Strategic
Petroleum
Reserve

Final Environmental Impact Statement for

Ironton Mine

FES 76/77-10

July 1977

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Strategic Petroleum
Reserve Office

FEA/S-77/205

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

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

A. SUMMARY

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

Prepared By: : The Strategic Petroleum Reserve Office
Federal Energy Administration (CO-05-60472-00)
Washington, D.C. 20461
(202) 634-5500

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. 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 candidate site discussed herein would be part of the ESR and would involve storage of 21 million barrels of oil in an abandoned underground limestone mine, located near Ironton, Ohio, which is presently owned by the Alpha-Portland Cement 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 Ironton, Ohio Early Storage Reserve site. The most sensitive parameters to be affected by oil storage development at this site appear to be air quality and water quality. The significant 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 Ironton Mine; degradation of surface water quality due to sedimentation from runoff and erosion during pipeline construction activities; 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. Oil spill releases to land and water environments would cause localized losses to vegetation and fauna along the pipeline corridor and at the terminals. The maximum estimated credible spill of 3000 barrels could severely pollute a local natural area of up to 100 acres and up to 15 miles of local stream channel, but the frequency of occurence of such a spill, based on historical data, is extremely low. No significant adverse socioeconomic impacts have been identified.

4. Alternatives Considered

Alternative Storage Sites

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

Nonstructural Alternatives

Structural Alternatives

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

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

Federal:

Department of Agriculture
Department of the Army
Department of Commerce
Department of Health, Education and Welfare
Department of Transportation
Department of the Treasury
Environmental Protection Agency
Federal Power Commission
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 8, 1977

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SECTION 1.0

BACKGROUND

This document is a site specific Environmental Impact Statement (EIS) for the proposed storage of crude oil at the Ironton limestone mine located in Lawrence County, Ohio. 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, Public Law 94-163 (the Act) for the purpose of providing the United States with sufficient petroleum reserves to minimize the effects of any future oil supply interruption. The Act requires that within seven years the SPR contain a reserve equal to the volume of crude oil imports during the three consecutive highest import months in th 24 months preceding December 22, 1975 (approximately 500 million barrels). The Act further requires the creation within three years of an Early Storage Reserve (ESR) of 150 million barrels as the initial phase of the SPR to provide early protection from near-term disruptions in the supply of petroleum products.

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

Because of the severe time constraints placed upon the ESR completion schedule by the Act, FEA 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 through DES 76-8, September 1976) were filed with the Council on Environmental Quality and made available to the public on the same day so that the environmental impacts associated with the possible use of these sites could be compared with each other. The 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, Weeks Island have been selected for use as storage facilities.

The other three candidate sites include the Ironton limestone mine (Lawrence County, Ohio), the Central Rock limestone mine (Fayette County, Kentucky), and the Kleer salt mine (Van Zandt County, Texas). Ironton and Central Rock would both supply the refineries in an area served by the Capline - Ashland pipeline network and are 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 sites therefore comprise a group of alternatives. Section 8.3.2 includes a more detailed discussion of the rationale supporting the selection of the alternative sites in a bref summary of the impacts associated with each of the other six sites besides the Ironton Mine. The Kleer Mine would serve the Texoma pipeline and is therefore not an alternative for the Capline market. The draft EIS for Ironton, Central Rock and Kleer (DES 76-9, 10 and 11 January 1977) have been filed with the Council on Environmental Quality and made available to the public.

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

SECTION 2.0

DESCRIPTION OF THE PROPOSED ACTION

2.1 INTRODUCTION AND SUMMARY

Ironton Mine is located in the Appalachian plateau region of Ohio (Figure 2.1-1), approximately 16 miles northwest of Huntington and 70 miles west of Charleston, West Virginia. The site is outside the city limits of Ironton, Ohio (Figure 2.1-2), in the south central portion of Lawrence County. The surrounding area includes urban and suburban, industrial, forest and scattered small agricultural lands. The Ohio River passes in a northwest-southeast direction 1-1/2 miles northwest of the 397-acre mine site, and forms the Ironton city limit to the west. The abandoned limestone mine and site are owned by the Alpha-Portland Cement Company. The majority of the land is wooded; there is also an abandoned cement plant, gas wells, and assorted buildings and structures (Figure 2.1-3). The elevations found on the property range from a low of 560 to a high of 890 feet mean sea level (MSL). The floor of the cavern is about 74 feet MSL.

FEA is considering acquisition, by purchase or lease, of the existing underground caverns of the Alpha-Portland Cement Mine together with sufficient surface area for conversion of the caverns into a crude oil storage facility, to be part of the National Strategic Petroleum Reserve Program. Because the mine has been abandoned and there are no plans to renew production, there is no need to also consider mine relocation.

Necessary construction activities would include: sinking two new 12-inch vent shafts; pumping out and chemically treating seepage water currently in the mine; sealing shafts 1 and 2 with double concrete bulkheads upon completion of installation of the pumping equipment; installing oil pipelines, pumps, manifolds, and metering equipment between the new pump station and the pump shaft; installing an electrical power substation; constructing a pipeline from the Ironton Mine to the vicinity of Ashland's Catlettsburg Terminal (a distance of about 13 miles, Figure 2.1-4); and constructing terminal facilities (including pumps, meters, control system, and power house) at or near Ashland's

Catlettsburg Terminal. No extensive utility corridors are anticipated to be needed because the property is already serviced by a utility corridor (see Figure 2.1-4).

Construction at the site would include conversion of one of the existing shafts to accommodate pumping equipment, and sealing of the other shaft after utilization for emergency access and ventilation during the underground construction phase of the work. The underground preparation of the mine would consist of some survey work to confirm floor gradients, check storage capacity, and determine optimum locations for vent shafts; construction of some drainage channels; and provisions for a sump below the pump shaft. In addition, a geotechnical investigation of the mine would be required to verify the containment function.

Conversion of the mine would require approximately 65 workers. During standby storage, manpower requirements would be limited to 2 or 3 personnel for security and equipment inspection. For planning purposes, the 21 million barrels of stored crude oil are assumed to be withdrawn at approximately 5-year intervals, under emergency conditions in response to oil supply interruptions. The cavern would be filled again as soon thereafter as practical. Approximately 8 to 10 personnel would be required during the oil transfer operations.

About 3600 man-weeks of labor would be required to develop the Ironton oil storage facility; this work force would extend over a 55-week period. Capital costs for mine conversion would amount to $1.0 million; total cost of the oil handling equipment and distribution facilities will be $6.7 million. Total project development costs would total more than $7.7 million, or $0.37 per barrel of oil stored.

Disposal of waste associated with mine conversion would consist primarily of overburden and limestone removed during the construction of necessary shafts. This material will be removed and, where possible, disposed of onsite. If this is not practical, the material will be transported from the site and used as fill material. All other wastes generated during construction will be removed. Gaseous wastes will be limited to engine exhausts and hydrocarbons vented and flared during cavern filling. Liquid wastes will include sanitary effluent disposed of in a septic tank system and seepage water from the mine, which will be treated in a temporary onsite water treatment facility. This facility will be designed to handle volumes in excess of 1000 gallons per minute (gpm) during the pumpout operation. During operation of the Ironton storage facility, a permanent onsite water treatment facility capable of handling a volume of 20 gpm will be utilized. Once treated to acceptable state and federal water quality standards, including NPDES specifications, this effluent will be pumped into Ice Creek.

Conversion of the Ironton Mine to an oil storage facility will be designed to comply with all MESA and OSHA requirements. The Ironton Mine has been selected for consideration, in part, on the basis of its geologic suitability for oil storage. The use of existing shafts for installation of a pumping system and the volume of storage possible at Ironton (21 million bbls) make consideration of this mine site practical. Possible accident modes are recognized and accounted for in designing the storage and transportation facilities.

The Ohio Public Utilities Commission, which has regulatory control over the construction of pipelines for oil transportation, has adopted the Federal regulations (Code of Federal Regulations, 1969) which require new pipelines to be constructed underground below the level of cultivation. In Kentucky, 3 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, but they are normally for a maximum of 5 years and are nonrenewable. Thus, aboveground pipelines have not been considered as part of the proposed project plan for the Ironton oil storage facility.

The oil storage and new mine facilities are presently in the preliminary design stage. Future studies will 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.

