 1975, Compilation of air pollutant emission factors, second edition, supplement no. 5 (December).

U.S. Geological Survey, 1975, Water resources data for Kentucky - water year 1975, Kentucky District, Louisville, Kentucky.

_____, December 1973, Derivation of homogeneous streamflow records in the upper Kentucky River Basin, southeastern Kentucky, Water Resources Division, Kentucky District, Louisville, Kentucky.

_____, 1968, The hydrology of the Lexington and Fayette County, Kentucky area, Lexington and Fayette County Planning Commission, Lexington, Kentucky.

U.S. Geological Survey and American Association of Petroleum Geologists, 1962, Tectonic map of the United States.

U.S. Weather Bureau, May 1961, Rainfall frequency atlas of the United States, Tech. Paper No. 40, Washington, D.C.

_____, December 1955, Rainfall intensity - duration frequency tables, Tech. Paper No. 25, Washington, D.C.

Wharton, Mary E., and R.W. Barbour, 1973, Trees and shrubs of Kentucky, The University Press of Kentucky, Lexington, Kentucky.

_____, 1971, The wildflowers and ferns of Kentucky, University Press of Kentucky, Lexington, Kentucky.

Whitesides, D.V., 1971, Yields and specific capacities of bedrock wells in Kentucky, U.S. Geological Survey Information Circular 21, Series X.

Whitesides, D.V., and E.S. Nichols, 1961, Water levels in observation wells in Kentucky excluding Jefferson County, 1948 through 1960, Kentucky Geological Survey Information Circular 7, Series X, Lexington, Kentucky.

Wilson, E.H., and D.G. Sutton, 1973, Oil and gas map of Kentucky, sheet 3, East-central part, Kentucky Geological Survey, University of Kentucky, Series X.

APPENDIX A

KENTUCKY WATER QUALITY STANDARDS

KENTUCKY WATER QUALITY STANDARDS, 401 KAR 5:025, July 2, 1975.

Section 1. Prohibitions.

No person or group of persons as defined in KRS Chapter 224 shall cause to be violated any one (1) of the minimum standards in Section 2 or any one (1) of the standards established in Sections 3 to 9 of this regulation.

Section 2.

The following are minimum conditions applicable to all waters of the Commonwealth of Kentucky. All waters of the Commonwealth shall be:

(1) Substantially free from substances attributable to municipal, industrial or other discharges or agricultural practices that will settle to form putrescent sludge deposits;

(2) Free from floating debris, oil, scum and other floating materials attributable to municipal, industrial or other discharges or agricultural practices in amounts sufficient to be unsightly or deleterious;

(3) Free from materials attributable to municipal, industrial or other discharges or agricultural practices producing color, odor or other conditions in such degree as to create a nuisance; and

(4) Free from substances attributable to municipal, industrial or other discharges or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant or aquatic life.

(5) In the standards established by subsections (1) to (4), every person as defined in KRS Chapter 224 shall remove from their discharges those substances described in subsections (1) through (4) to the lowest practicable level attainable under current technology.

Section 3. Stream use Classification.

In addition to the minimum conditions set forth in Section 2, the use classification found in Sections 4 to 9 shall govern where applicable.

Section 4. Public Water Supply and Food Processing Industries

The following criteria are applicable to surface water at the point at which water is withdrawn for use for a public water supply or by a food processing industry:

(1) Bacteria: Coliform group shall not exceed 5,000 per 100 ml as a monthly arithmetical average value as determined by either MPN or MP count nor exceed this number in more than twenty (20) percent of the samples examined during any month; nor exceed 20,000 per 100 ml in more than five (5) percent of such samples.

(2) Threshold-odor number after normal treatment shall (not) be less than three (3).

(3) Dissolved solids shall not exceed 500 mg/l as a monthly average value, nor exceed 750 mg/l at any time. Values of specific conductance of 800 and 1,200 micromhos/cm, at 25 degrees Centigrade, may be considered equivalent to dissolved solids concentrations of 500 and 750 mg/l.

(4) Radioactive substances: Gross beta activity shall not exceed 1,000 picocuries per liter, pCi/l, nor shall activity from dissolved alpha emitters exceed 3 pCi/l.

(5) Chemical constituents shall not exceed the following specified concentrations at any time:

Constituents	Concentrations, mg/l
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium (Hexavalent)	0.05
Cyanide	0.025
Fluoride	1.0
Lead	0.05
Selenium	0.01
Silver	0.05

Section 5. Industrial Water Supply

The following criteria are applicable to water at the point at which water is withdrawn for use, either with or without treatment, for industrial cooling and processing, other than food processing, and shall be applicable only within a mixing zone:

(1) pH shall not be less than 5.0 nor greater than 9.0 at any time.

(2) Temperature shall not exceed 95 degrees Fahrenheit at any time.

(3) Dissolved Solids shall not exceed 750 mg/l as a monthly average value, nor exceed 1,000 mg/l at any time. Values of specific conductance of 1,200 and 1,600 micromhos/cm, at 25 degrees Centigrade, may be considered equivalent to dissolved solids concentrations of 750 and 1,000 mg/l.

Section 6. Aquatic Life

The following criteria are for evaluation of conditions for the maintenance of well balanced, indigenous fish population. The aquatic use standards shall not apply to areas immediately adjacent to outfalls. Areas immediately adjacent to outfalls shall be as small as possible, be provided for mixing only, and shall not prevent the free passage of fish and drift organisms.

(1) Dissolved oxygen. Concentrations shall average at least 5.0 mg/l per calendar day and shall not be less than 4.0 mg/l at any time or any place outside the mixing zone.

(2) pH values shall not be less than 6.0 nor more than 9.0.

(3) Temperature shall not exceed 89 degrees Fahrenheit.

(a) There shall be no abnormal temperature changes that may affect aquatic life unless caused by natural conditions.

(b) The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained.

(c) The maximum temperature rise at any time or place above natural temperatures shall not exceed 5 degrees Fahrenheit in streams.

In addition, the water temperature for all streams shall not exceed the maximum limits indicated in the following table:

Stream maximum temperature for each month in degrees Fahrenheit

January	50
February	50
March	60
April	70
May	80
June	87
July	89
August	89
September	87
October	78
November	70
December	57

(d) The allowable temperature increase in public water impoundments shall be limited to 3 degrees Fahrenheit in the epilimnion if thermal stratification exists. Public water impoundments include all impounded water of the Commonwealth which are open to the public and used by the public.

(4) Toxic substances shall not exceed one-tenth of the 96-hour median tolerance limit of fish. Where there are substances that are toxic because of their cumulative characteristics, other limiting concentrations may be used in specific cases as presently approved by the Federal Environmental Protection Agency, or as later adopted by the Division of Water quality.

Section 7. Put-and-Take Trout Streams

The following criteria are applicable to those waters designated by the division as put-and-take trout streams:

(1) Dissolved oxygen concentrations shall not be less than 6.0 mg/l at any time or any place. Spawning areas, during the spawning season, shall be protected by a minimum DO concentration of 7.0 mg/l.

(2) Temperature: Stream temperatures shall not be increased artificially above the natural temperature at any time in cold water trout streams.

Section 8. Recreation

Unless caused by natural conditions, the following criteria shall apply in waters to be used for recreational purposes, including but not limited to such water-contact activities as swimming and water skiing. Bacteria: The total coliform level shall not exceed an average 1,000 per 100 ml. Total coliform shall not exceed this number in twenty (20) percent of the samples in a month, nor exceed 2400/100 ml on any day. If the level of total coliform is exceeded, then a fecal coliform standard shall be used. There shall be a reduction of fecal coliform to such degree that during the months of May through October fecal coliform density in the discharge does not exceed 200 per 100 ml as a monthly geometric mean, based on not less than ten (10) samples per month, nor exceed 400 per 100 ml in more than ten (10) percent of the samples examined during a month, and during the months of November through April, the density does not exceed 1,000 per 100 ml as a monthly geometric mean, based on not less than ten (10) samples per month, nor exceed 2,000 per 100 ml in more than ten (10) percent of the samples examined during a month.

Section 9. Agricultural

No criteria in addition to the minimum conditions enumerated in Section 2 are proposed for the evaluation of stream quality at the point at which water is withdrawn for agricultural and stock watering use.

Section 10. Multiple Uses

One or more uses established in Section 4 to 9 may apply to the same waters. The use criteria shall apply to those waters suitable for use or uses provided in Section 3. In the event there is a conflict between or among the applicable uses, the more stringent use criteria shall apply.

AUTHORITY. This regulation is adopted and issued pursuant to Section 220.610 (7) (8) (9) (10) (11) (12) (13) (16) of the Kentucky Revised Statutes.

1. Permits For New Works. Any person planning or constructing any new works whereby sewage, industrial wastes or other wastes may be discharged into any waters of the Commonwealth shall make written application to the Water Pollution Control Commission for approval to discharge such sewage or waste. Application shall be filed prior to the preparation of final plans for a disposal system. However, no approval shall be issued until final complete, detailed plans and specifications for a disposal system have been submitted and found to be satisfactory. Final plans and specifications and other supporting data as may be required by the Commission should be submitted at least 30 days prior to the date upon which action by the Commission is desired.

(1) The application shall describe the processes which produce the wastes to be treated, the character and quantity of wastes, and explain in detail the proposed disposal system and its method of operation. It shall also indicate the expected degree of reduction in pollution load to be effected by operation of the disposal systems.

(2) Where there is an existing sewerage or waste discharge, data on the volume and strength of sewage shall accompany the application. These data shall be obtained from actual measurement by established methods. The laboratory analyses shall be made on composite samples and the data shall cover a sufficient period of time to be representative of actual conditions. It is recommended that the applicant or designing engineer confer with the Commission for details concerning the collection and analyses of samples.

(3) The final plans and specifications for a disposal system shall include:

(a) General Layout
(b) Detailed Construction Plans
(c) Specifications

(d) Summary of Design Data

(e) Cost Estimate

(4) The disposal system shall be constructed in accordance with the final plans and specifications as approved by the Commission and no construction changes shall be made unless the permittee shall first submit each such revision to the Commission and receive written approval thereof.

2. Permits for Existing Works. All persons responsible for existing works which discharge sewage, industrial wastes or other wastes into any waters of the Commonwealth shall file, prior to June 15, 1951, an application for permit to continue to discharge such wastes, said application to be made on forms furnished by the Commission.

(1) Whenever there is any question concerning the suitability or adequacy of existing structures, equipment, or other parts of the sewerage, industrial waste or other waste collection and treatment or disposal system to properly perform the function of preventing pollution of waters of the Commonwealth, the Commission may require the submission of plans or other data necessary to ascertain the details of such works in relation to their possible direct or indirect effect upon the pollution of waters of the Commonwealth.

(2) Records of operation of sewage, industrial waste and other waste collection and treatment or disposal works may be required and upon written request these data shall be submitted to the Commission. Reports may be required weekly, monthly or as deemed necessary and directed by the Commission.

(3) Samples or analyses of sewage, industrial wastes, other wastes and of water from the receiving streams or other body of water shall be submitted to the Commission when and in such manner as directed.

3. Issuance of Permits. Permits for the discharge of sewage, industrial waste, and other waste into waters of the Commonwealth may be issued after the Commission has reviewed the application and other supporting data as may be required, and after the Commission has determined that the discharge of sewage of wastes under the conditions

set forth in the application will not be in conflict with the provisions of KRS 220.580 to 220.650. Permits shall stipulate the conditions under which and the time during which the discharge may be permitted. Provided, however, that a tolerance permit may be issued in cases where the pollution is not immediately dangerous to health, will not prevent reasonable use of the water by other riparian owners, and cannot be immediately corrected on a temporary or permanent basis by any means short of stopping the operation of a public service or industry. Before any such tolerance permit is issued, the persons responsible for such pollution shall file a statement with the Commission indicating that work will be started to correct the condition and continued according to a specified schedule until completed.

4. Denial, Revocation, or Modification of Permits. Permits will automatically terminate at the end of the period specified or if no time is specified they may be terminated, after written notice and public hearing, when it is shown that conditions under which the permit was issued are being violated.

KENTUCKY SPILLS REGULATIONS, 401 KAR 5:015

Section 1. Any person having knowledge in advance of the necessity to bypass a sewage system shall notify the Division of Water before such bypass is commenced. Notification shall be given as far in advance as possible.

Section 2. Whenever by reason of emergency or accident a spill or discharge occurs from a sewage system or from a container or pipeline used to transport or store substances which would result in or contribute to the pollution of the waters, the person in charge of (responsible for) such activity shall immediately notify the Division of Water by the most rapid means available.

Section 3. Any person notifying the department pursuant to Sections 1 and 2, shall report the point of discharge, the nature of the material discharged, the quantity of the material discharged and an assessment of possible environmental impact.

Section 4. Notification required under Section 1 may be made by any mode of communication. Notification required by Section 2 shall be made by the most rapid means of communication available. If notification is not initially made in writing, it shall be confirmed by written notification within ten (10) days if requested by the division director or his appointed representative.

Section 5. Persons failing to report as required in Sections 1, 2, (and) 3 and 4 are subject to the penalties provided by KRS 224.994.

APPENDIX B

ESTIMATES OF EMISSIONS PRODUCED BY HYDROCARBON FLARING AND VAPOR LOSSES AND MODEL USED TO CALCULATE DOWNWIND GROUND LEVEL CONCENTRATIONS

APPENDIX B

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 include 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 suggests 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 is 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 (o.075 lb/ft^3), which equals 0.09 lb/ft^3; the volume of a barrel of oil is 5.65 ft^3.

Therefore: 28,000 bbls/day = 158,000 ft^3/day
= 14,210 lbs/day

0.1 percent of this is H_2S or 14 lbs/day
= 0.08 gm/sec H_2S

If this concentration is flared, the weight of SO_2 is about double that of the converted H_2S.

Therefore: 28 lbs/day = 0.15 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 of order 10^{-6} or less, and can therefore be neglected. Odor compounds can be conservatively estimated as 0.1 percent of the leaking material. Consequently, for 28,000 barrels per day, the hydrocarbon loss is estimated by:

$$(28{,}000\ \frac{\text{barrels}}{\text{day}})\ (300\ \frac{\text{lbs}}{\text{barrel}})\ (5\%)\ (10^{-4}) = 42\ \text{lbs/day or } 0.22\ \text{gm/sec hydrocarbons}$$

The odor compound, or 0.1 percent of this rate, would amount to 0.04 lbs/day, or 0.0002 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 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 will 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 (applicable to subsequent cavern fills).

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 approximately two days. 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 of 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), σ_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), σ_z and σ_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 (σ_y). The above equation is then used with the new value for σ_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.

Atmospheric Dispersion

The episodic occurrence of limited atmospheric dispersion conditions in the United States has been studied by Holzworth (1974). The most limiting dispersion condition Holzworth considered is: a period of 2 or more consecutive days with mixing depths (H) less than or equal to 500 meters, transport wind speeds (U, the unweighted mean of the surface plus upper wind speeds through the mixing layer) less than or equal to 2 meters per second, and no significant precipitation (because of its cleansing effects). The calculation of atmospheric dilution episodes is based on the product, H X U, which can be considered a ventilation factor. The product H X U is expressed in m^2/sec, and represents the volumetric rate per unit distance normal to the wind direction at which clean and polluted air within the mixing layer is transported across the upwind and downwind sides of a given area. Holzworth's data present the frequency of slowest dispersion (worst stagnation) 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 results of Holzworth's study indicate that the easternmost region of Kentucky is a less than favorable location relative to other locations in the United States for the five episode dispersion periods. Calculation of H X U values for five different air stagnation periods at Huntington, West Virginia (the nearest station to the site), shows that Huntington ranked 40th best out of 62 stations for the 1-day episode period, 43rd best for the 2-day episode period, 38th for the 3-day episode period, 37th highest for the 4-day episode and 17th highest for the 5-day episode period. There were two occurrences during the 5-year period of a limited dispersion condition with mixing heights less than 500 meters and transport wind less than 2.0 m/sec.

The average mixing heights and mixing layer wind speeds for Huntington are presented below. Generally, dispersion characteristics are worst in summer and autumn when wind speeds are light and morning mixing depths are low.

	Morning		Afternoon	
Season	Mixing Height (meters)	Wind Speed (m/s)	Mixing Height (meters)	Wind Speed (m/s)
Winter	634	5.3	1079	6.4
Spring	721	5.5	1986	6.5
Summer	338	2.7	1641	4.3
Autumn	403	3.1	1340	4.9
Annual	524	4.2	1511	5.5

Source: Holzworth, G.C., 1972, Mixing heights, wind speeds and potential for urban air pollution throughout the contiguous United States: EPA, Office of Air Programs, Research Triangle Park, North Carolina.

APPENDIX C

AMBIENT SOUND LEVELS

APPENDIX C

AMBIENT SOUND LEVELS

Nomenclature

The range of sound pressures that can be heard by humans is very large. This range varies from two ten-thousand-millionths (2×10^{-10}) of an atmosphere for sounds barely audible to humans to two thousandths (2×10^{-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:

$$\text{Sound pressure level (dB)} = 20 \log_{10} \left(\frac{P}{Po}\right)$$

where Po is a reference sound pressure required for 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 nightime period (220-0700) only.

L_{dn} - Equivalent day/night sound level, defined as:

$$L_{dn} = 10 \log_{10} ([15 \times 10^{L_d/10} + 9 \times 10^{(L_n + 10)/10}]/24)$$

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 federal Environmental Protection Agency has established guidelines for limits of L_{dn} requisite for the protection of public health and welfare.*

According to EPA guidelines, outdoor ambient sound levels, L_{dn}, below 55 dB will not degrade public health and welfare.

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.

*"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.

APPENDIX D

LIST OF BIRDS LIKELY TO OCCUR IN THE CENTRAL ROCK MINE REGION

APPENDIX D

BIRDS LIKELY TO OCCUR IN THE CENTRAL ROCK MINE SITE REGION[1]

Common Name	Scientific Name	Status[3]
Common loon	*Gavia immer*	N.A.
Red-throated loon	*Gavia stellata*	N.A.
Red-necked grebe	*Podiceps grisegena*	R
Horned grebe[2]	*Podiceps auritus*	N.A.
Pied-billed grebe[2]	*Podilymbus podiceps*	N.A.
Double-crested cormorant	*Phalacrocorax auritus*	V
Great blue heron[2]	*Ardea herodias*	C
Green heron	*Butorides virescens*	*
Little blue heron	*Florida caerulea*	C
Cattle egret	*Bubulcus ibis*	V
Great egret	*Casmerodius albus*	U
Black-crowned night heron	*Nycticorax nycticorax*	U
Yellow-crowned night heron	*Nyctanassa violacea*	R
Least bittern	*Ixobrychus exilis*	R
American bittern	*Botaurus lentiginosus*	U
Canada goose[2]	*Branta canadensis*	U
Snow goose	*Chen caerulescens*	R
Mallard[2]	*Anas platyrhynchos*	N.A.
Black duck[2]	*Anas rubripes*	N.A.
Gadwall[2]	*Anas strepera*	U
Green-winged teal[2]	*Anas crecca*	U
Blue-winged teal[2]	*Anas discors*	*
American wigeon[2]	*Anas americana*	N.A.
Northern shoveler[2]	*Anas clypeata*	N.A.
Wood duck[2]	*Aix sponsa*	*
Redhead[2]	*Aythya americana*	U
Ring-necked duck[2]	*Aythya collaris*	N.A.
Canvasback[2]	*Aythya valisineria*	N.A.
Greater scaup	*Aythya marila*	R
Lesser scaup[2]	*Aythya affinis*	N.A.
Common goldeneye[2]	*Bucephala clangula*	U
Bufflehead[2]	*Bucephala albeola*	U
Ruddy duck[2]	*Oxyura jamaicensis*	N.A.
Hooded merganser	*Lophodytes cucullatus*	N.A.
Common merganser	*Mergus merganser*	N.A.
Red-breasted merganser	*Mergus serrator*	N.A.