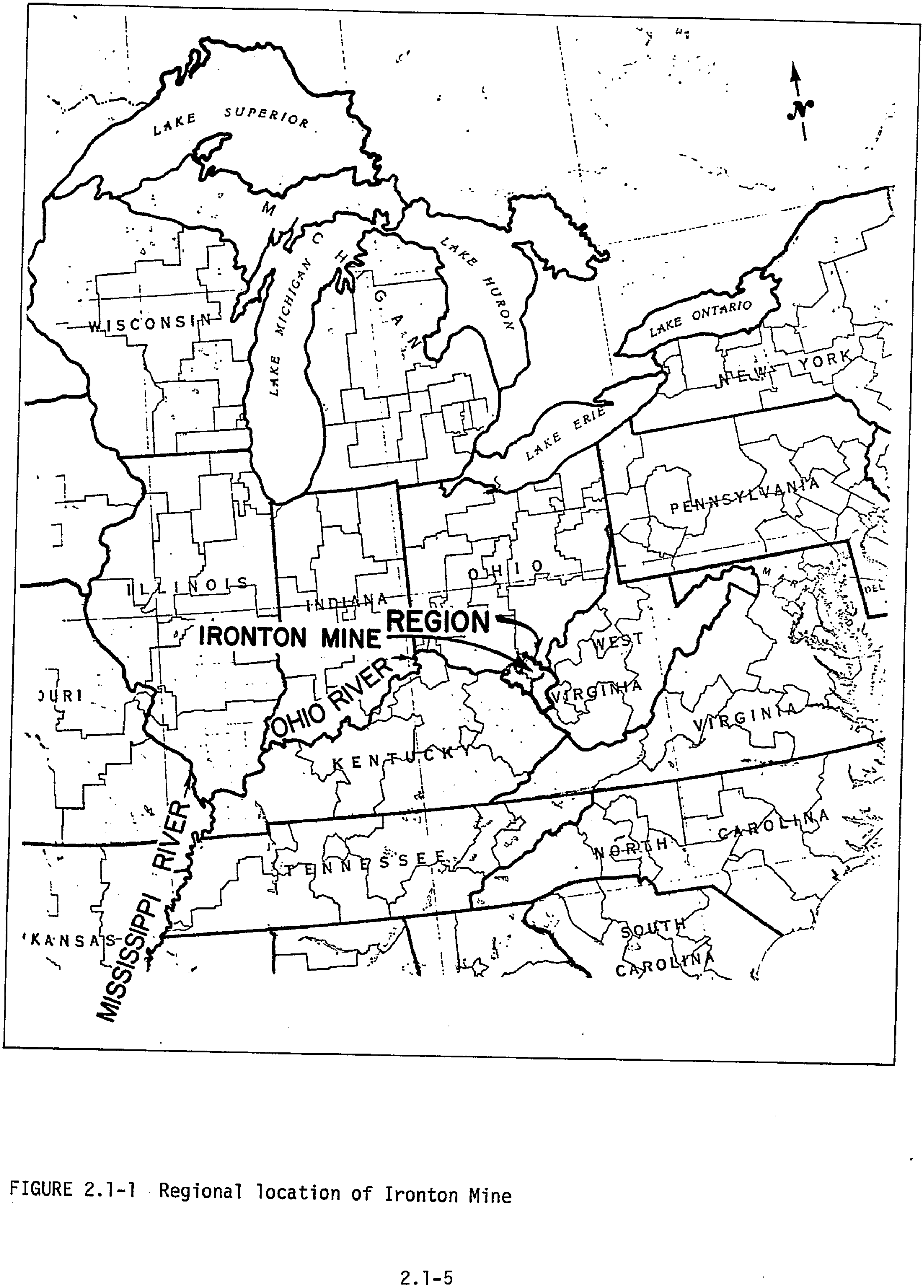

FIGURE 2.1-1 Regional location of Ironton Mine

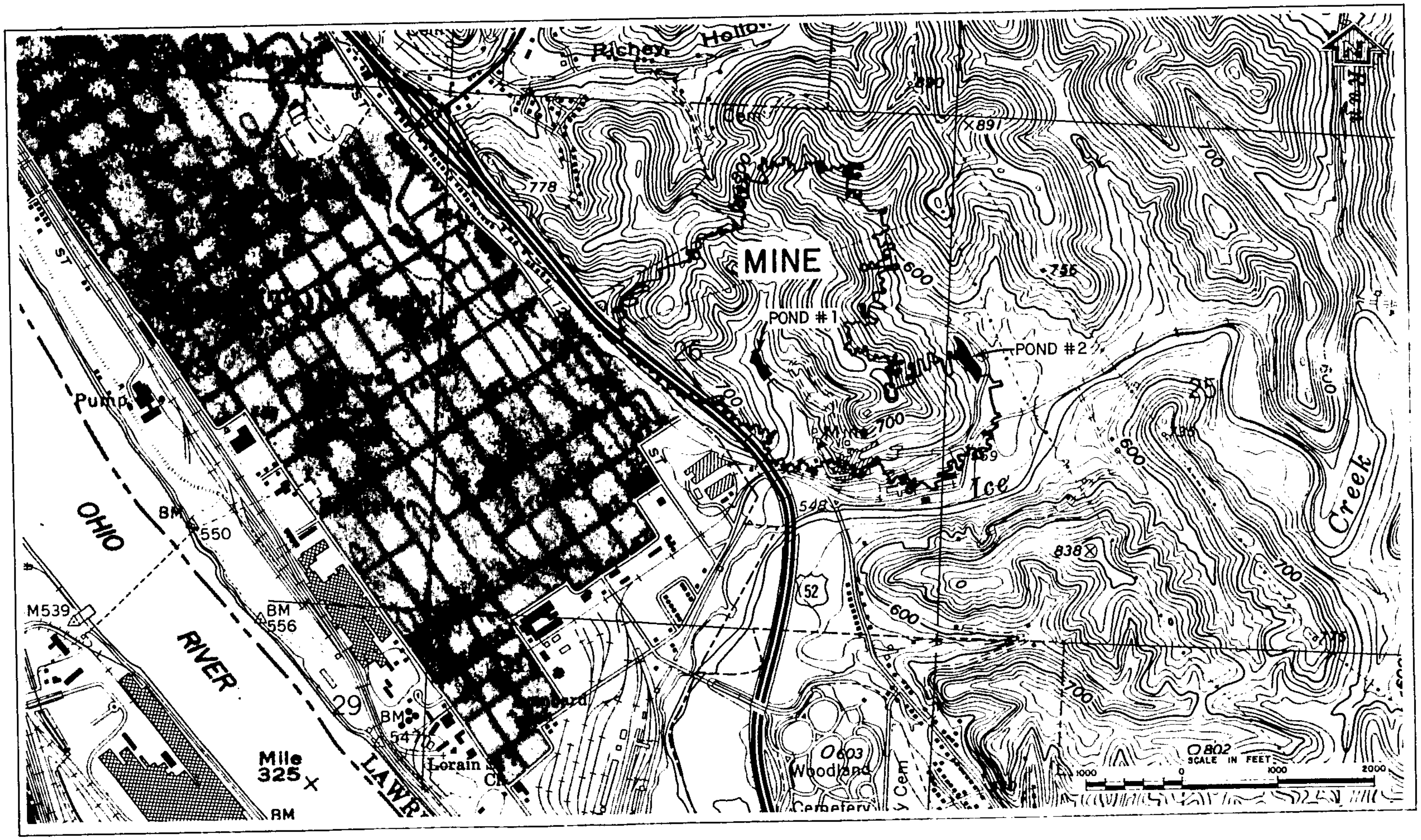

FIGURE 2.1-2 Local map showing Ironton Mine in Ironton, Ohio

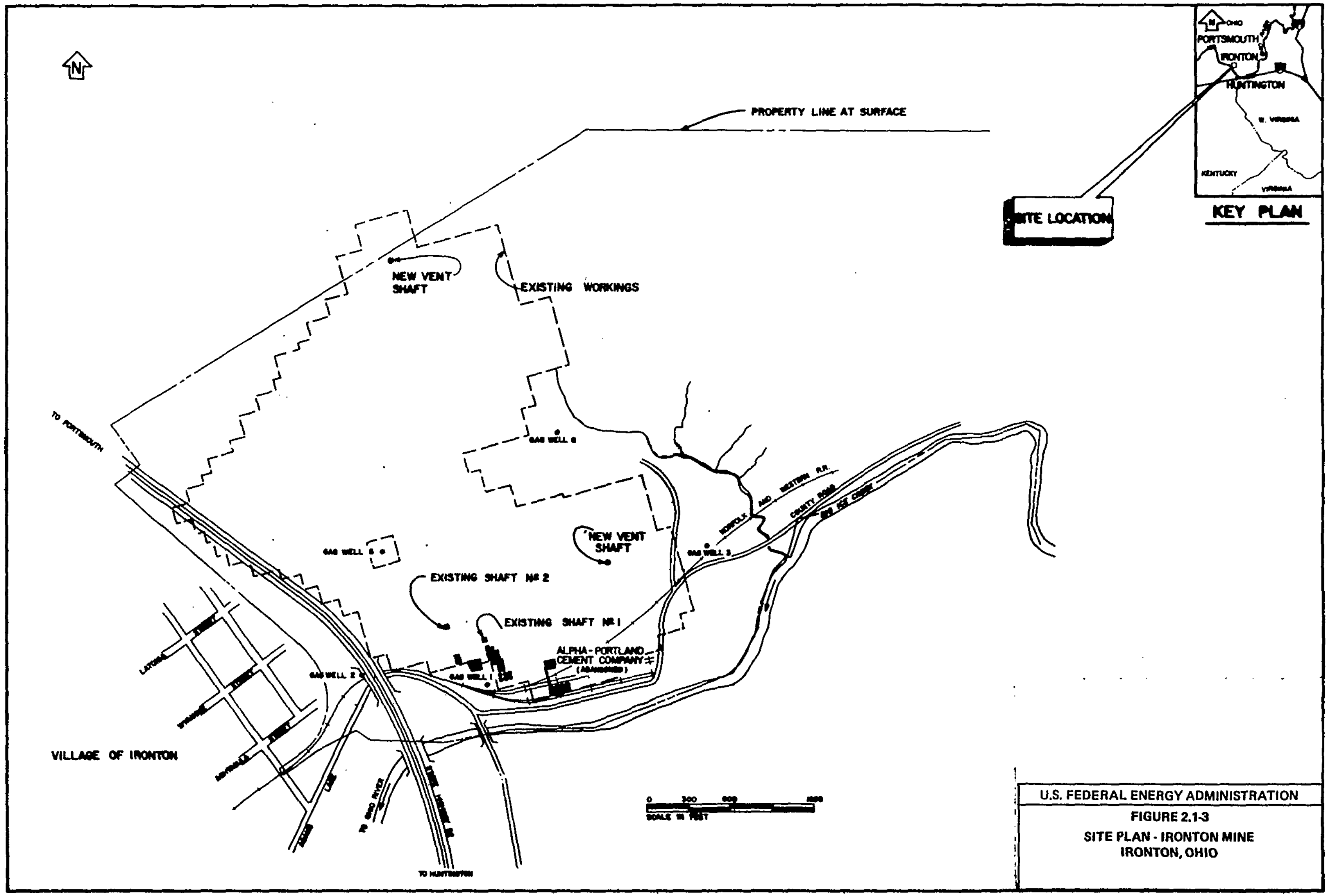

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FIGURE 2.1-3

SITE PLAN - IRONTON MINE
IRONTON, OHIO

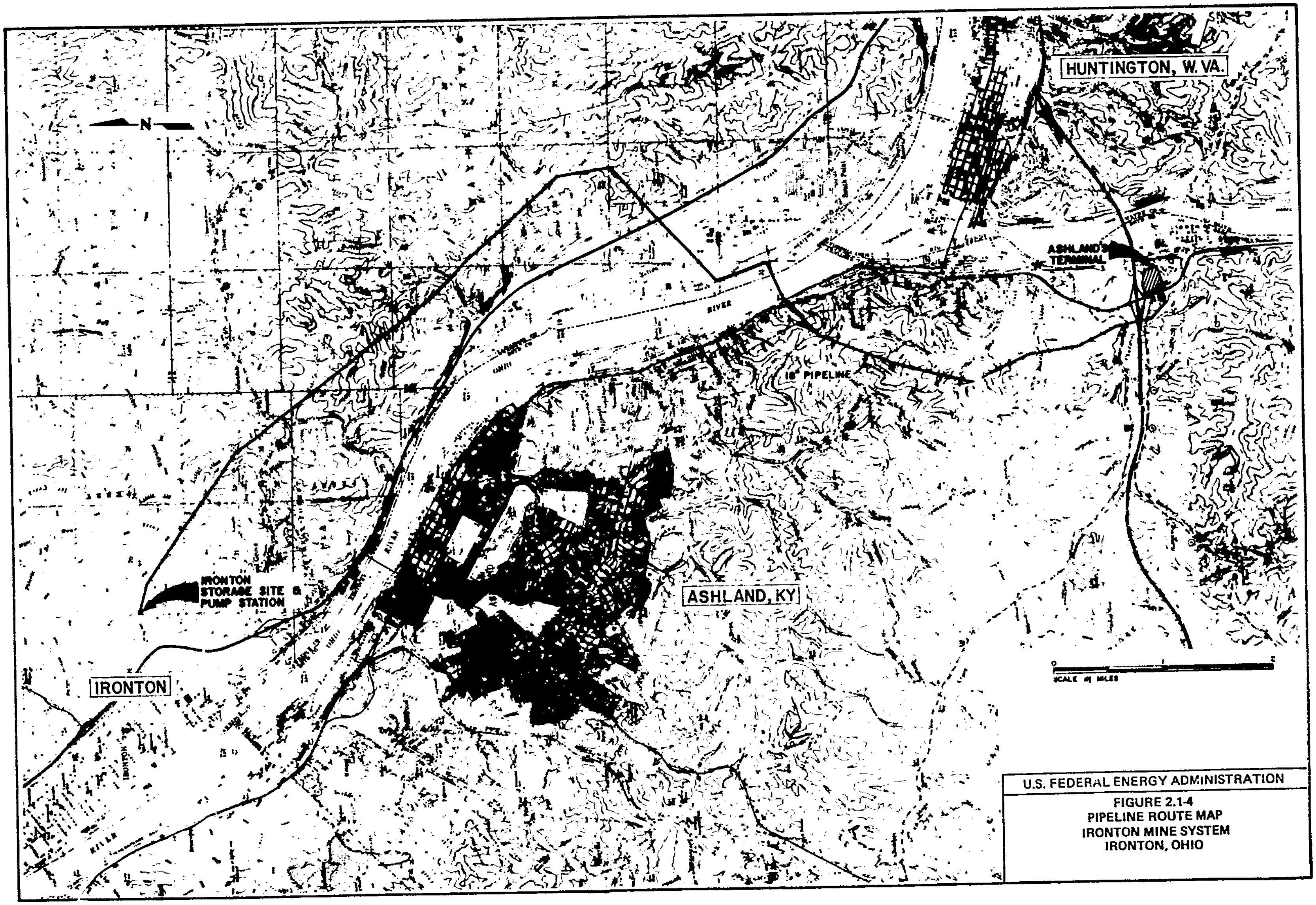

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FIGURE 2.1-4
PIPELINE ROUTE MAP
IRONTON MINE SYSTEM
IRONTON, OHIO

2.2 EXISTING MINE FACILITIES

The Ironton Mine is an abandoned limestone mine located in a predominantly industrial area at the southeast border of Ironton, Ohio (Figure 2.1-2). During its productive period (1913-1970), it was the source of crushed limestone rock that was used in the nearby cement plant facilities to make cement. During the 57-year operating history of the mine, approximately 122,000,000 cubic feet of material were excavated.

Since the earliest operation of the Ironton Mine, the operation was completely underground. Room-and-pillar excavation techniques were used. In the early phases of mine operations, the room height and width was typically 20 feet. At a later stage in mine development, the room size was expanded to a height and width of 40 feet.

Surface mine facilities consist of large concrete structures that were used during the operational period of the mine. The two shafts for the mine are located in the southern portion of the site and are approximately 350 feet apart (Figure 2.2-1). Shaft No. 1 is at an elevation of 635 feet MSL; shaft No. 2 is located at an elevation of 580 feet MSL. Both shafts descend into the mine to a floor elevation of 74 feet above MSL (Figure 2.2-2). Normal pool elevation of the Ohio River at Ironton is 515 feet above MSL.

2.2.1 Aboveground Facilities

The total surface area of the property encompasses about 397 acres. Surface facilities at the Ironton Mine site include a mine warehouse, office buildings, a machine shop, and maintenance facilities, in addition to closed structures situated over shafts 1 and 2 for security and safety purposes (Figure 2.1-3). At the present time, the buildings are being demolished by Alpha-Portland.

Vehicle access to the property is by Adams Lane, a paved county road passing under State Highway 52 at the southwestern edge of the property and traversing east along the southern portion adjacent to the abandoned Alpha-Portland Cement Company facilities (Figure 2.1-3). A railroad spur line of the Norfolk and Western Railroad services both the abandoned mine and the cement plant. Several sidings, used during operation of the cement plant, are still in place.

The domestic water supply for both the mine and the cement plant was provided by a Rainey collector well situated immediately north of the plant access road bridge over Corn Creek. During operation, this collector well system provided the human consumption requirements in addition to an ancillary washing and cleaning supply required periodically on the site. Electrical power was supplied to the mine and cement plant by overhead high voltage lines, which were used to power the various compressors and handling equipment during the operational phase. During active mine operations, the existing line was a primary voltage, 4160-volt, 3-phase, 4-wire, 60-cycle, 100-ampere service system.

Surface water runoff near the mine site is generally not polluted; two catchment ponds located on the site supplied water for the mine and cement plant facility (Figure 2.1-2). During operation of the mine, mine seepage water was disposed of directly into Ice Creek. Effluent quantities were typically minor, consisting largely of drilling water. Ice Creek is apparently polluted as a result of indiscriminate, untreated public dumping in the vicinity of the cement plant.

The volume of solid waste generated at the facility during operation was not large. Current demolition of buildings and structures on the site also generates only relatively small volumes of waste in the form of rubble, concrete block and other structural materials. Where possible, this material is being disposed of onsite or placed in trucks and transported offsite to appropriate disposal locations. Liquid wastes are not currently being generated.

2.2.2 Underground Facilities

Two vertical shafts (Figures 2.2-1 and 2.2-2) provided access to the Ironton Mine during its operation. Existing shaft No. 1 is a squared shaft 8 by 13.5 feet, extending from a surface elevation of 635 feet MSL a distance of 561 feet to the mine floor elevation of 74 feet MSL. Shaft No. 2 is also a squared shaft, 8 feet by 13 feet, extending from a surface elevation of 580 feet MSL to a distance of 506 feet to the mine floor elevation of 74 feet MSL. Both shafts are concrete-lined throughout. In addition, both shafts are situated away from the lowest floor level of the mine.

During its operation, the mine was developed at one level by the room-and-pillar method, and the underground works occupy approximately 158 acres (Figure 2.2-1). The mine room size during initial operations (one-third of the mine) was 20 feet wide and 20 feet high. The remaining two-thirds of the mine was excavated with room-and-pillar techniques to dimensions of 40 feet in width and 40 feet in height. The pillars generally are spaced on approximately 100-foot centers, and the cuts are all approximately 20 feet wide. The actual size of the pillars is quite variable but most appear to be about 60 to 70 feet square. The actual recovery ratio has not been calculated, but it is estimated to be about 40 percent. The room sizes provide for an estimated potential oil storage capacity of 21 million barrels.

The mine floor follows a bed of high quality limestone that dips upward slightly toward the north at a grade of 10^{0} or less. Base elevation of the mine floor is approximately 74 feet MSL. Some water seepage enters the mine down the main shaft (No. 2). Possible seepage from the air shaft may contribute additional water. The source of this seepage is believed to be surface runoff through sandstone layers. A cross-section of the mine is shown in Figure 2.2-2.

The removal of seepage water is a factor in considering the Ironton Mine for use as a crude oil storage facility. Primarily, inflow is from vertical shafts 1 and 2. During active mine operation, the main sump was operated approximately 9 hours a week at 150 gpm. This indicates a seepage flow of less than 15 gpm. None of the seepage is known to occur from wall or floor cracks, or springs. The southeast end of the mine is flooded, with the depth of water ranging from zero at the shafts to an estimated 15 feet in the southeast corner of the mine. Assuming an average water seepage rate of 10 gpm over the 5 years since mine closure, an estimated 40 million gallons of water will have to be pumped out and treated prior to use of the caverns as a storage facility. Treatment would require removal of ammonia and heavy metals (barium, copper and mercury) to a quality sufficient to meet state water quality standards prior to disposal in Ice Creek.

Ground water movement in the area is the result of the Sharon Conglomerate - sandstone overlying the Maxville Formation, considered to be a major aquifer over this and other portions of Ohio. Alluvial sand and gravel aquifers provide the major source of ground water in the Ironton area. As observed previously, ground water seepage occurs at the Ironton Mine in very small quantities.

In the upper part of the mined horizon, a shale layer and a dolomite limestone exist, and considerable spalling has occurred in the shale. Areas of severe spalling have been protected by gunite or cast concrete, particularly along the main haulways. The characteristics of the shale must be investigated with regard to possible slaking in oil. Extensive protective work would be necessary to ensure the structural integrity of the pillars if there is any risk of such slaking.

Above the crown of the mine the thickness of limestone that is left in place ranges from a maximum of 15 feet in the northern section of the mine to zero in the southeast section, exposing the overlying sandstone in one spot in the southeast corner of the mine. About 90 feet of limestone is left in place below the working horizon of the mine.

There are no exploratory drill holes penetrating the mine, but two gas wells which do penetrate the mine have been plugged. No information is available on the precise method of plugging, but substantial pillars were left around them, and no problems with, or evidence of, gas leakage into the mine, was ever experienced by the mining company.

No evidence of faulting was observed in the mine, and mine personnel did not recall encountering any faults during mine operation. There is some very minor jointing in the mine which is lithologically confined, penetrating only one or two beds and being truncated at bedding planes. Some bedding joints and a certain amount of contortion can be seen locally in the bedding. All joints are relatively tight.

The extraction ratio of the mine is relatively low. Almost no artificial support has been utilized in the mine except in some tunnel intersection areas where a pattern of 4-foot long rock bolts have been placed on a 5-foot by 5-foot spacing. The pillars generally are in excellent condition; spalling appears to be limited to a depth of a few inches.

2.2.3 Mine Operation

During active operation of the Ironton Mine, limestone was used only for production of cement; no aggregate or other limestone products were produced for sale at the mine. In 1956, the mine employed approximately 79 hourly employees and 3 supervisory personnel. The majority of these personnel worked in the mine. In 1963, after a modernization and mechanization program, the mine employed 32 personnel for the mine, though at one time the work force averaged 25 to 27 personnel.

Production of cement as a raw material in the construction industry is subject to fluctuation in supply and demand, so profit levels at the Ironton Mine were extremely variable. In 1958-1959, when housing was experiencing a "boom" period, the Ironton facility averaged $500,000 to $750,000 of profit per year. However, in the 1960's, with the decline in housing demand, the Ironton facility experienced a net loss rather than a profit. In fact, the lack of demand and unprofitability of operation contributed substantially to the mine's closure.

In the early phases of operation at Ironton, mules were used to haul rock on track in the mine to the hoist shaft, which would raise the rock to the surface for subsequent processing. In the period 1926-1928, a new hoist system and direct current railroad were installed in the mine. The electric train consisted of a locomotive and 30-car system. Each car would be carried up the hoist on a skip and offloaded, then returned to the floor of the mine for subsequent loading. In 1963, the mine was upgraded, and the rail system removed and replaced by 20-ton capacity diesel trucks used to haul the stone to the skip platform, from which the stone was transported to the surface for use in the cement plant. Upon reaching the surface, the limestone was deposited in a crushing machine, involving trammel mills. From that point, the crushed material was transported to the rotary kiln for roasting transformation to cement.

In the 1960's, limestone was extracted from the Ironton Mine at the rate of 1500 tons per day. The mine was operated for a 5-day period, which was adequate to supply the cement plant for a 7-day continuous 24-hour operation period. Actual operation of the Ironton Mine involved a yearly period of 320 days or 45.7 weeks. During the remainder of the year the plant was shut down for major equipment maintenance and cleanup.

Currently, the mine is abandoned, shafts are sealed for security and safety, and the concrete plant is in a stage of dismantlement. Salvage operations have been undertaken, although many of the structures on the site have not been removed or dismantled.