APPENDIX D

Common Name	Scientific Name	Status[3]
Turkey vulture	*Cathartes aura*	*
Black vulture	*Coragyps atratus*	U,*
Sharp-shinned hawk[2]	*Accipiter striatus*	R,*
Cooper's hawk[2]	*Accipiter cooperii*	U,*
Red-tailed hawk[2]	*Buteo jamaicensis*	*
Red-shouldered hawk	*Buteo lineatus*	U,*
Broad-winged hawk	*Buteo platypterus*	U,*
Rough-legged hawk[2]	*Buteo lagopus*	R
Golden eagle	*Aquila chrysaetos*	V
Bald eagle	*Haliaeetus leucocephalus*	N.A.
Marsh hawk[2]	*Circus cyaneus*	N.A.
Osprey[2]	*Pandion haliaetus*	U
American kestrel[2]	*Falco sparverius*	N.A.
Ruffed grouse	*Bonasa umbellus*	R,*
Bobwhite[2]	*Colinus virginianus*	U,*
Sandhill crane	*Grus canadensis*	V
King rail	*Rallus elegans*	V
Virginia rail	*Rallus limicola*	R
Sora	*Porzana carolina*	U
Common gallinule	*Gallinula chloropus*	R
American coot[2]	*Fulica americana*	C
Semipalmated plover	*Charadrius semipalmatus*	U
Piping plover	*Charadrius melodus*	V
Killdeer[2]	*Charadrius vociferus*	C,*
American golden plover	*Pluvialis dominica*	R
Black-bellied plover	*Pluvialis squatarola*	R
Ruddy turnstone	*Arenaria interpres*	V
Common snipe[2]	*Capella gallinago*	C
Upland sandpiper	*Bartramia longicauda*	V
Spotted sandpiper[2]	*Actitis macularia*	N.A.
Solitary sandpiper	*Tringa solitaria*	C
Greater yellowlegs	*Tringa melanoleuca*	U
Lesser yellowlegs	*Tringa flavipes*	U

APPENDIX D

Common Name	Scientific Name	Status[3]
Red knot	Calidris canutus	V
Pectoral sandpiper	Calidris melanotos	U
White-rumped sandpiper	Calidris fuscicollis	V
Baird's sandpiper	Calidris bairdii	V
Least sandpiper	Calidris minutilla	U
Dunlin	Calidris alpina	R
Western sandpiper	Calidris mauri	R
Sanderling	Calidris alba	R
Short-billed dowitcher	Limnodromus griseus	R
Stilt sandpiper	Micropalama himantopus	R
Buff-breasted sandpiper	Tryngites subruficollis	V
Red phalarope	Phalaropus fulicarius	V
Wilson's phalarope	Steganopus tricolor	R
Northern phalarope	Lobipes lobatus	V
Glaucous gull	Larus hyperboreus	A
Herring gull	Larus argentatus	R
Ring-billed gull	Larus delawarensis	U
Bonaparte's gull	Larus philadelphia	R
Forster's tern	Sterna forsteri	R
Common tern	Sterna hirundo	U
Least tern	Sterna albifrons	R
Caspian tern	Hydroprogne caspia	R
Black tern	Chlidonias niger	V
Rock dove[2]	Columba livia	C,*
Mourning dove	Zenaida macroura	C,*
Yellow-billed cuckoo	Coccyzus americanus	C,*
Black-billed cuckoo	Coccyzus erythropthalmus	U,*
Barn owl	Tyto alba	U,*
Screech owl[2]	Otus asio	C,*
Great horned owl[2]	Bubo virginianus	R,*
Snowy owl	Nyctea scandiaca	V
Barred owl[2]	Strix varia	R,*
Long-eared owl[2]	Asio otus	V
Short-eared owl[2]	Asio flammeus	U
Saw-whet owl	Aegolius acadicus	V

APPENDIX D

Common Name	Scientific Name	Status[3]
Chuck-will's-widow	Caprimulgus carolinensis	R,*
Whip-poor-will	Caprimulgus vociferus	R,*
Common nighthawk	Chordeiles minor	C,*
Chimney swift	Chaetura pelagica	C,*
Ruby-throated hummingbird	Archilochus colubris	U,*
Belted kingfisher[2]	Megaceryle alcyon	U,*
Common flicker[2]	Colaptes auratus	C,*
Pileated woodpecker[2]	Dryocopus pileatus	U,*
Red-bellied woodpecker[2]	Centurus carolinus	C,*
Red-headed woodpecker[2]	Melanerpes erythrocephalus	R,*
Yellow-bellied sapsucker[2]	Sphyrapicus varius	C
Hairy woodpecker[2]	Dendrocopos villosus	U,*
Downy woodpecker[2]	Dendrocopos pubescens	C,*
Eastern kingbird	Tyrannus tyrannus	C,*
Western kingbird	Tyrannus verticalis	V
Scissor-tailed flycatcher	Muscivora forficata	A
Great crested flycatcher	Myiarchus crinitus	C,*
Eastern phoebe[2]	Sayornis phoebe	C,*
Yellow-bellied flycatcher	Empidonax flaviventris	N.A.
Acadian flycatcher	Empidonax virescens	U,*
Willow flycatcher	Empidonax traillii	*
Alder flycatcher	Empidonax alnorum	R
Least flycatcher	Empidonax minimus	C
Eastern wood pewee	Contopus virens	C,*
Olive-sided flycatcher	Nuttallornis borealis	V
Horned lark[2]	Eremophila alpestris	C,*
Tree swallow	Iridoprocne bicolor	C
Bank swallow	Riparia riparia	*
Rough-winged swallow	Stelgidopteryx ruficollis	C,*
Barn swallow	Hirundo rustica	C,*
Cliff swallow	Petrochelidon pyrrhonota	U
Purple martin	Progne subis	U,*
Blue jay[2]	Cyanocitta cristata	C,*
Common crow[2]	Corvus brachyrhynchos	C,*

APPENDIX D

Common Name	Scientific Name	Status[3]
Carolina chickadee[2]	Parus carolinensis	C,*
Tufted titmouse[2]	Parus bicolor	C,*
White-breasted nuthatch[2]	Sitta carolinensis	U,*
Red-breasted nuthatch[2]	Sitta canadensis	R
Brown creeper[2]	Certhia familiaris	U
House wren	Troglodytes aedon	C,*
Winter wren[2]	Troglodytes troglodytes	U
Bewick's wren[2]	Thryomanes bewickii	R,*
Carolina wren[2]	Thryothorus ludovicianus	C,*
Long-billed marsh wren	Telmatodytes palustris	V
Short-billed marsh wren	Cistothorus platensis	V
Mockingbird[2]	Mimus polyglottos	C,*
Gray catbird	Dumetella carolinensis	C,*
Brown thrasher[2]	Toxostoma rufum	C,*
American robin[2]	Turdus migratorius	C,*
Wood thrush	Hylocichla mustelina	C,*
Hermit thrush[2]	Catharus guttatus	N.A.
Swainson's thrush	Catharus ustulatus	C
Gray-cheeked thrush	Catharus minimus	U
Veery	Catharus fuscescens	U
Eastern bluebird[2]	Sialia sialis	C,*
Blue-gray gnatcatcher	Polioptila caerulea	C,*
Golden-crowned kinglet[2]	Regulus satrapa	C
Ruby-crowned kinglet[2]	Regulus calendula	N.A.
Water pipit[2]	Anthus spinoletta	V
Cedar waxwing[2]	Bombycilla cedrorum	N.A.
Loggerhead shrike[2]	Lanius ludovicianus	R,*
Starling[2]	Sturnus vulgaris	C,*
White-eyed vireo	Vireo griseus	C,*
Bell's vireo	Vireo bellii	V

APPENDIX D

Common Name	Scientific Name	Status[3]
Yellow-throated vireo	Vireo flavifrons	U,*
Solitary vireo	Vireo solitarius	U
Red-eyed vireo	Vireo olivaceus	C,*
Philadelphia vireo	Vireo philadelphicus	U
Warbling vireo	Vireo gilvus	U,*
Black-and-white warbler	Mniotilta varia	*
Prothonotary warbler	Protonotaria citrea	R,*
Swainson's warbler	Limnothlypis swainsonii	V
Worm-eating warbler	Helmitheros vermivorus	R,*
Golden-winged warbler	Vermivora chrysoptera	R
Blue-winged warbler	Vermivora pinus	R,*
Tennessee warbler	Vermivora peregrina	C
Orange-crowned warbler	Vermivora celata	R
Nashville warbler	Vermivora ruficapilla	C
Northern parula	Parula americana	*
Yellow warbler	Dendroica petechia	C,*
Magnolia warbler	Dendroica magnolia	C
Cape May warbler	Dendroica tigrina	C
Black-throated blue warbler	Dendroica caerulescens	R
Yellow-rumped warbler[2]	Dendroica coronata	N.A.
Black-throated green warbler	Dendroica virens	C
Cerulean warbler	Dendroica cerulea	U,*
Blackburnian warbler	Dendroica fusca	U
Yellow-throated warbler	Dendroica dominica	U,*
Chestnut-sided warbler	Dendroica pensylvanica	C
Bay-breasted warbler	Dendroica castanea	C
Blackpoll warbler	Dendroica striata	N.A.
Pine warbler	Dendroica pinus	R
Prairie warbler	Dendroica discolor	C,*
Palm warbler[2]	Dendroica palmarum	U
Ovenbird	Seiurus aurocapillus	R,*
Northern waterthrush	Seiurus noveboracensis	C
Louisiana waterthrush	Seiurus motacilla	C,*
Kentucky warbler	Oporornis formosus	U,*
Connecticut warbler	Oporornis agilis	V
Mourning warbler	Oporornis philadelphia	R
Common yellowthroat	Geothlypis trichas	C,*
Yellow-breasted chat	Icteria virens	C,*
Hooded warbler	Wilsonia citrina	U,*
Wilson's warbler	Wilsonia pusilla	U

APPENDIX D

Common Name	Scientific Name	Status[3]
Canada warbler	*Wilsonia canadensis*	C
American redstart	*Setophaga ruticilla*	U,*
House sparrow[2]	*Passer domesticus*	C,*
Bobolink	*Dolichonyx oryzivorus*	N.A.
Eastern meadowlark[2]	*Sturnella magna*	C,*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	V
Red-winged blackbird[2]	*Agelaius phoeniceus*	C,*
Orchard oriole	*Icterus spurius*	C,*
Northern oriole	*Icterus galbula*	*
Rusty blackbird[2]	*Euphagus carolinus*	U
Brewer's blackbird	*Euphagus cyanocephalus*	V
Common grackle[2]	*Quiscalus quiscula*	C,*
Brown-headed cowbird[2]	*Molothrus alter*	C,*
Scarlet tanager	*Piranga olivacea*	U,*
Summer tanager	*Piranga rubra*	U,*
Cardinal[2]	*Cardinalis cardinalis*	C,*
Rose-breasted grosbeak	*Pheucticus ludovicianus*	C
Blue grosbeak	*Guiraca caerulea*	R,*
Indigo bunting	*Passerina cyanea*	C,*
Dickcissel	*Spiza americana*	C,*
Evening grosbeak[2]	*Hesperiphona vespertina*	R
Purple finch	*Carpodacus purpureus*	N.A.
Common redpoll	*Acanthis flammea*	V
Pine siskin[2]	*Spinus pinus*	U
American goldfinch[2]	*Spinus tristis*	C,*
Rufous-sided towhee[2]	*Pipilo erythrophthalmus*	C,*
Savannah sparrow[2]	*Passerculus sandwichensis*	*
Grasshopper sparrow	*Ammodramus savannarum*	C,*
Henslow's sparrow	*Ammodramus henslowii*	R,*
Le Conte's sparrow	*Ammospiza leconteii*	V
Vesper sparrow	*Pooecetes gramineus*	*
Lark sparrow	*Chondestes grammacus*	*
Dark-eyed junco[2]	*Junco hyemalis*	C
Tree sparrow[2]	*Spizella arborea*	U
Chipping sparrow[2]	*Spizella passerina*	C,*
Field sparrow[2]	*Spizella pusilla*	C,*
Harris's sparrow	*Zonotrichia querula*	V

APPENDIX D

Common Name	Scientific Name	Status[3]
White-crowned sparrow[2]	*Zonotrichia leucophrys*	U
White-throated sparrow[2]	*Zonotrichia albicollis*	C
Fox sparrow[2]	*Passerella iliaca*	N.A.
Lincoln's sparrow	*Melospiza lincolnii*	U
Swamp sparrow[2]	*Melospiza georgiana*	U
Song sparrow[2]	*Melospiza melodia*	C,*
Lapland longspur	*Calcarius lapponicus*	R
Snow bunting	*Plectrophenax nivalis*	V

[1] Environmental Resources Inventory of the Lexington, Kentucky Urban Area by U.S. Army Corps of Engineers Topographic Laboratories, 1974.