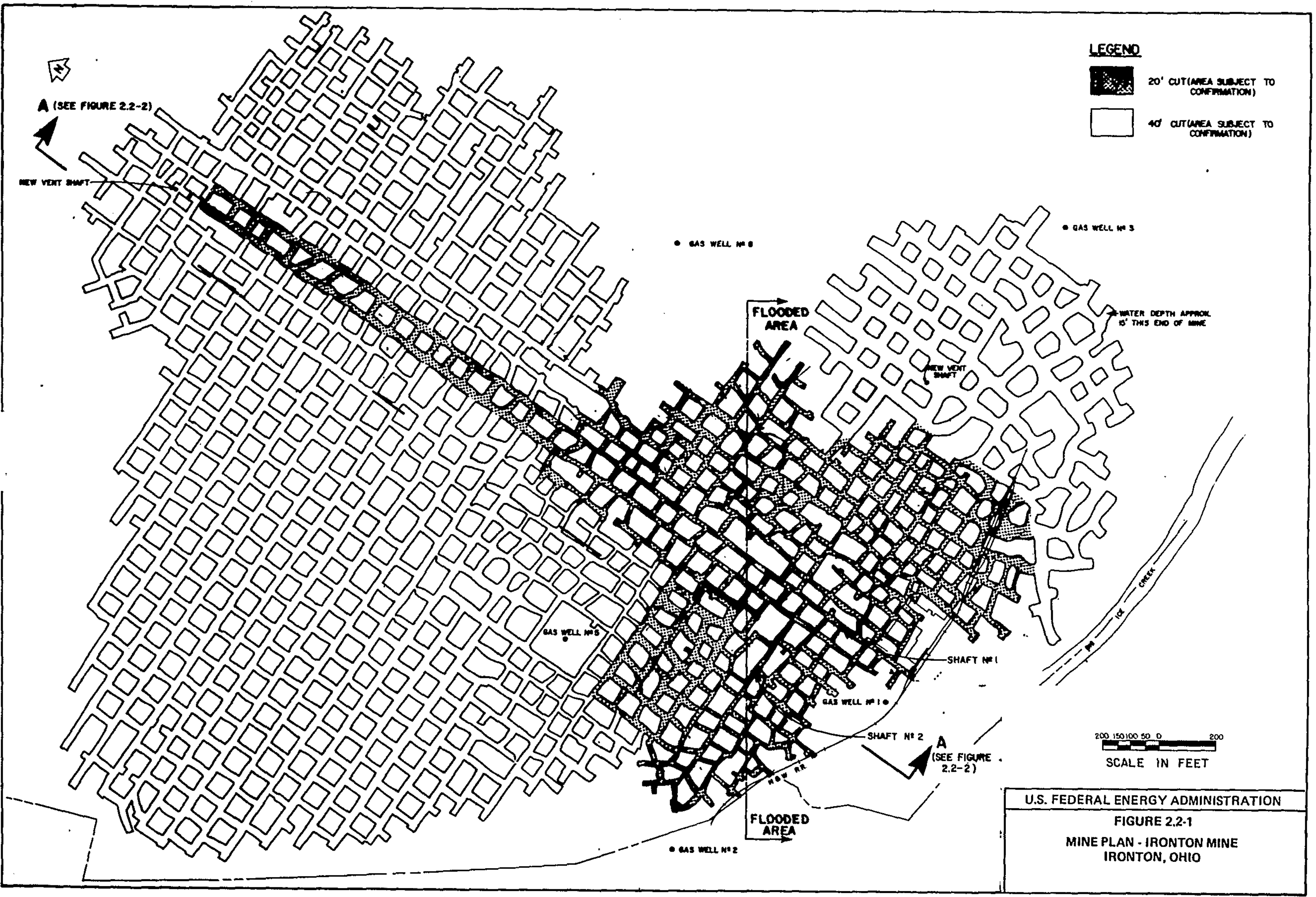

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FIGURE 2.2-1

MINE PLAN - IRONTON MINE
IRONTON, OHIO

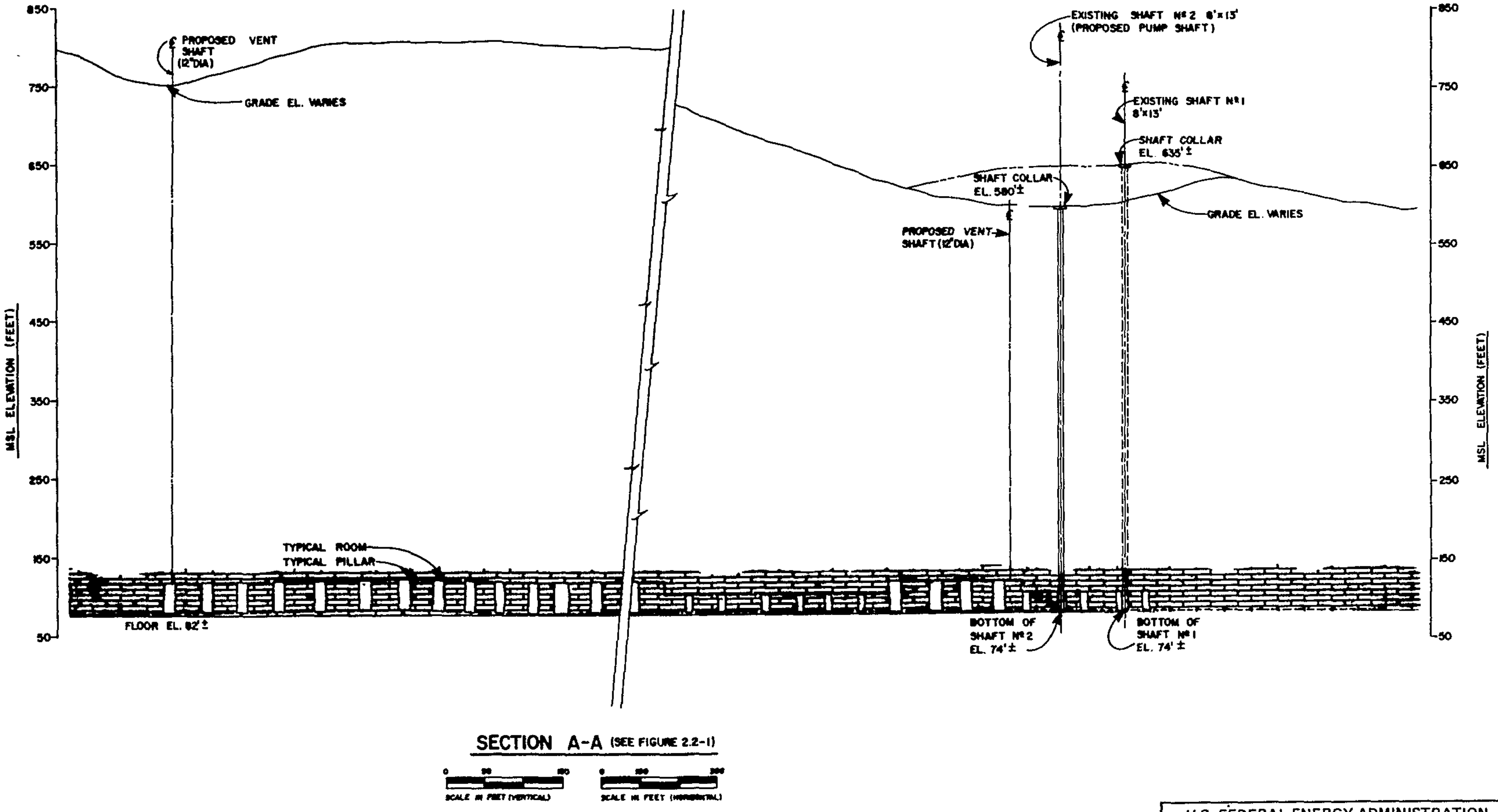

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FIGURE 2.2-2
IRONTON MINE PROFILE

2.3 MINE CONVERSION

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

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

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

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

There is extensive practical experience in underground oil product, crude oil, and liquefied petroleum gas (LPG) storage in both 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 related to underground storage is provided in Section 2.4.

Conversion of the abandoned Ironton Mine for crude oil storage will involve: the removal of the existing shaft equipment including hoists, skips, and ancillary materials; the sinking of two new 12-inch vent shafts, installation of oil pumps and casings; and construction of the necessary oil distribution facilities. The schedule of construction activities is given on Figure 2.3-1; required manpower is shown in Table 2.3-1.

2.3.1 Underground Conversion

2.3.1.1 Pump System

Ironton Mine has two existing rectangular shafts that were used for both ventilation and transport of personnel and limestone (Figure 2.2-2). Both shafts are situated near the low area of the mine, intersecting the mine floor at an elevation of 74 feet MSL. As a result, no extensive drainage network would be required to recover stored oil. Shaft No. 2 was selected to accommodate the pumping equipment because of its shorter shaft length and relative lack of debris and structures at the surface. During construction, shaft No. 1 would be left open for emergency access and ventilation; after completion of the underground work, it would be sealed by double concrete bulkheads, one near the ground surface and the other a short distance above the roof of the mine. The lower bulkhead would be keyed into the limestone. The upper bulkhead seal at shaft No. 2 would be part of a foundation designed to carry the weight of the pumping equipment (Figure 2.3-2) since the existing shaft concrete lining would not carry the load. Steel support framing will be inserted in the shaft and grouting placed behind the casing area. A concrete collar and foundation would be installed to support the pumps and piping.

Two 12-inch vent holes would be drilled at the higher level rooms of the mine (north and east, Figure 2.2-1) for ventilation (and flaring) during filling. This would prevent trapped air and hydrocarbons from accumulating in the cavern during filling.

The pump shaft equipment would consist of: three 18-inch diameter oil pump casings; one 12-inch diameter casing for installing a sludge and dewatering pump; one 4-inch instrument casing; and one 20-inch oil fill casing. Access into the pump shaft will be provided by a 30-inch diameter man-way with a caged ladder and an elevator for inspection of the shaft lining and pump casings (Figure 2.3-2).

Vapor pressures in the cavern are expected to be between 0.5 and 1.5 atmospheres during oil storage. In accordance with European practice, however, seals would be designed for a possible overpressure of 10 atmospheres to account for abnormal conditions. Gases would be vented and flared during filling to maintain low cavern pressures (Section 2.3.3).

2.3.1.2 Mine Caverns

The floor of the Ironton Mine slopes gradually from a low elevation of about 60 feet MSL in the southeast corner to 84 feet MSL in the north end. In order to provide drainage of oil from the entire mine, shaft No. 2 would have to be deepened and channels constructed to drain oil from the low portions to the vicinity of the pumps. As the mine floor is relatively level, grading requirements would not be significant. Some minor excavation may be necessary to insure interconnection between the areas of different room heights so that the total capacity would be available for storage. A sump would be provided below the pump shaft, and water would be placed in the sump below the elevation of the lip. Screens would be placed around the sump to prevent debris from entering and possibly clogging the pumps. Rock bolts and wire mesh would be placed on the roof and in the shaft perimeter above the sump area to contain any minor spalling. All debris that could float to the sump or restrict oil recovery would be hoisted from the mine.

2.3.2 Aboveground Conversion

Removal of the remaining abandoned structures and surface grading would be required to prepare the aboveground area on the Ironton site for oil storage. It is assumed that the current owners would complete demolition activities before site acquisition. Additional acreage would be required for the construction of a new 18-inch diameter underground pipeline (Figure 2.1-4) between the storage facility and a terminal located at the Ashland Refinery at Catlettsburg. Total land requirements have been estimated at 2 acres at the Catlettsburg Terminal/Ashland Refinery location, 2 acres for the pump station located at the mine property, and 64 acres for the pipeline right-of-way between the storage area and the terminal (assuming a 13.1-mile long corridor with a 40-foot average width). Ice Creek would provide ponding water for drilling during the vent shaft sinking operation. The 18-inch pipeline would provide flow capacity equal to the maximum expected delivery rate of oil to the Catlettsburg Terminal, thus eliminating the need for new storage tanks.

The preliminary design for all oil handling and distribution facilities is 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° API
2. Specific Gravity: 0.893 @ 60°F
3. Viscosity: 200 SSU @ 60°F, 43.33 centistokes @ 60°F
4. Sulfur Content: less than 1 percent by weight
5. Reid Vapor Pressure: 3 psi @ 60°F
6. Basic sediment and water content between 0.5 and 1 percent.

The proposed substation, powerhouse, manifolding, meter proving loop, and metering system are presented on Figures 2.3-3 through 2.3-5. Dashed lines indicate the arrangement of the system to be used for delivery to the distribution pipeline.

A common set of turbine flow meters (Figure 2.3-4) would be used to measure crude volumes pumped in and out of the cavern and 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.

Electrical power would be provided from an existing transmission line located on the property (Figure 2.3-5). Minor modifications to the existing distribution system at the mine, 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.

To meet the proposed storage fill schedule, the inlet and outlet pump system would consist of three 400-horsepower submersible cavern booster pumps, each with its own casing (Figure 2.3-4). The pump shaft location was selected to optimize efficiency and utilize the least shaft length. Minimal site preparation and grading would be needed. The booster pumps would be used to pump the crude or product from the mine cavern to the surface facility. The surface equipment necessary during operation includes one 10-horsepower electric sump pump used to dewater the mine sump, two 500-horsepower mainline pumps required during cavern filling and withdrawal operation, a metering manifold and meter prover, and a complete water treatment system to treat water pumped out of the cavern (Figure 2.3-4).

An 18-inch pipeline would be constructed and buried between the Ironton storage facility and the Catlettsburg Terminal located at the Ashland Refinery (Figure 2.1-4), a distance of about 13.1 miles. The pipeline alignment would run from Ironton to the southeast, north of the town of South Point, then west across the Ohio River, and then south and east entering the Catlettsburg Terminal from the west. The pipeline route was selected to avoid significant elevation differences or hydraulic control points between the storage facility and the terminal. Figures 2.3-6, 2.3-7, and 2.3-8 show piping, instrumentation and electrical systems required at or near the Catlettsburg Terminal. No additional storage tanks are required at Catlettsburg.

Although the pipeline route was selected to avoid populated areas, it passes through industrial, low-income residential, and forested lands. Since limestone rock is located near the surface along the pipeline route, some blasting and restoration of this land would be required.

2.3.3 Operation

Oil will be delivered to Ashland's Terminal at Catlettsburg 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 pipeline to Patoka, Illinois. From Patoka the oil would be pumped through the Ashland pipeline to Catlettsburg. The proposed route is shown on Figure 2.3-9. All facilities required to transport the oil currently exist and are in operation; thus no new construction is required.

Delivery from Ashland's Terminal at Catlettsburg 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 Catlettsburg.

The Catlettsburg Terminal and Ashland Refinery are presently serviced by the 24-inch Ashland pipeline (Figure 8.3-1). Current pipeline capacity is 152,000 BPD, although only 124,000 BPD is now processed at the refinery. Crude oil would be delivered to the Ironton Mine for storage using the 28,000 BPD excess pipeline capacity. According to the schedule in Figure 2.3-1, fill would begin in week 89. A total of 107 weeks would be required to completely fill the cavern (greater fill rates are possible and are considered in Section 8.0).

Oil would be withdrawn to the refinery at Catlettsburg at a rate of 140,000 BPD to meet the intended 150-day withdrawal schedule.

A modern supervisory control system has been designed for unattended operation and will allow the dispatcher to observe the status of operations at the pump station and terminal, and to shut down the flow in the system if any potentially dangerous deviation in normal operating conditions occurs. One function of the 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. Since oil would be retained in the pipeline during standby storage, the supervisory control system would monitor pipeline conditions continuously during the project's lifetime.

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 utilizing the supervisory control system or by activating 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 5 times during its lifetime to meet national emergency conditions. Oil stored at Ironton is considered to have unlimited shelf 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 to be familiar enough with overall operations to act in a supervisory capacity. The others can probably be drawn in part from the refinery work force or the Catlettsburg Terminal and might be used during cavern filling as well.

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

Pollution generated at the storage facility would be minor and local. Approximately 42 pounds per day of hydrocarbons are estimated to leak from piping during this period (see Appendix C). A temporary flare system would be required during fill periods for combustion of hydrocarbon and hydrogen sulfide vapors vented from the cavern. Flaring is a safety precaution to reduce concentrations of combustible gases and SO_2 in the mine vicinity. Venting would also prevent excessive buildup of vapor pressure within the cavern. After the cavern is filled, the vent system would be sealed and the flare system removed. During standby storage, no escape route would exist for the vapors; vapor pressures within the cavern would not exceed 1.5 atmospheres.

Several types of liquid wastes would be generated at the site. Only during fill and withdrawal would significant numbers of workers be present; sanitary sewage would be disposed of in a septic tank system. Minimal ground water seepage occurs in the existing mine. Quantities expected to be pumped out during operation of the oil storage project are not expected to exceed 10 gpm. The water can be pumped to the surface and treated at the pump station water treatment facility. The treatment system is designed to limit concentrations of oil and grease, ammonia, BOD, barium, copper, and mercury in the mine water effluent stream to levels which comply with Ohio water quality standards. Treatment methods are expected to include a conventional API separator for oil-water mixtures, a stream stripper for soluble ammonia, an activated sludge digestor for BOD, and appropriate precipitation agents for heavy metals (Figure 2.3-4). Additional treatment may be required, depending on the quality of water found in the mine. In addition to the low flow rate treatment system to be used during facility operation, a high-volume, temporary system would be required to treat the water presently in the mine prior to filling the caverns with oil (see Section 4.2.2).

Oil spillage is a potentially significant 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 the Catlettsburg Terminal.

Water supply for domestic purposes would be taken from the existing collector well system. Water for shaft sinking would be drawn from ponds on the site (Figure 2.1-2). Less than 35 gpm would be required during construction, and negligible amounts during facility operation.

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 Ironton. 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 insurance against the catastrophic 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 2.3-2. 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 $217,700 per year for static storage, plus an additional $1,547,600 per month for filling, and $3,711,100 per month for withdrawal. These costs do not include transport of oil by tanker to St. James Terminal or by pipeline to Catlettsburg.

TABLE 2.3-1 Estimate of employment and earnings--mine conversion, Ironton site

Average No. Workers Per Week			Average Wage for 55-Week Period (Cincinnati Pay Scales)	Total Earnings
Specialists	(25%)	16	$28,000	$ 448,000
Skilled	(35%)	23	23,000	529,000
Nonskilled	(40%)	26	19,000	494,000
Total		65		$1,471,000

NOTE: Due to the size and economic diversity of the Huntington/Ashland SMSA, it has been assumed that all jobs will be filled by workers within commuting distance of the project.

TABLE 2.3-2 Cost summary for Ironton Mine project

Construction costs[a]

Mine conversion	1,090,000	($0.05/bbl)
Oil handling and distribution facilities	6,980,000	($0.33/bbl)
TOTAL CONSTRUCTION COSTS	8,070,000	($0.38/bbl)

Operation and Maintenance costs[b]

	Monthly during[c]:	
Annual Storage	Filling (24.7 months)	Withdrawal (5 months)
$217,700 ($0.01/bbl)	$6600	$15,100
	($163,000 per fill or $0.008/bbl)	($75,500 or $0.004/bbl)

---

a - Excludes acquisition and abandonment of mine site and purchase of oil.

b - Static storage costs include $96,000 in storage facility ad valorem taxes applicable if the facility is privately owned and operated.

c - Transportation costs do not include tanker transfer or transport costs or costs of distribution by pipeline to the Catlettsburg Terminal.

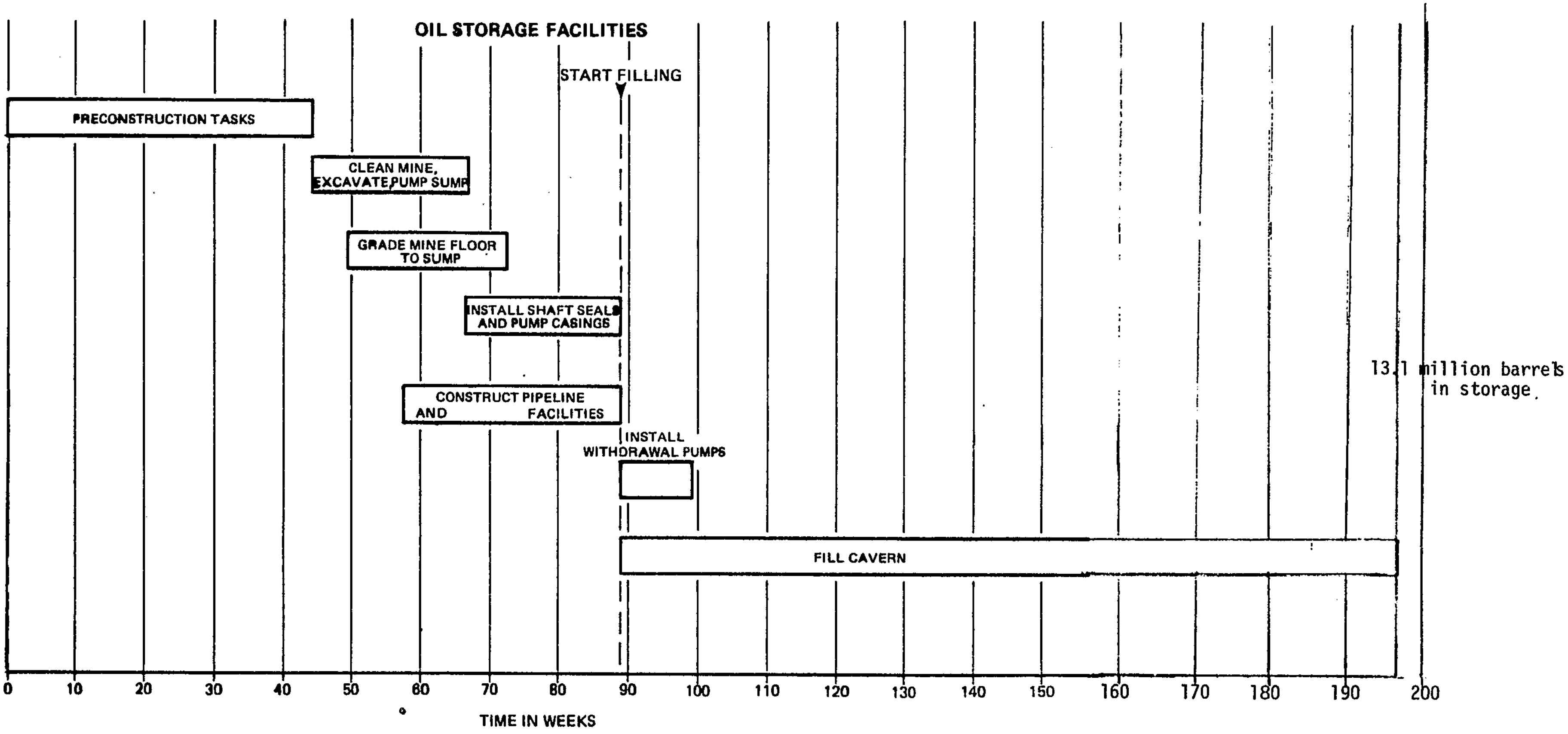
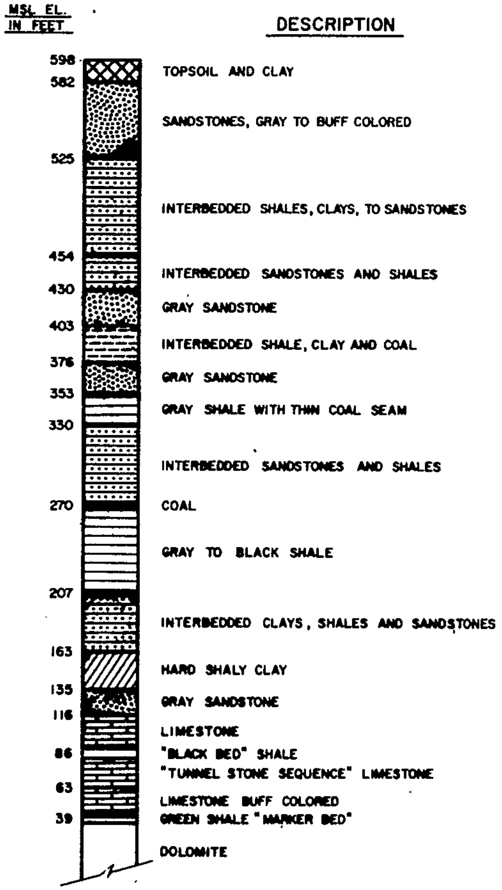
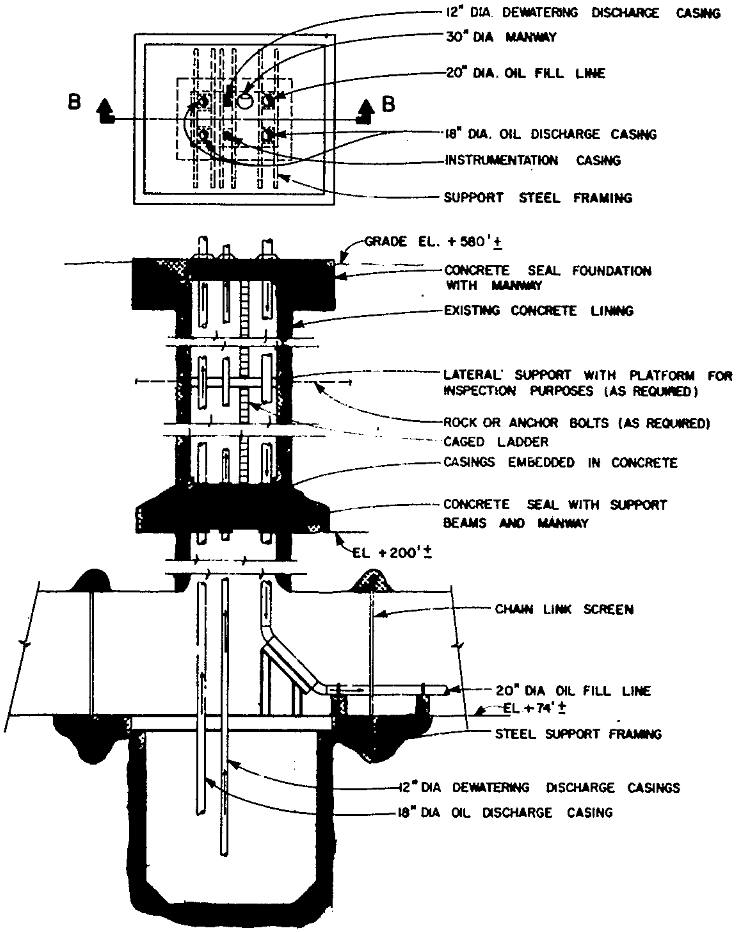


FIGURE 2.3-1 Construction schedule for oil storage project development, Ironton Mine site