[2] Species recorded during Lexington, Kentucky Christmas Bird Counts, 1973-74.

[3] Status:
- C = Common to abundant, at least locally
- U = Uncommon, but found regularly in small numbers
- R = Rare, found infrequently but may be expected, especially at certain times of the year
- V = Very rare or irregular
- A = Accidental visitor
- N.A. = Not Available
- * = Indicates species breeds within the state

APPENDIX E

LIST OF FISHES THAT OCCUR IN THE AREA OF CENTRAL ROCK MINE

APPENDIX E

ANNOTATED SPECIES LIST OF FISHES THAT MAY OCCUR IN THE STUDY AREA

Family	Genus	Species	Common Name	Status[1]	Remarks
Petromyzontidae	Ichthyomyzon	bdellium (Jordan)	Ohio lamprey	A	Known from Licking River and of possible occurrence in large streams of the study area.
		greeleyi (Hubbs and Trautman)	Allegheny brook lamprey	U	Uncommon in Kentucky River and its main tributaries.
		unicuspis (Hubbs and Trautman)	Silver lamprey	U	Uncommon in Red River and of probable occurrence in the Kentucky River.
	Lampetra	aepyptera (Abbott)	Least brook lamprey	U	Uncommon in Red River of Kentucky River basin but probably occurring within the study area.
		lamottei (Lesueur)	American brook lamprey	U	Uncommon in Kentucky River and its principal tributaries.
Acipenseridae	Scaphirhynchus	platorhynchus (Rafinesque)	Shovelnose sturgeon	R	Formerly known from the Licking and Kentucky rivers but not reported for many years.
Polyodontidae	Polyodon	spathula (Walbaum)	Paddlefish	R	The Kentucky and Licking Rivers are near the extreme eastern range of the paddlefish, which is unlikely to occur any longer in the Ohio basin east of the Falls of the Ohio.
Lepisosteidae	Lepisosteus	osseus (Linnaeus)	Longnose gar	C	Common in rivers and associated impoundments within the study area. An important rough fish.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
Clupeidae	Dorosoma	cepedianum (Lesueur)	Gizzard shad	C	Common in larger creeks and rivers in the study area. Occasionally abundant and an important forage fish in impoundments within the area.
		petenense (Gunther)	Threadfin shad	A	Introduced but of questionable success in Buckhorn Reservoir, Middle Fork of the Kentucky River. Strays might exist in the Kentucky River portion of the study area.
Hiodontidae	Hiodon	tergisus (Lesueur)	Mooneye	C	Common in the Kentucky River and mouths of tributaries.
Salmonidae	Salmo	gairdneri (Richardson)	Rainbow trout	U	This species is introduced on a put and take basis in Boone Creek, between Clark and Fayette counties, and in other streams in the Kentucky River basin. Especially in winter this species may stray into the main river. Uncommon.
Esocidae	Esox	americanus vermiculatus (Lesueur)	Grass pickerel	U	Occurs uncommonly and sporadically among weed beds in North Elkhorn Creek and perhaps other streams in the study area.
		masquinongy (Mitchill)	Muskellunge	R	Formerly present in the Kentucky River where strays may still exist rarely.
Cyprinidae	Campostoma	anomalum (Rafinesque)	Stoneroller	C	Abundant in creeks and larger tributaries throughout the study area.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
	Cyprinus	carpio (Linnaeus)	Carp	C	A non-native fish common in larger streams and several reservoirs of the area, generally in murky water with mud bottom.
	Carassius	auratus (Linnaeus)	Goldfish	U	Pets are released into streams and reservoirs and are occasionally seen or collected. Uncommon.
	Ericymba	buccata (Cope)	Silverjaw minnow	C	A common inhabitant of medium-sized creeks throughout the area in shallow reaches where streams flow over exposed bedrock.
	Hybopsis	aestivalis (Girard)	Speckled chub	R	Of doubtful occurrence in the area, but may enter Stoner Creek, Clark County and could still exist in the Kentucky River.
		amblops (Rafinesque)	Bigeye chub	C	Common in medium-sized creeks throughout the area with strays probable in the Kentucky River.
		dissimilis (Kirtland)	Streamline chub	A	Uncommon and sporadic in the upper Kentucky basin and not likely to occur in the study area.
		storeriana (Kirtland)	Silver chub	R	Occurs in rivers to the north of the study area but of doubtful occurrence in the Kentucky River within the study area.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
	Nocomis	biguttatus (Kirtland)	Hornyhead chub	R	An isolated population reported from North Elkhorn Creek but not taken in recent years. Rare.
		micropogon (Cope)	River chub	U	Of scattered occurrence in large creeks and rivers within the area. Uncommon.
	Notemigonus	crysoleucas (Mitchill)	Golden shiner	U	No natural populations of this species but it could appear in sluggish back-waters as escapees from bait buckets or rearing ponds.
	Notropis	ardens (Cope)	Rosefin shiner	C	The most abundant and widespread shiner minnow in very small creeks of the area. Of some importance as a forage fish for game species in streams.
		ariommus (Cope)	Popeye shiner	R	Rare and perhaps now absent from the Kentucky River.
		atherinoides (Rafinesque)	Emerald shiner	C	The typical riverine shiner of the area but reduced in numbers in recent years. Common. A forage species.
		boops (Gilbert)	Bigeye shiner	C	Of scattered occurrence and locally common in medium-sized streams of the area.
		buchanani (Meek)	Ghost shiner	U	In the Kentucky River and mouths of tributaries, especially where somewhat murky. Uncommon.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
		chrysocephalus (Rafinesque)	Striped shiner	C	The most widespread and common shiner minnow in the area, being found in streams of all sizes. Probably very important to stream game fishes as a forage species.
		photogenis (Cope)	Silver shiner	C	Common in clear streams of moderate size and of rather scattered occurrence in the study area.
		rubellus (Agassiz)	Rosyface shiner	C	A common cohabitant with the silver shiner in clear streams of the study area and taken more frequently than the former. A forage species.
		spilopterus (Cope)	Spotfin shiner	C	A common shiner minnow in medium-sized streams of the area but taken rather less frequently than the rosyface shiner. A forage species.
		stramineus (Cope)	Sand shiner	U	A typical shiner of medium to fairly large streams, especially over clean sand. Uncommon in the study area.
		umbratilis (Girard)	Redfin shiner	U	Not known from much of the study area but common in Eagle Creek, Scott County, and probably found in the tributaries of South Fork of Licking River in Bourbon County.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
		volucellus (Cope)	Mimic shiner	U	Common in turbid creeks and sluggish backwaters of the Kentucky River but populations small and scattered in the study area.
		whipplei (Girard)	Steelcolor shiner	U	Known from the lower Red River in Clark County and to be expected uncommonly in other large tributaries of the Kentucky River in the study area.
	Phenacobius	mirabilis (Girard)	Suckermouth minnow	R	Found in strong riffles of larger streams but rare in the study area.
	Phoxinus	erythrogaster (Rafinesque)	Southern redbelly dace	U	Uncommon in creeks on the eastern edge of the study area and quite sporadic elsewhere in the study area.
	Pimephales	notatus (Rafinesque)	Bluntnose minnow	C	The most common and widespread fish in the study area, occurring in pools of all sizes of streams. Quite tolerant of murky water and muddy substrate. Questionable forage importance.
		vigilax (Baird and Girard)	Bullhead minnow	A	Known from the lower Kentucky and Licking rivers and perhaps entering the study area.
		promelas (Fafinesque)	Fathead minnow	C	Common in some farm ponds and locally reared for bait. Also known from pools in medium-sized to large streams, appearing unpredictably.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
	Rhinichthyes	atratulus (Hermann)	Blacknose dace	U	Locally common but restricted to spring-fed Bluegrass streams and steep-gradient creeks adjacent to the Kentucky River.
	Semotilus	atromaculatus (Mitchill)	Creek chub	C	The most abundant fish in extremely small creeks but of widespread occurrence elsewhere in the streams of the study area.
Catostomidae	Carpiodes	carpio (Rafinesque)	River carpsucker	C	A common sucker of the Kentucky and Licking Rivers, not infrequently entering the lower reaches of even the smaller tributaries.
		cyprinus (Lesueur)	Quillback	C	Common in the Kentucky River and its major tributaries.
		velifer (Rafinesque)	Highfin carpsucker	U	Reported from the Kentucky River but rather uncommon. Sometimes confused with the quillback.
	Catostomus	commersoni (Lacepede)	White sucker	C	Adults common in rivers and larger creeks. Young are seen even in small streams. Common.
	Hypentelium	nigricans (Lesueur)	Northern hog sucker	C	This is the common sucker in medium-sized to large creeks of the area. Found most commonly in clear water with clean substrate.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
	Ictiobus	bubalus (Rafinesque)	Smallmouth buffalo	C	Probably the most common river sucker in the Kentucky River. Small specimens generally do not enter tributaries. A food species.
		cyprinellus (Vallenciennes)	Bigmouth buffalo	U	Uncommon in the Kentucky River and lower Red River. A fine food fish but taken infrequently.
	Minytrema	melanops (Rafinesque)	Spotted sucker	R	Typical of shallow, weedy backwaters. To be expected in the study area.
	Erimyzon	oblongus (Mitchill)	Creek chubsucker	R	Reported from the Licking River basin and might be present in the study area.
	Moxostoma	anisurum (Rafinesque)	Silver redhorse	U	An uncommon sucker in the Kentucky River and its largest tributaries.
		carinatum (Cope)	River redhorse	U	An uncommon sucker in the Kentucky River.
		duquesnei (Lesueur)	Black redhorse	C	A common redhorse in large streams of the study area.
		erythrurum (Rafinesque)	Golden redhorse	C	Common in rivers of the region and found in good numbers also in clear, medium-sized to large creeks within the study area. The most characteristic redhorse sucker of this region.
		macrolepidotum (Lesueur)	Shorthead redhorse	U	An uncommon redhorse in the Kentucky River and lower Red River within the study area.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
Ictaluridae	Ictalurus	furcatus (Lesueur)	Blue catfish	R	Enters the Kentucky River portion of the study area but now rare.
		melas (Rafinesque)	Black bullhead	C	Most common in ponds and reservoirs but also numerous in streams and rivers of the area. Quite tolerant of turbidity.
		natalis (Lesueur)	Yellow bullhead	C	The most common catfish of the study region in small to medium-sized streams but much less frequently seen in rivers or standing waters.
		punctatus (Rafinesque)	Channel catfish	C	Common and widely stocked in farm ponds and reservoirs, and native in larger streams, especially where clear and provided with some current. Prized as food.
		flavus (Rafinesque)	Stonecat	U	Uncommon in streams of the study area but common in the Kentucky basin just upstream.
		miurus (Jordan)	Brindled madtom	U	Uncommon and possibly confined to the lower Red River in the study area.
	Pylodictis	olivaris (Rafinesque)	Flathead catfish	U	Not so common as formerly in large streams of the study area. Prized as a food fish and the largest of local catfishes.
Cyprinodontidae	Fundulus	notatus (Rafinesque)	Blackstripe topminnow	U	Common in only a few scattered spots in the study area. In quiet, weedy pools of creeks and backwaters in rivers.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
Poeciliidae	Gambusia	affinis (Baird and Girard)	Mosquitofish	C	Frequently introduced in all types of waters for mosquito and midgefly control but often disappearing in severe winters. Common.
Atherinidae	Labidesthes	sicculus (Cope)	Brook silverside	C	Common in quiet pools of creeks and backwaters of rivers but rather unpredictable in occurrence within the study area.
Percichthyidae	Morone	chrysops (Rafinesque)	White bass	C	An important game fish common in Kentucky River and larger impoundments.
Centrarchidae	Ambloplites	rupestris (Rafinesque)	Rock bass	C	A common and prized game fish in medium-sized to large tributaries of the area, especially where water is clear and rocky or weedy hiding spots are available.
	Lepomis	auritus (Linnaeus)	Redbreast sunfish	A	Introduced in some fishing ponds and lakes but to be expected rarely.
		cyanellus (Rafinesque)	Green sunfish	C	The most abundant sunfish in the study area, being adapted to ponds and streams, regardless of clarity. Not highly valued as a game fish.
		gulosus (Cuvier)	Warmouth	C	Rather uncommon in the study area but found both in standing and running waters. Considered a good game sunfish.
		macrochirus (Rafinesque)	Bluegill	C	The most abundant and acceptable sunfish in ponds and reservoirs of the study area. Frequently found also in large creeks and rivers. Both native and stocked populations exist.