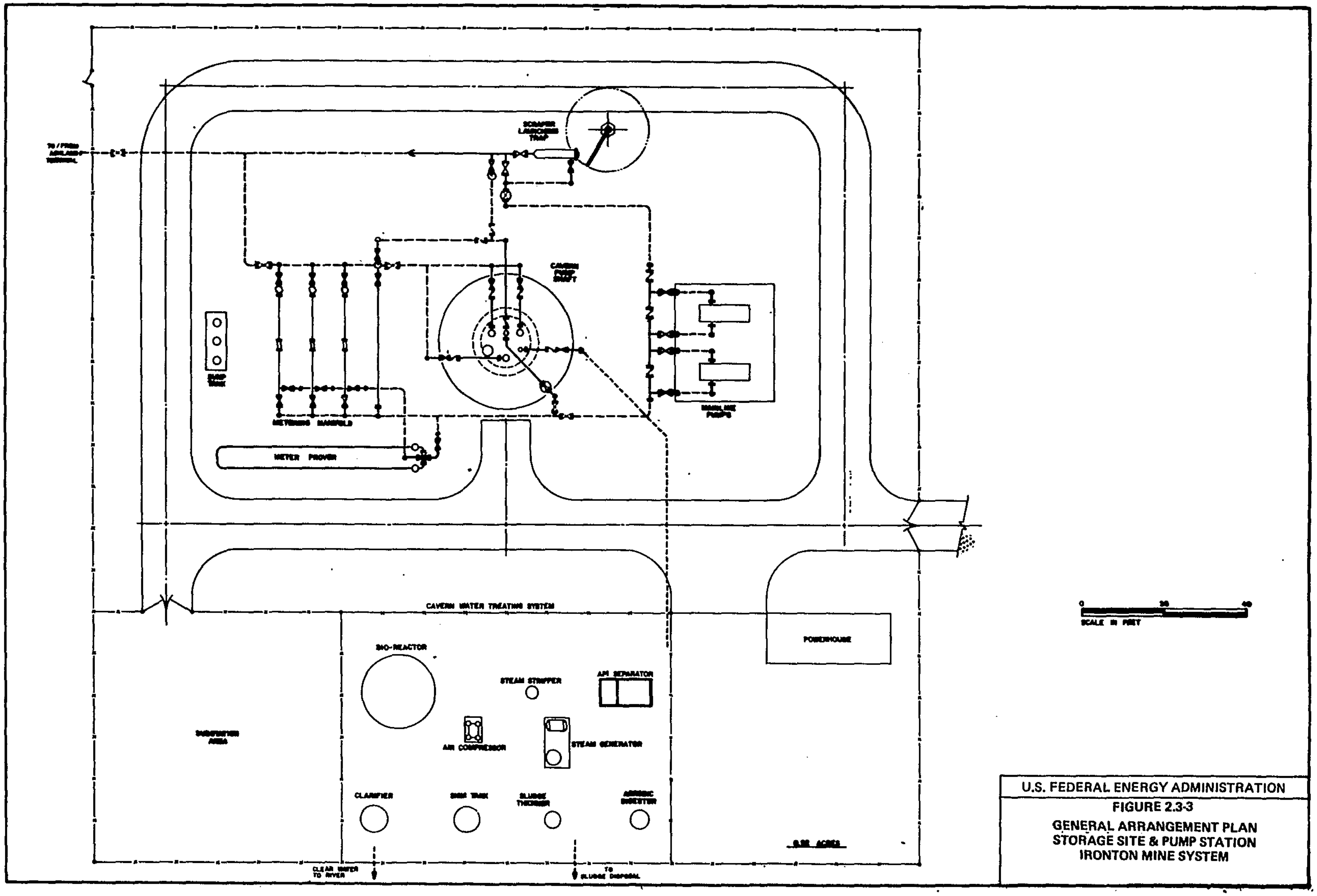
GENERALIZED GEOLOGIC PROFILE



SECTION B-B
PUMP SHAFT DETAILS

U.S. FEDERAL ENERGY ADMINISTRATION

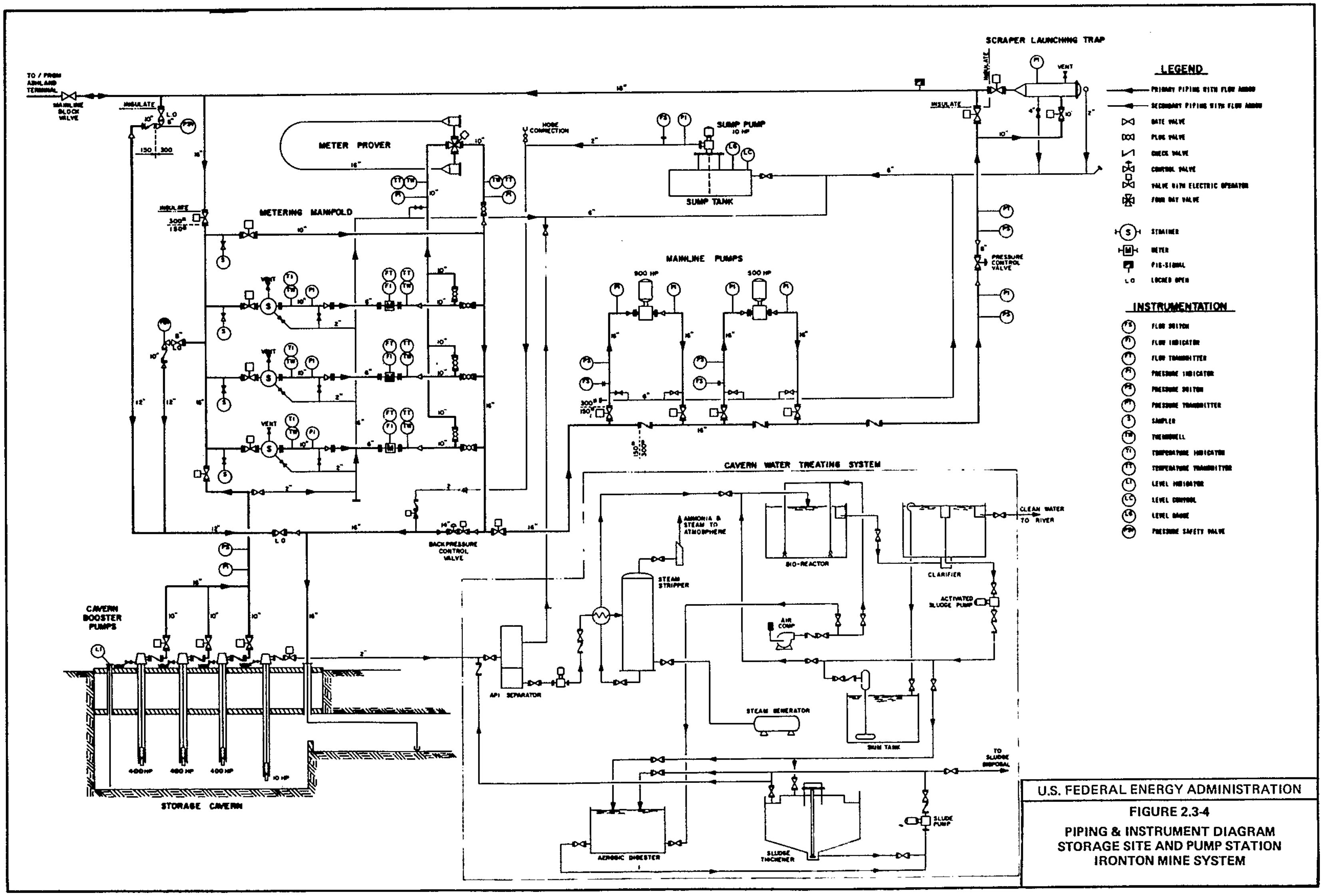
FIGURE 2.3-2
IRONTON MINE
SECTIONS AND DETAILS