Family	Genus	Species	Common Name	Status	Remarks
		megalotis (Rafinesque)	Longear sunfish	C	The most common small stream sunfish in the area but quite uncommon in standing waters of large rivers or in reservoirs. Acceptable as a game fish but usually smaller than the bluegill.
		microlophus (Gunther)	Redear sunfish	A	Not a native sunfish to the study area. Stocked in some farm ponds and may occur occasionally as escapees in streams.
	Micropterus	dolomieui (Lacepede)	Smallmouth bass	U	Common only in a few streams of the study area, such as North Elkhorn Creek. Otherwise uncommon but always sought as a game fish.
		punctulatus (Rafinesque)	Spotted bass	C	Common in some larger creeks and the principal bass of rivers in the study area. An important game fish.
		salmoides (Lacepede)	Largemouth bass	C	This is the most popular bass from the sportsman's view and natural or stocked populations commonly exist in farm ponds and reservoirs of the study area. The largemouth bass is uncommon in streams.
	Pomoxis	annularis (Rafinesque)	White crappie	C	Common in impoundments, Kentucky River and deeper pools of large creeks. Furnishes considerable fishing, particularly in colder months.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
Percidae	Etheostoma	blennioides (Rafinesque)	Greenside darter	C	Common in creeks and larger tributaries throughout the study area, especially in strong riffles or over exposed clean bedrock in pools. Perhaps in Kentucky River below dams.
		caeruleum (Storer)	Rainbow darter	U	Common within the study area only in a few cooler streams with clean riffles, especially creeks that enter the Kentucky River with a steep gradient.
		flabellare (Rafinesque)	Fantail darter	C	Most widely distributed and abundant darter in the area, occurring in creeks of all sizes and various quality. Typically in gravel riffles.
		nigrum (Rafinesque)	Johnny darter	C	Common but somewhat localized in smaller streams of the area, being found in quieter water at foot of riffles or in shallow exposed pools.
		spectabile (Agassiz)	Orangethroat darter	C	Common, especially in small, upland creeks of moderate gradient and often replaced by the rainbow darter in cooler streams with steep gradient.
		variatum (Kirtland)	Variegate darter	R	Rare in the study area, being confined to few individuals in the lower Red River. Common eastward.
		zonale (Cope)	Banded darter	C	Common in deeper riffles of larger clear creeks. Uncommon in the Kentucky River below dams.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
		sp. (undescribed)	Emerald darter	R	Restricted to a few individuals that stray into lower Red River at eastern edge of study area.
	Percina	caprodes (Rafinesque)	Logperch	C	Common in larger creeks, especially in weedy reaches and the only Percina which is widespread in the area.
		cymatotaenia (Gilbert and Meek)	Bluestripe darter	R	Perhaps represented in the area by occasional strays into lower Red River.
		maculata (Girard)	Blackside darter	U	Uncommon and sparsely distributed in quieter pools of large creeks, especially in eastern portion of the area and in Red River. Strays perhaps in the Kentucky River.
		phoxocephala (Nelson)	Slenderhead darter	U	Uncommon in the area, represented by some individuals in lower Red River and to be expected in Kentucky River below the dams.
		sciera (Swain)	Dusky darter	U	Uncommon in the study area, being represented in lower Red River and perhaps below dams in the Kentucky River.
		shumardi (Girard)	River darter	U	Uncommon in lower Red River and below dams in Kentucky River.
	Stizostedion	canadense (Smith)	Sauger	U	Uncommon in the Kentucky River portion of the study area and no longer an important game species.

APPENDIX E

Family	Genus	Species	Common Name	Status	Remarks
		vitreum (Mitchill)	Walleye	U	Uncommon in the Kentucky River portion of the study area and no longer an important game species.
Sciaenidae	Aplodinotus	grunniens (Rafinesque)	Freshwater drum	C	Common only in Kentucky River and lower reaches of larger tributaries. A game and food fish of moderate importance.
Cottidae	Cottus	bairdi (Girard)	Mottled sculpin	A	Doubtful but perhaps entering the eastern part of the study area in small, spring-fed creeks.
		carolinae (Gill)	Banded sculpin	C	Common in cool, spring-fed streams throughout most of the study area.

[1]A = Absent
C = Common
R = Rare
U = Uncommon

Source: U.S. Army, Corps of Engineers, 1974

APPENDIX F

OIL SPILL RISK ANALYSIS METHODOLOGY

APPENDIX F

OIL SPILL RISK ANALYSIS METHODOLOGY

F.1 PIPELINE SPILLS

The risk for pipeline spills in 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 total exposure average of 145,000 miles of pipeline. This rate is 128 x 10^{-5} spills/year/mile (also expressible as 1.28 spills/year/1000 miles) compared to a European rate of 110 x 10^{-5} spills/year/1000 mile. However, the U.S. historical data base includes pipe in excess of 30 years age. Therefore, it is considered appropriate to adjust the spill basis for new pipelines to:

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 13.5-mile pipeline were always full of oil, as is standard practice in order to take advantage of additional storage volume and simplify operation, the estimated spill risk per year would be:

$$(13.5 \text{ miles}) (50 \times 10^{-5}/\text{year/mile}) = 0.00675/\text{year}$$

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 one 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, $(0.99325)^{22}$ = 86.16 percent chance of no spills in 22 years

$22\ (0.861566)\ (\frac{0.00675}{0.99325})$ = 12.88 percent chance of one spill in 22 years

$(\frac{21}{2})\ (0.128812)\ (\frac{0.00675}{0.99325})$ = 0.92 percent chance of two spills in 22 years

The computational method has a spill error in precluding two spills in any one year. By computing daily exposure, that chance is:

$$66430\ (0.000018)^2\ (0.999982)^{363} = 0.002 \text{ percent}$$

If the pipeline were emptied of oil when not in use, the period of exposure becomes:

5 fills	(14 x 5 million bbl/50,000 bbl/day	= 1400
5 empties	150 days x 5	= 750
		2150 days = 5.89 years

The spill probability is then:

none	$(0.99325)^{5.89}$	= 96.09 percent
one	$5.89\ (0.96089\ (\frac{0.00675}{0.99325})$	= 3.85 percent
two	$(4.89/2)\ (0.03846)\ (\frac{0.00675}{0.99325})$	= 0.06 percent

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 crossed can be computed similarly (see Table 4.3-3) by apportioning the length of pipeline to the annual spill probability:

Stream	Percentage of total pipeline length within watershed
Town Branch	2.2
Wolf Run	15.1
Steeles Run	11.3
Manchester Branch	4.5
Cave Creek	13.9
South Elkhorn Creek	32.0
West Hickman Creek	21.0

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, although there is no oil spill risk. Instead, the purging fluid could be spilled.

The maximum credible spill for the pipeline can be judged from various combined static and pumping losses. The maximum pumping rate would be about 65 barrels per minute to handle 14 million barrels in 150 days. A 16-inch line would contain about 1500 barrels per mile. The leak detection capability will vary 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	-	2150 barrels
10% Break :	1 mile of line + 1 hour pumping	-	1890 barrels
2% Break :	1 mile of line + 12 hours pumping	-	2436 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 2500 barrels is therefore 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, 1969-1974) is 1083 barrels. The spill size distribution may be approximated as:

Spill Size		Percent Occurrence		Contribution To Expectation
Under 500 bbl	-	19	-	48 bbl
500 - 1500 bbl	-	58	-	580 bbl
1500 - 2500 bbl	-	23	-	460 bbl
				1088 bbl

1088/1083 bbl - 0.5 percent error

F.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 45 MDWT tankers through Southwest Pass and up the Mississippi River to St. James, the accident rate (resulting in spills) is taken at 0.0758 spills per vessel-year. Approximately 47 round trips, at 5 days each, would be required for each fill period (14 million barrels). Thus, 0.05 spills per fill, or 0.25 spills during the assumed project lifetime, are expected.

Based on data for accidents in U. S. harbors (U. S. Coast Guard, 1973), the average size of oil spills resulting from a tanker accident is taken to be 428 barrels. The size distribution of spills can be determined by numerically fitting the applicable probability function f(s) to the expectation integral:

$$\int_0^\infty sf(s) = 428$$

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:

$$f(s) - \frac{1}{rs\sqrt{2\pi}} \exp\left(-\ln s/s_o\right)^2 / 2r^2$$

where s_o = 428, 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 45 MDWT tanker transport shows the numerically approximate result:

Size (bbl)	Percent Occurrence	Contribution to Expectation (bbl)
0 - 200	45.8	45.8
200 - 500	35.0	122.5
500 - 1,000	13.1	98.3
1,000 - 2,000	4.3	64.5
2,000 - 5,000	1.3	45.5
5,000 - 10,000	0.39	29.3
10,000 - 20,000	0.09	13.5
20,000 - 50,000	0.017	5.9
50,000 - 60,000	0.007	3.9
		429.2 bbl
		(0.3% 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.

F.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 0.5×10^{-6} to 9×10^{-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 0.3×10^{-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	- 1×10^{-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 has been 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 estimated spill frequency at St. James has been estimated to be 1 in 90 tanker calls.

The volume spill rate of 0.5×10^{-6} may be reasonable, but a more pessimistic rate of 1×10^{-6} has been assumed for unloading the vessels. For loading spills, the volume spill rate was assumed to double to 2×10^{-6} Thus, lightering operations have a spillage rate of 3×10^{-6}.

The resultant projected transfer spills per fill cycle become:

<u>Lightering operations</u>

Number of calls	47
Number of spills	2.6 (1 in 18)
Volume spilled	42 barrels (3×10^{-6} of throughput)
Maximum credible spill	1000 barrels

<u>St. James Terminal Transfer</u>

Number of calls	47
Number of spills	.52 (1 in 90)
Volume spilled	14 barrels (1×10^{-6}) of throughput)
Maximum credible spill	500 barrels

F.4 TERMINAL SPILLS

The average rate of occurrence of terminal spills reported in the Department of Transportation data base (1968-1973) is about 50 spills per year. For an estimated 9.1 million barrels per day throughput average associated with the systems reporting these discharges, the accident rate is 1.5×10^{-8} incidents per barrel throughput. However, oil moving from production to consumption may 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 these spills are due to operator error, rather than equipment failures. The Central Rock storage, with a single reservoir, is the simplest possible type of terminal.

A spill frequency of 1.5×10^{-9} per barrel (10 percent of total rate) can be assigned to an average U. S. terminal. Because of the comparative simplicity of the Central Rock terminal--the lack of switching operations and interconnecting linkages--this terminal is estimated to have a failure rate of one-third the U. S. 1968-1973 average; or 5×10^{-10} events per barrel throughput. Since the throughput per fill or withdrawal is 14 million barrels, the frequency of terminal spill per fill is 0.007, or 1 chance in 143.

The chance of spills in 10 fill-empty events is:

$$\text{no spills} - (0.993)^{10} = 93.22 \text{ percent}$$

$$\text{one spill} - 10(0.9322)\left(\frac{0.007}{0.993}\right) = 6.57 \text{ percent}$$

$$\text{two spills} - 4.5(0.0657)\left(\frac{0.007}{0.993}\right) = 0.21 \text{ percent}$$

A negligible error is introduced by a computing basis which excludes the chance of two spills in one filling. By taking the chance per million barrels, one finds the chance of two spills in one filling as:

$$66(0.9995)^{12}\,(0.0005)^2 = 0.0016 \text{ percent}$$

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, however, and the use of judgmental models in describing terminal spills is necessary. Underground limestone mine storage is not typical of the average terminal in the 1968-1973 data base. If terminal spill risk is equally dependent on events related to throughput and events related to volume, the assertion that the Central Rock (and similar) terminals should result in one-third 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 1083 barrels. However, with the elimination of storage reservoir spills (Tates Creek storage tanks are contained within dikes, thus eliminating the environmental exposure), Central Rock becomes an atypical sample. Using accidental draining of the 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 size spill for the pipeline alone (i.e., 2500 barrels). Also, with pipeline supply the terminal could have periods of very low staffing levels, which increases the chance of larger spills.

The fitted distribution (by histogram approximation) for the average terminal spill is:

Spill Size	Percent Occurrence	Contribution To Expectation
0 - 200 bbl	47.6	48
200 - 500 bbl	39.4	138
500 - 1000 bbl	10.1	76
1000 - 2000 bbl	2.6	39
2000 - 2500 bbl	0.3	7
		308

Therefore: 308/300 = 2 percent error.

The terminal at Tates Creek is a typical U. S. terminal, subject to average spill frequencies and the possible complete loss of the contents of one or more storage tanks. However, the terminal is diked, and such spillage can be discounted as a primary environmental hazard to the extent that the dikes remain secure. The pumping station is outside of the dikes, and represents an exposure equivalent to that found at the surface facilities at Central Rock Mine site.

F.5 COMMENTS ON TECHNICAL ASPECTS OF RISK

F.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 14 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 is recorded. The key ingredient in those large spills was negligence. Oil was reported to have flowed from a ruptured pipeline for 10 days. The barge was loaded with an open porting valve, and no one noticed. A recent barge spill in the Chesapeake Bay of 250,000 gallons (6952 barrels) was attributed to cargo hatches not being secured completely. It can be considered possible that at some time in the program, someone will repeat such an error, but it will not go unnoticed beyond the required inspection period.

F.5.2 Expectation

Statements of expectation, such as: "the expected number of spills is 0.3;" "the spill expectation is 9 barrels per year with a maximum credible spill of 2500 barrels;" frequently confuse readers not familiar with the concept. Expectation is the average over a hypothetical, large sample. Hypothetically, if the event described above were replicated 4 times, then a spill would be expected in one of them (4 X 0.3 = 1.2). If the situation were hypothetically extended over several thousand years, some of the events would be of 2500 barrels.

Large spills have low probabilities of occurrence, such that their return periods (the inverse of annual probability) are long. For example, a terminal spill of 2000 - 2500 barrel size has a return period of around 50,000 years, including both the Central Rock and Tates Creek terminals. About 300,000 years would be needed to provide a sample period in which the spectrum of events would approach the statistical average conditions, compared to the 22 years available. The spill could in fact occur during that 22 year period, but it is unlikely.

F.5.3 Distribution

The statement that spill sizes are log normally distributed means basically that 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 formula; this 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 these spills. Its use in predicting pipeline and terminal spills 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.

F.5.4 Accuracy

The parameters used to describe spill risks are subject to many sources of error, such as:

- Error 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 alter 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 judgmental 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 one spill in 22 years from a pipeline rupture. Such a spill could involve any size outflow (with the larger less likely) from 10 to 2500 barrels. This variability of impact from the Central Rock project makes the question of whether the return period for a 2000- to 2500-barrel spill should be 2300 or 1500 years, instead of 1900 years, somewhat academic. In the context of storing one billion barrels, however, the error is more significant. If the expectation of spillage (0.001 percent) is applied to one billion barrels, one is speaking of 10,000 barrels ± 2000 barrels at the expectation. However, one cannot say that other storage methods and locations in the program would have as low an expectation as the limestone cavern.

F.6 DEGRADATION AND CLEANUP OF OIL

The ideal spreading of petroleum on the surface of water involves three 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. 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 aid of 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 waters, 150- to 400-foot widths can be covered (20 to 50 acres per hour). In water restricted by banks, jetties, sand bars, etc., widths of 15 to 50 feet only can be achieved (2 to 7 acres per hour). In particular, the Kentucky River has an average area of 15 acres per mile, so maximum skimming capacity is about 0.5 mile per hour for one skimmer. In the side channels, depth and width restrictions limit skimmer entry. In some wetland areas, men in hand-poled scows would have to do the cleanup by spreading and collecting sorbents.

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 one knot, if the stream is too shallow for the booms and skimmers available, or if the stream is rocky and turbulent. The recovery effort has to be multi-staged in such cases, 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 (Appendix G). 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 wetland edges along the channel), then between 60 and 75 percent of the oil can ultimately be recovered. If the spill disperses into a wetland 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 computing 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 oils deposited in the wetland areas, slow degradation is the most probable ultimate fate. For globules in the water, eventual deposition in sediments and preservation in the sediments is likely.

APPENDIX G

OIL SPILL CONTAINMENT AND RECOVERY PLAN

APPENDIX G

OIL SPILL CONTAINMENT AND RECOVERY PLAN

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 waters 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, Public Law 92-500 (Amendments of 1972). The Central Rock oil storage facility 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 operation, measures, and equipment to be used to prevent spills 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 Environmental Protection Agency and the Department of Transportation (35 FR 11677 et. seq.). The Central Rock pipeline lies intrastate, but is engaged in the interstate transport of oil. Whether it would come under Kentucky guidelines for the SPCC, Department of Transportation, or the Environmental Protection Agency (i.e., either 40 CFR 109 or 40 CFR 112 as the basis), the thrust of the requirements are the same.

In the event of a spill, the Environmental Protection Agency 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 both drinking water sources and primary contact recreational waters may be involved in a spill from the Central Rock storage system, the use of chemical agents would be very closely regulated. If permitted at all, 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 operation. Helicopter support as a safety backup to skimming operations is one example of the support that a strike force might be able to provide, but which is not generally available through commercial operators.

If wastewater or treated wastewater should be discharged from the facility as a result of pipeline purging, or oily rainwater collected behind protective berms, then the procedures for the National Pollution Discharge Elimination System (NPDES) will apply to the facility (40 CFR 125, as amended), under Public Law 92-500, sections 402 and 405. Primary concerns in meeting the requirements for the discharge permit would be to insure that untreated accumulations of oil could not be accidentally discharged through the waste system, 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 have to be replaced more often.