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-3

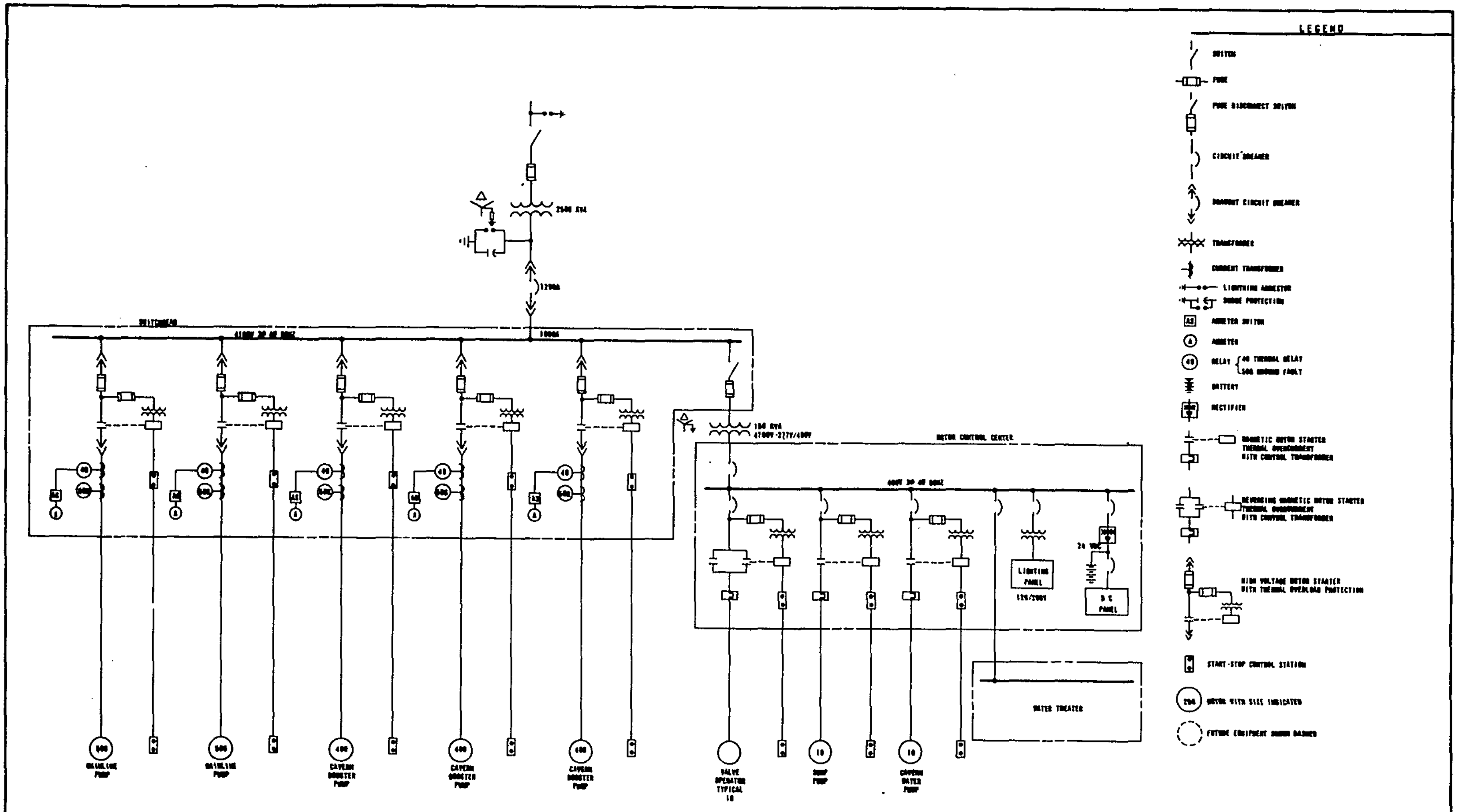
GENERAL ARRANGEMENT PLAN
STORAGE SITE & PUMP STATION
IRONTON MINE SYSTEM



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-4

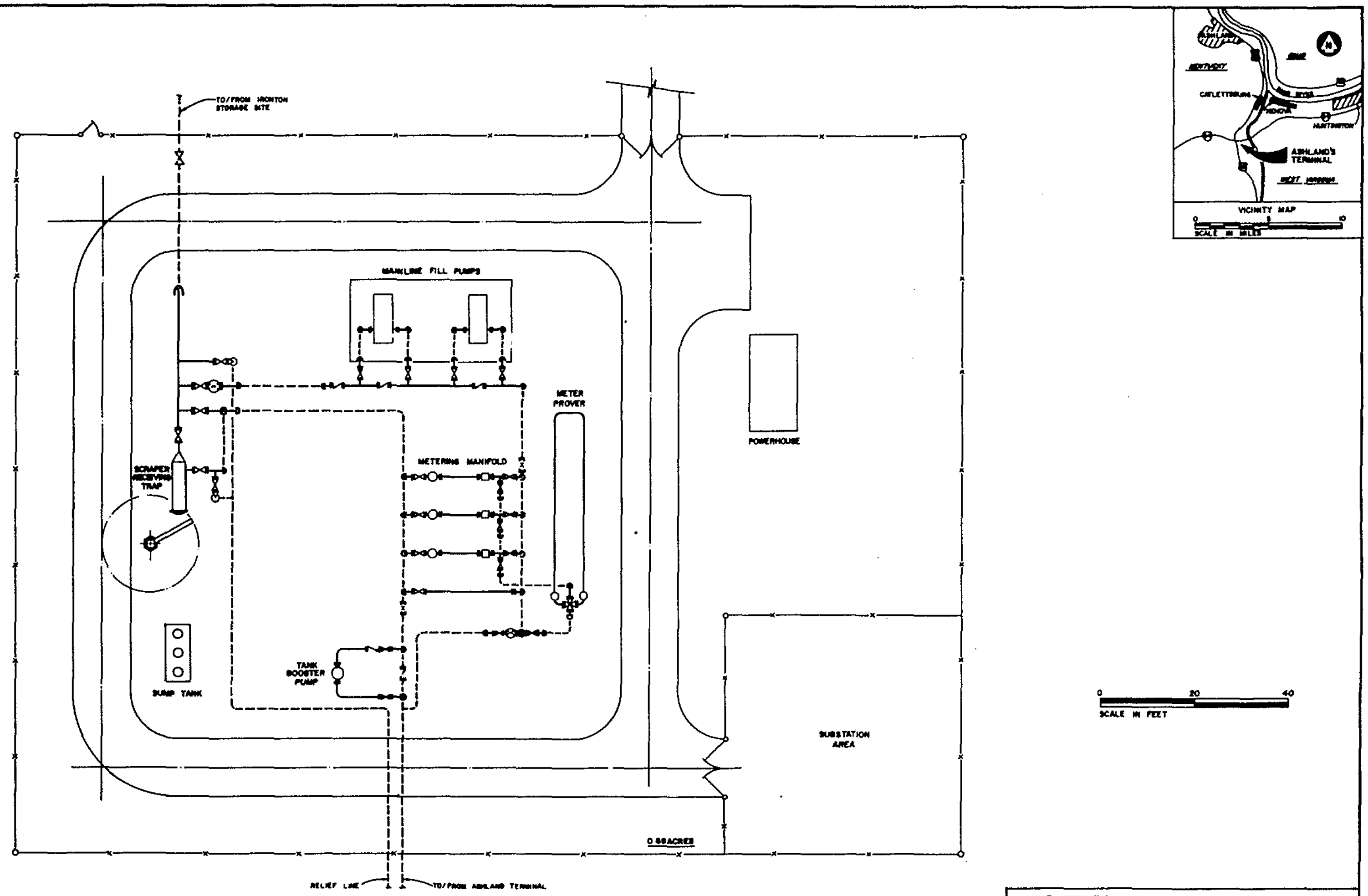
PIPING & INSTRUMENT DIAGRAM
STORAGE SITE AND PUMP STATION
IRONTON MINE SYSTEM



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-5

ELECTRICAL ONE-LINE DIAGRAM
STORAGE SITE & PUMP STATION
IRONTON MINE SYSTEM



U.S. FEDERAL ENERGY ADMINISTRATION

FIGURE 2.3-6

GENERAL ARRANGEMENT PLAN
CATLETTSBURG TERMINAL
IRONTON MINE SYSTEM

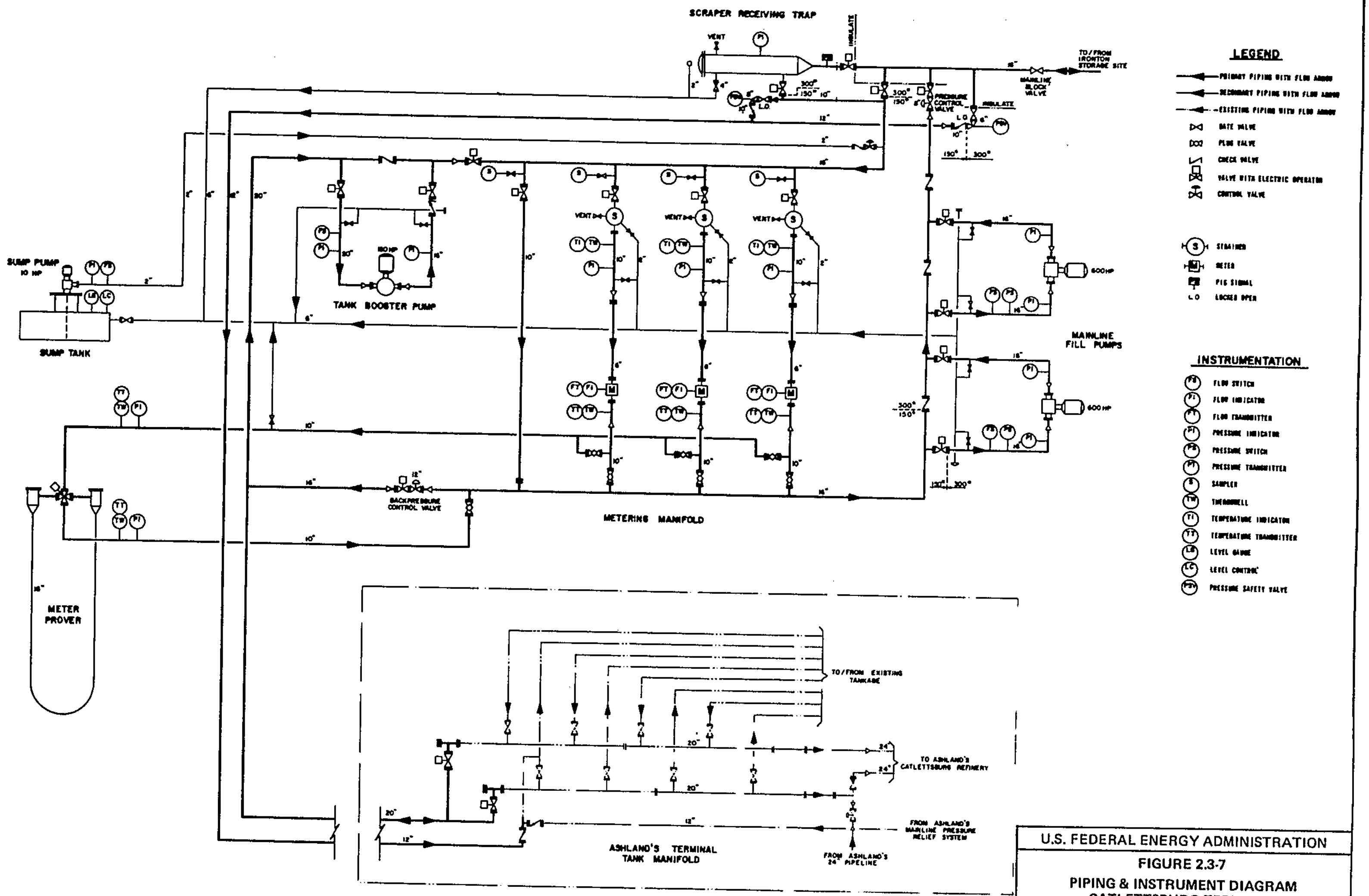


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FIGURE 2.3-7
PIPING & INSTRUMENT DIAGRAM
CATLETTSBURG TERMINAL
IRONTON MINE SYSTEM