A complete SPCC does not have to be prepared until the facility begins operation. For purposes of the Environmental Impact Statement, it is sufficient to outline the elements of such a plan for the efficacy of cleanup technology pertinent to the spill risk associated with the Central Rock 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.

Primary emphasis at the site would be containment of spills. Oily wastewaters or purging waters would be passed through an oil separator before discharge into the sewer system. If sewer service were permitted by the local authorities, the water would be passed through some type of reactor, such as an activated charcoal filter, and then to a sump before discharge to receiving waters. A bottom-discharging sump would regulate the discharge to prevent accidental discharge of oil.

The elements of the preventive plan at the site will involve routine inspections of equipment on a regular basis and procedural routines that constantly seek differences in the amounts of oil being moved. The plan will include:

1. Monitoring of Flow Volumes - 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, of the readings at the Central Rock facility and Tates Creek Terminal. Two automatic systems will be used: 1) a sensitive system to advise of all pressure surges, pump flutter, or other minor conditions; and 2) a less sensitive fault detector to shut down the system automatically upon alarm.

2. Emergency Shutdown Capability - This procedure will allow anyone spotting a leak at the facility or in the meter provers to activate the alarm procedures which shut appropriate valves. Activation switches will be located at several strategic points, including one at the outer perimeter of the facility. All major control valves will have manual

overrides so that they can be operated to close the system in a power failure. Off and on positions of all equipment will be clearly indicated.

3. Personnel and Training - Adequate numbers of personnel must be on hand during operations to ensure safe operations and to assist in emergency containment routines. Because of the automation that can be incorporated into terminal designs, adequate personnel will probably be determined by the number of persons who could close all necessary valves manually within a set period of time following a power failure. Persons designated "in charge" should pass qualification demonstrations and be able to communicate adequately with all other personnel.

4. Operating Procedures - These procedures will 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 will be required. Any employee should be authorized to shutdown 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 shutdown. If the system is controlled remotely, i.e, if equipment at the Central Rock storage site should be controlled by operators at Tates Creek Terminal, this control should not be permitted until relinquished by the supervisors of the remote facility.

5. Equipment Maintenance Program - Equipment service and life will be documented; regular pressure and stress tests will be conducted; bolt and coupling flanges, coupling seals, and gaskets will be examined for wear, abrasion, and so forth on a regular basis.

Staffing competent, trained personnel for positions that are not permanent (i.e., which last 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 can be assumed that a few supervisory personnel will be available from the petroleum industry.

The elements of the cleanup plan will include:

1. Inspection of the Berms - Deterioration of the berms due to rain erosion, rodent burrowing, and so forth will be promptly repaired. Rodent burrows could require grouting and/or screens in the ground to prevent the undermining of barriers.

2. Containment of Spilled Oil - Accumulations of oil will be promptly collected and removed to prevent exposure to rainwater which might wash them over a berm or otherwise disperse them. Any zones of accumulation will be checked to ensure that soil impermeability is sufficient to prevent migration of the oil. Supplies of sorbent material will be available for collecting spills too small for liquid recovery.

3. Response Mobilization - If any oil escapes into the environment due to loss of dike integrity or unusual conditions (such as sprayed oil), guidelines for notifying and mobilizing additional response teams will be followed.

Pipeline Spills

The first activities to be conducted 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 terrain around Lexington, static draining of the line would be limited to specific segments 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 possible affected streams could 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 is important.

It is expected that most of the cleanup contractors who would be used in the event of a spill will be associated with the operations on the Ohio River: at Paducah, Louisville, Cincinnati, Evansville, or Ashland. Personnel to operate equipment and assist in oil recovery would have to be recruited for the cleanup.

APPENDIX H - COMMENTS RECEIVED

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

333 Waller Avenue, Lexington, KY 40504

March 3, 1977

Executive Communications
Room 3309
Federal Energy Administration
Washington, DC 20461

00005

Dear Sir:

This office has completed its review of the draft environmental impact statement for Central Rock Mine strategic petroleum reserves (DES 76-9). As a result of this review we offer the following comments and questions for consideration.

1. There appears to be no commitment to minimize erosion and adverse ground water and surface water effects due to pipeline construction or spills. There are statements of what could be done, but this gives the reader nothing to judge by. Other details of the planning are sufficient to allow development of a definite plan to minimize these effects.

2. It appears that the effects of potential oilspills and potential seepage into local aquifers may be understated. Bluegrass horse farms depend almost solely on surface water and ground water from streams for their livestock. Even a small spill could have catastrophic effects.

3. Though the statement seems to give good assurance that the petroleum can be adequately contained within man-made caverns, there is some reason for concern that escaping gases may find their way into the natural plumbing system, contaminating ground water and creating other hazards.

We appreciate the opportunity to comment.

Sincerely,

Glen E. Murray
State Conservationist

cc:
Council on Environmental Quality, Washington, DC (5 copies)
Administrator, SCS, Washington, DC
Office of the Coordinator of Environmental Quality Activities,
  Office of the Secretary, USDA, Washington, DC

DEPARTMENT OF THE ARMY
LOUISVILLE DISTRICT CORPS OF ENGINEERS
P. O. BOX 59
LOUISVILLE, KENTUCKY 40201

ORLPD-R

22 March 1977

Mr. Steven E. Ferguson
Executive Communications
Room 3309
Federal Energy Administration
Washington, D.C. 20461

Dear Mr. Ferguson:

Thank you for the opportunity to review the Draft Environmental Impact Statement on the Strategic Petroleum Reserve, Central Rock Mine, Kentucky. We would like to submit the following comments:

a. Page 3.3-5. The dates for the Kentucky water quality standards should be cited since these standards are periodically amended.

b. Page 3.6-19. In the list of three bird species presently on the state list of endangered fauna, it is the southern bald eagle (*Haliaeetus l. leucocephalus*) which is endangered, not the northern bald eagle.

c. Page 3.9-8. (3.9.2.3). Under Highways, paragraph 2, the 1990 estimated population for Lexington-Fayette County, Kentucky is listed as 270,000. This seems to conflict with figures given in the text on page 3.9-11 under Housing (290,000) and page 3.9-32 under Table 3.9-15 (290,000).

d. Page 4.1-2. The only known Old Grand Dad Distillery is approximately 15 miles away. It is presumed, therefore, the reference to its lake's siltation is for comparison only since it is doubtful if any pipeline construction at the Central Rock site would affect it.

It is suggested the proposed alignment for the 16-inch pipeline from the Tates Creek Terminal to the storage area should be reexamined and probably rerouted slightly to both shorten and reduce environmental impacts.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

The pipeline crossing at West Hickman Creek will require a Department of the Army (DA) permit since the "normal" stream flow is greater than five cubic feet per second (cfs). We are inclosing two information documents to explain the Corps of Engineers' permit program.

This document sets out probable and worst-case impacts and appears to analyze them objectively. The suggested mitigation measures seem adequate to minimize deleterious impacts.

If we can be of further assistance, please contact this office.

Sincerely yours,

JAMES N. ELLIS
Colonel, Corps of Engineers
District Engineer

2 Incl
As stated

KO

UNITED STATES DEPA⌐⌐MENT OF COMMERCE
The Assistant Secreta   or Science and Technology
Washington, D.C. 20230

March 15, 1977

00007

Executive Communications
Federal Energy Administration
Room 3309
12th & Pennsylvania Avenue, N.W.
Washington, D. C. 20461

Gentlemen:

This is in reference to your draft environmental impact statement entitled "Strategic Petroleum Reserve, Central Rock Mine." The enclosed comments from the National Oceanic and Atmospheric Administration (NOAA) are forwarded for your consideration.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving ten (10) copies of the final statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosure: Memo from NOAA - Environmental Data Service

UNITED STATES D 'ARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL DATA SERVICE
Washington, D.C. 20235

FEB 1 6 1977

February 15, 1977 Dx61/DL

TO: William Aron, Director
Office of Ecology and Environmental Conservation, EE

FROM: Douglas Le Comte
Special Projects

SUBJECT: EDS Review of DEIS 7702.11 - Strategic Petroleum Reserve, Central Rock Mine

General Comment

The discussion of climatology and air quality is exceptionally thorough and generally accurate. A couple of minor items, however, need to be changed.

Specific Comments

Page 3.4-1, 2nd paragraph, 3rd sentence:

"There are no bodies of water large enough or close enough to Lexington to exert any influence upon the climate." This is not really true, as both the Gulf of Mexico and the Atlantic are important sources of moisture for the air currents which traverse Kentucky, especially during the summer. The quoted sentence probably is referring to local climatic influences, in which case this should be made clear.

Page 3.4-7, 3rd paragraph, 2nd sentence:

"...strong insulation...are conducive to tornadic activity..." The word "insolation" should replace "insulation." Better yet, the term "surface heating" would be more understandable to most of the readers.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

MAR 2 1977

Executive Communications
Room 3309
Federal Energy Administration
Washington, D.C. 20461

00001

Gentlemen:

We have reviewed the Draft Environmental Impact Statements for the Central Rock mine and the Ironton mine, two candidate sites in the initial phase of the Strategic Petroleum Reserve. Based upon the data contained in the documents, it is our opinion that the proposed action will have only a minor impact upon the human environment within the scope of this Department's review. Therefore the impact statement appears to adequately address our concerns.

Sincerely,

Charles Custard
Director
Office of Environmental Affairs

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
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 01 1977

00002

Executive Communications, Room 3309
Federal Energy Administration
Washington, D. C. 20461

Gentlemen:

This is in response to a letter from Michael E. Carosella, Associate Assistant Administrator, Special Programs, dated January 12, 1977, inviting our comments on the Draft Environmental Impact Statement for Central Rock Mine, DES 76-9, December, 1976.

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, Assistant Director
for Environmental Projects
Division of Site Safety and
Environmental Analysis

cc: Council on Environmental
Quality (5)

Indiana State Clearinghouse
State Budget Agency
212 State House
Indianapolis, Indiana 46204

RECEIVED
FEB 15 1977
STATE BUDGET AGENCY

Date Received

Suspense Date

PROJECT REVIEW

TO:

Date

PROJECT NAME:

The attached project summary notification is referred to your agency for review and comments. If your agency has an interest in this grant application, please complete this page. Your cooperation is asked in returning this memo to the Clearinghouse Office, indicating your interest or not, within 10 days of receipt.

_____ Our agency is not interested in this project

_____ Comments submitted herewith

_____ Meeting desired with applicant

Is this project consistent with the goals and objectives of your agency?

✓ yes _____ no Comments--

Is there evidence of overlapping or duplication with other agencies?

_____ yes ✓ no Comments--

Please use reverse side or separate sheets for additional comments, if necessary.

John G. Feingold
Reviewers Signature

2/14/77
Date

Outdoor Recreation Planner
Title

633-4677
Telephone Number

Indiana State Clearinghouse
State Budget Agency
212 State House
Indianapolis, Indiana 46204

[illegible]
Date Received
1-31-77
Suspense Date
[illegible]

PROJECT REVIEW
FEB 2 1977

TO: [illegible]
[illegible]
[illegible]

Date [illegible]

PROJECT NAME: [illegible]

The attached project summary notification is referred to your agency for review and comments. If your agency has an interest in this grant application, please complete this page. Your cooperation is asked in returning this memo to the Clearinghouse Office, indicating your interest or not, within 10 days of receipt.

____ Our agency is not interested in this project
_X_ Comments submitted herewith
____ Meeting desired with applicant

Is this project consistent with the goals and objectives of your agency?

_X_ yes ____ no Comments-- The Indiana Energy Office finds that the objectives of the Strategic Petroleum Reserve is consistent with the policies of the State of Indiana and therefore has our support. The concept of a stored reserve of oil to act as a buffer in an embargo situation has the obvious merits of protecting the health, welfare and safety of our Nation as a whole with Indiana sharing the benefits.

Is there evidence of overlapping or duplication with other agencies?

____ yes _X_ no Comments--

Please use reverse side or separate sheets for additional comments, if necessary.

Reviewers Signature
Thomas F. Kibler

March 1, 1977
Date

Director
Title

317/633-6753
Telephone Number

Indiana Energy Office

St. Identification No.
77011680000

Date Received
1-31-77

Review Terminated
3-11-77

Indiana State Clearinghouse
State Budget Agency
212 State House
Indianapolis, Indiana 46204

AUTHORIZATION TO FILE APPLICATION

TO: Mr. Michael E. Carosella
Associate Assistant Administrator
Federal Energy Administration

PROJECT: Environamental Impact Statement for the Central Rock Mine &
The Ironton Mine

FEA
Federal Program Title; Agency and FDA Catalog No.

Amount of Funds Requested

The State Clearinghouse has reviewed the summary notification pertaining to the above project. With regard to the summary notification, the Clearinghouse makes the following disposition concerning this application:

X The proposed project is in accord with State plans, goals, and objectives at this time.

X Refer to the attached comments.

You may now complete and file your formal application with the appropriate Federal Agency. This form, with comments if any, is to be attached to that application, and the lower portion of this form is to be completed by you, detached, and returned to the State Clearinghouse when the formal application is submitted.

Signature (Mrs. Sally Corn)

State Clearinghouse Reviewer
Title

March 11, 1977
Date

Indiana State Clearinghouse
State Budget Agency
212 State House
Indianapolis, Indiana

St. Identification No. 77011680000

The formal application for EIS Central Rock Mine&Ironton Mine (Name of Project) was submitted to the FEA (Federal Agency) on ______ (Date) by ______ (Name of Applicant)

Signature

STATE of INDIANA
STATE BOARD OF HEALTH
An Equal Opportunity Employer

INDIANAPOLIS

Address Reply to:
Indiana State Board of Health
1330 West Michigan Street
Indianapolis, IN 46206

TO: Mr. Roland J. Mross
Federal Aid Director
State Budget Agency

Attention Indiana State Clearinghouse

February 21, 1977

FROM: William T. Paynter, M. D. WTP
State Health Commissioner

SUBJECT: A-95 Project Review
State Identification No. 77 C1168 CCCC Kentucky — Ohio
DEIS by Federal Energy Administration on plan to store oil in limestone mines at Lexington, Kentucky or Ironton, Ohio.

The Indiana State Board of Health has reviewed the documents forwarded from your office on February 2, 1977, relative to the subject project and offers the comments as checked below.

(X) No comments.
( ) No objections to this proposal. However, plans and specifications for the indicated (x) health and sanitary features must be submitted for review and recommendations for appropriate approvals prior to construction.

- ( ) Water production
- ( ) Water distribution
- ( ) Sewage collection
- ( ) Sewage treatment
- ( ) Solid waste management
- ( ) Fuel combustion and incineration
- ( ) Long-term nursing care facilities
- ( ) Schools, hospitals, community health facilities, jails
- ( ) Other

RECEIVED
FEB 21 1977
STATE BUDGET AGENCY

( ) Cannot endorse this proposal for the following reasons:

- ( ) The community is on the sewer ban list so additional sanitary sewer connections are prohibited.
- ( ) The project site is inadequate for the intended purpose.
- ( ) The economic soundness of the proposal is questioned.
- ( ) Other

ROBERT D. BELL
SECRETARY

JULIAN M. CARROLL
GOVERNOR

COMMONWEALTH OF KENTUCKY
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
OFFICE OF THE SECRETARY
FRANKFORT, KENTUCKY 40601
TELEPHONE (502) 564-3350

March 9, 1977

Executive Communications
Room 3309
Federal Energy Administration
Washington, D.C. 20461

RE: Draft Environmental Impact Statement for Central Rock Mine

Dear Sirs:

The above mentioned Environmental Impact Statement has been circulated to the eighteen Kentucky Environmental Review Agencies. Enclosed are the comments returned by the agencies. Any further comments will be forwarded to you.

Sincerely,

ROBERT D. BELL
Secretary

Enclosures

ROBERT D. BELL
Secretary

JULIAN M. CARROLL
Governor

COMMONWEALTH OF KENTUCKY
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
BUREAU OF ENVIRONMENTAL PROTECTION
XXXXXXXXXXXXXXXXX
COMMISSIONER
FRANKFORT, KENTUCKY 40601

February 21, 1977

RECEIVED
1977
OFFICE OF PLANNING AND RESEARCH

MAR 2 4 2 PM '77
OFFICE OF THE SECRETARY
DEPT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION

MEMORANDUM

TO: Office of Planning and Research

THROUGH: Commissioner
Bureau of Environmental Protection

Norman E. Schell
Director, Division of Solid Waste

FROM: Samuel N. Johnson, Jr., P.E.
Chief Sanitary Engineer

SUBJECT: Environmental Impact Statement 77-4D.E.I.S.

The following are the Division of Solid Waste's comments:

In the event of a pipeline break or leak, considerable contamination of soil and vegetation could take place. While recovery of some of the oil from such contamination is usually possible, most of this contaminated material would require either landfilling techniques for disposal or land spreading over a wide area. These methods should be discussed as possibilities under Section 4.3.8.8.

Transportation of oil by pipeline has long been practiced by industry and considerable experience exists in handling spills.

Construction of such a pipeline as the one from the Tate's Creek Terminal to the Central Rock Company Site, in either a fee simple property R.O.W. or in a utility easement, presents some unique access problems. This depends on the wording of the easement or purchase agreement and can cause major problems in land subdivision along the route.

Kentucky Heritage Commission
104 Bridge Street
Frankfort, Kentucky 40601

RECEIVED
1977
OFFICE OF
PLANNING AND RESEARCH

Memorandum

TO: Environmental Review
Office of Planning and Research

FROM: (Mrs.) Eldred W. Melton *Eldred W. Melton*
Executive Director and State Historic Preservation Officer

SUBJECT: 77-4 DEIS - Strategic Petroleum Reserve, Central Rock Mine

DATE: March 1, 1977

My staff and I have reviewed the subject DEIS. It is indicated in the DEIS that the "state historic office" (see pages 4.2-15 and 4.2-16) will conduct the reconnaissance surveys to identify historic and/or archeological resources within the project area. Regrettably, it is not possible for this office to perform such survey work for all federal, federally funded and/or federally licensed projects in Kentucky.

Pursuant to the Procedures of the Advisory Council on Historic Preservation (36CFR, Part 800), a copy of which is enclosed, identification of National Register properties within the area of potential environmental impact of a federal, federally funded or federally licensed undertaking is the responsibility of the federal "agency official" or his designee. Since this identification process must be accomplished in consultation with the State Historic Preservation Office (my sole involvement/responsibility at this early stage in the Advisory Council's Procedures), I recommend that a qualified historian and/or architectural historian and professional archeologist be employed to conduct the historical and archeological reconnaissance surveys of the project area. If any properties are identified during the surveys, the professional historian and archeologist should apply the National Register Criteria (see Section 800.10 of the enclosed Procedures) and indicate if any of the sites meet this criteria. Consultation with the State Historic Preservation Officer will have been accomplished when I have reviewed and approved the reconnaissance survey reports.

If National Register eligible properties are identified within the project area, the "agency official" should seek a determination of eligibility from the Secretary of the Interior. If a property is determined eligible, the "agency official" should then apply the Criteria of Effect (Section 800. 8 of the enclosed Procedures) in consultation with the State Historic Preservation Officer. If there is an effect, the "agency official" must then apply the Criteria of Adverse Effect (Section 800. 9 of the enclosed) in consultation with the State Historic Preservation Officer. The Advisory Council on Historic Preservation makes the final determination in regard to a finding of no adverse effect or a finding of adverse effect. If the Advisory Council finds adverse effect then proceed to the Consultation Process (Section 800. 5 of the enclosed).

I hope this clarification will be of assistance in regard to this project.

UNIVERSITY OF KENTUCKY

LEXINGTON, KENTUCKY 40506

COLLEGE OF ARTS AND SCIENCES
DEPARTMENT OF ANTHROPOLOGY

18 Feb. 1977

Mr. Robert D. Bell, Secretary
Environmental Review
Office of Planning and Research
Department for Natural Resources
and Environmental Protection
6th Floor, Capital Plaza Tower
Frankfort KY 40601

Re: Strategic Petroleum Reserve, Central Rock Mine, Fayette County, Ky.
DES 76-9, December, 1976.

Dear Mr. Bell:

I appreciate the opportunity to review the referenced DEIS for the Central Rock Mine storage site. I note on page 3.7-1 that an "agreement has been made with the State Historic Officer to survey the Central Rock Mine site and pipeline routes for cultural resources when the route is specifically established". I can only add to this, with respects to prehistoric archaeological sites, that such a survey should be conducted on-site of all areas of the project which have not been disturbed by prior construction. Such a survey should be conducted by a competent archaeologist and, where the project encompasses lands owned by the state or any municipal corporation within it, will require a permit for investigation from this office under the provisions of KRS 164.720.

By such a survey the applicants will comply with the appropriate Federal guidelines established to insure the identification of archaeological sites on federally funded or approved projects.

Please contact me if I can be of further assistance.

Sincerely Yours,

R. Berle Clay
State Archaeologist

RECEIVED
FEB 21 1977
OFFICE OF
PLANNING AND