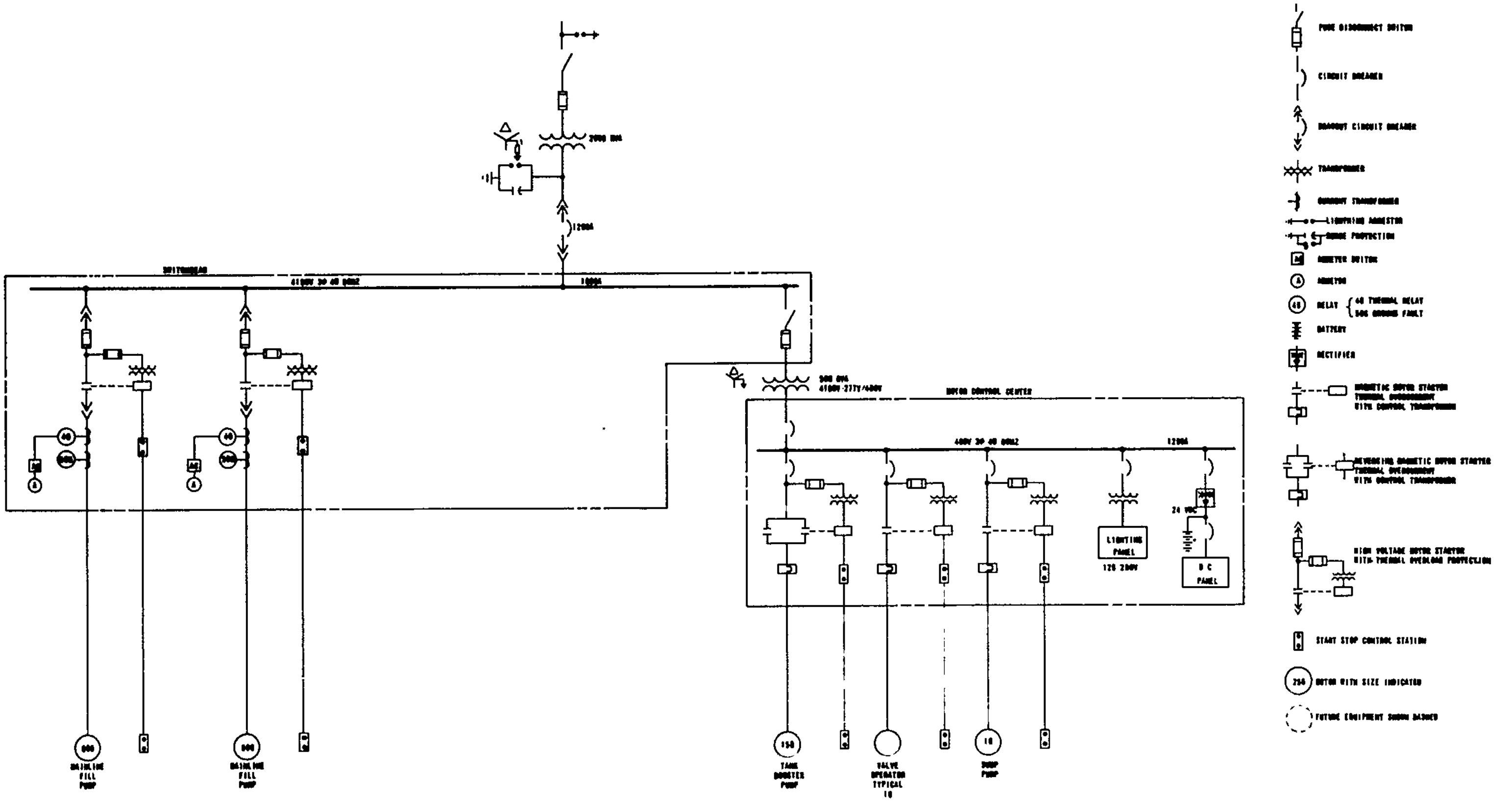

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FIGURE 2.3-8

ELECTICAL ONE-LINE DIAGRAM
CATLETTSBURG TERMINAL
IRONTON MINE SYSTEM

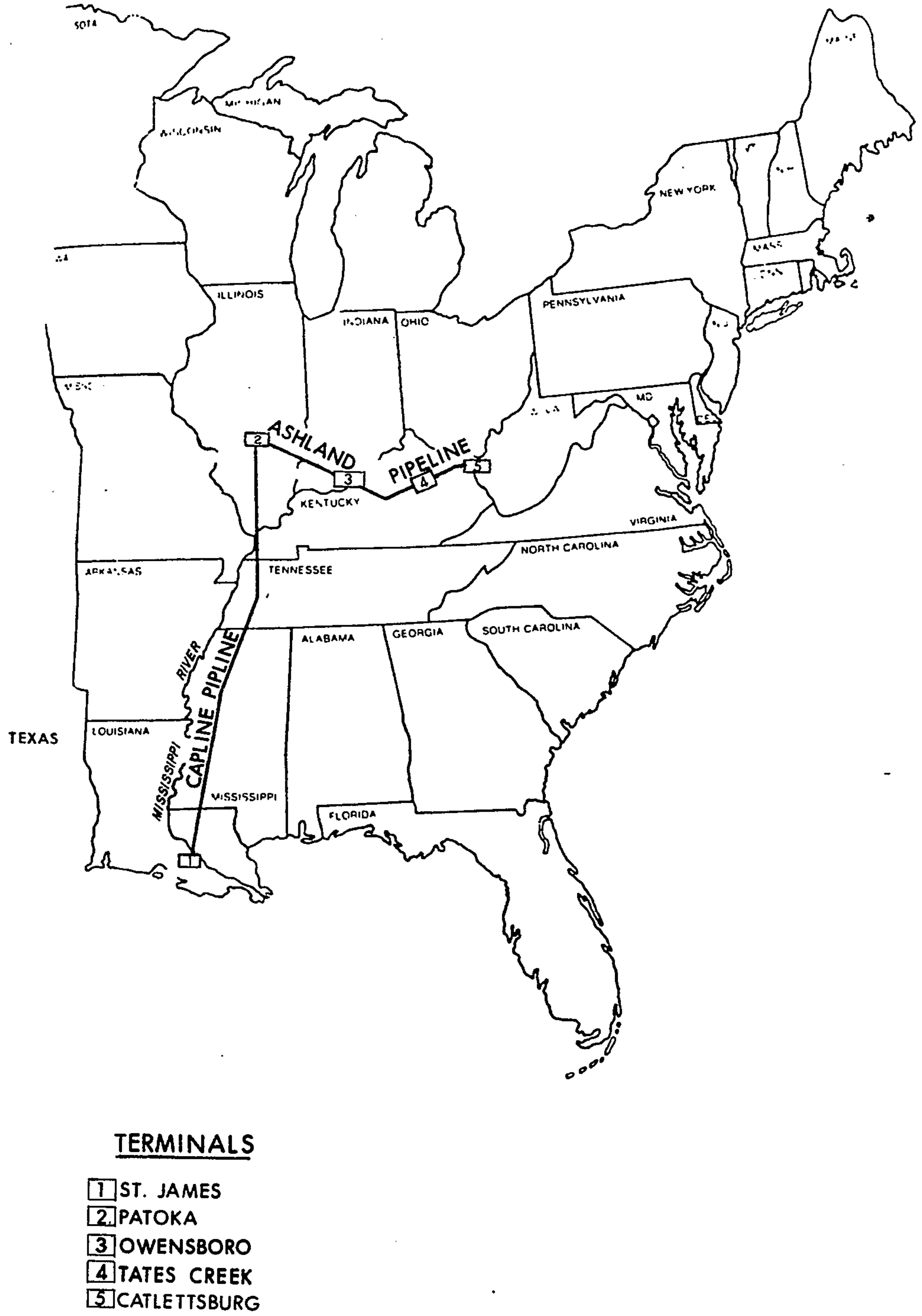

Figure 2.3-9 Marine and pipeline transportation routes to be used for delivery of crude oil to Catlettsburg

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SECTION 3.0

DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1 INTRODUCTION AND SUMMARY

The Ironton Mine is one of the proposed potential crude oil storage facilities suitable for the National Strategic Petroleum Reserve Program. This section summarizes the existing physical, biological, and socioeconomic environment at and around the mine site, proposed pipeline route, and connecting terminal. Detailed site information for Ironton Mine, Ashland's terminal at Catlettsburg 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 Catlettsburg are provided in Section 3.10.

3.1.1 Existing Site Environment

The Ironton Mine is located within the Unglaciated Plateau of Ohio and Kentucky. The 397-acre site lies outside the city limits of Ironton, in Lawrence County (Figure 2.1-2). Before shutdown in 1970, the mine was worked underground for limestone which was used to make cement in the Alpha-Portland Cement plant on the site. This operation employed a single shift of approximately 25 men. Alpha-Portland Cement Company still has mineral and surface rights to the 397 acres. General land use in the area within 5 miles of the site varies from residential-urban to agricultural and heavy mixed industrial.

Topographically, the Ironton site consists of a highly dissected upland area, possessing moderate to severe slopes which lead to lowland areas. The lowland areas consist principally of flat to gradually rolling floodplain or terrace areas which have formed along the Ohio River and its tributaries. Geologically, the site is situated in an area which has been influenced by the large regional structures of southeastern Ohio, western West Virginia and northeastern Kentucky. At the mine itself, limestone from the upper portion of the Maxville Group was extracted and processed to make cement. Hydrologically, the site is located within the Ohio River Basin. Including the Ohio River, there are 9 watersheds through which the proposed project will pass. Water quality in the area has been affected for many years by industrial and mining pollution.

The climate in the area is classified as temperate, with continental warm, humid summers and cool winters. The area has long growing seasons and abundant rainfall. Air quality is generally fair to poor because of the presence of large concentrations of heavy industry. In addition, short-term local air quality problems occur as a result of hydrocarbon emissions from automobile and other vehicular traffic.

The unglaciated plateau of Ohio and Kentucky supports abundant and varied wildlife which, in turn, supports a great deal of sport hunting and fishing activities. Commercial fishing in the area is very limited. Small mammals (such as opossum, rabbits, squirrels and racoons), rodents (such as moles, rats and mice), and many species of birds are likely to be found on the mine property. There is only marginally useful habitat at the mine site for waterbirds, herons or shorebirds.

Lawrence County has an area of about 455.5 square miles (291,500 acres). Forestry has been an important economic activity in the county since early settlement of the region; agriculture and livestock have developed since the early 1900's. The predominant portion of the farmland in the county is cropland. Of the 397 acres on the Ironton site, 37 percent is actual mining property, 28 percent is upland hardwoods, and 35 percent is mixed mesophytic hardwood slopes.

The city of Ironton serves the role of service, distribution and industrial center to the hill region. The local economy is more dependent on chemical production, coking, metallurgy, refining, and other heavy industries than on mining activities. The fastest growing sectors of the local economy are finance, insurance, and real estate. The agricultural sector of the economy has remained fairly static during the past decade.

3.1.2 Future Conditions in the Area Without the Proposed Action

Only a small fraction of Lawrence County was urbanized in 1972 due to its rugged topography. (The population was 56,868 in 1970.) The Lawrence County area is expected to continue moderate development during the next 10 to 20 years. The fastest growing nonagricultural areas are expected to be services, manufacturing (steel, chemical and glass), government and wholesale and retail trade. Industrialization has already brought air pollution problems to the region and the area is faced with additional challenges concerning soil erosion, water supply, and water pollution.

No significant changes from current conditions are expected at the mine site in the foreseeable future. If the SPR program is not implemented there, the site will probably remain abandoned. Since the mine property is under private ownership, sections of it could be sold or developed, as the owner wishes.

Future conditions in the local area without the project are also projected to remain little changed from present conditions, with the possible exception of limited industrial or residential development. Air and water quality, noise levels, land quality, and the character of nearby residential communities are expected to undergo little change in the near future.

3.1.3 Organization of the Section

The following sections present the existing environment in the region around and at the Ironton Mine site in more detail. The sections have been developed to include the various physical, chemical, biological, and socioeconomic factors important to the development of Ironton as a Strategic Petroleum Reserve site.

3.2 GEOLOGY

The Alpha-Portland Cement Limestone Mine, located in Ironton (Lawrence County) Ohio, lies on the eastern edge of the Interior Lowlands or outer part of the Central Stable Region. The Interior Lowlands are underlain by Precambrian rocks covered by relatively thick, flat-lying to gently-dipping Paleozoic and younger sediments. The region is largely plains country, standing only a few hundred feet above sea level and widely covered by drift and morainal deposits.

3.2.1 Physiography and Topography

Ohio may be divided into several physiographic provinces, the characteristics of which depend on varying geologic conditions. Ironton lies in an unglaciated portion of the Appalachian Plateaus Province, a part of the larger Appalachian Highlands Physiographic Division (Figure 3.2-1).

The area surrounding the Alpha-Portland Cement site is underlain by sedimentary rock formations that are repetitious sequences of coal, shale, limestone, and sandstone. Generally, the topography constitutes a maturely dissected upland with moderate to severe slopes. Major and minor tributary streams are dendritic in nature and all flow toward the Ohio River. The region around Lawrence County may be divided into four distinct geomorphic units: lowlands, dissected terraces, low hills, and high hills. The mine site lies within two of these landforms: the lowlands, or flood plains of the Ohio River; and the low hills to the north and east of the river, an upland in which streams have cut deep valleys in the shale and sandstone bedrock.

The lowlands are a major flat- to gently-rolling flood plain or alluvial terrace formed along the Ohio River and the mouths of smaller tributary streams to the north. Ironton is located on the terrace, as are the cities of Portsmouth and Huntington. Along the Ohio River on the southern boundary of Lawrence County, the terrace is approximately 1/2 to 1-1/2 miles wide. Local relief in the lowlands area is generally less than 50 feet, with elevations ranging from river level at approximately 530 feet mean sea level (MSL) to 580 to 600 feet MSL at the base of the low hills section to the northeast. Slopes vary from 0 to 8 percent, with the majority of the lowlands having an average slope of less than 5 percent. Well-preserved remnants of the valley floor, which show a gradual descent in elevation toward the northwest, represent the present drainage system of the county and are evidence of preglacial rivers.

Bordering the lowland terrace directly to the northeast is the low hills geomorphic section, a fairly rough area of dissected hills underlain by shale and sandstone. The softer shales have been eroded somewhat faster than the more resistant sandstones to form smooth ridges. In the southern part of the county, especially along the Ohio River, the strata are mainly sandstones which form many prominant cliffs and bare knobs. Modified V-shaped valleys are typical, with some evidence of narrow alluvial terraces. Major ridges in the area trend north-south. Elevations in the low hills area are about 800 to 900 feet above sea level, whereas hills farther north, northeast, and south vary from 1000 to 1100 feet. The low hills are characterized by local relief varying from 320 to 520 feet. The slopes generally exceed 25 percent except for small, isolated valley areas and flat ridge areas of usually less than 9 percent slope, and some narrow valleys with slopes of 9 to 24 percent (U. S. Army Corps of Engineers, 1975).

Drainage from the entire region around Ironton empties into the Ohio River. Pine Creek and its many tributaries drain the western part of Lawrence County. Storm Creek drains much of the southwestern part of the county, including Elizabeth, Aid, Lawrence and Upper Township, the latter of which includes the Ironton Mine site. Ice Creek drains the south central townships, while Symmes and Indian Guyan Creeks drain the eastern part of the county (section 3.3).

To the south of Ironton in the vicinity of Ashland, Kentucky (Figure 2.1-4) is an area of dissected terraces called the Flatwoods, covering a 10-mile-wide belt of flat country along the Ohio River. The Flatwoods consists of Pleistocene deposits of clay, sand, gravel and boulders; the terraces vary in width from 1 to 2 miles. Elevations rarely exceed 800 feet above MSL, with local relief averaging about 200 feet. Slopes are quite steep and range from 25 to 35 percent.

A generalized map of the local geomorphology and physiography of the Lawrence County area is shown on Figure 3.2.2.

3.2.2 Regional Stratigraphy and Tectonic History

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

All the surface rocks in the region of southern Ohio, western West Virginia, and northeastern Kentucky are of sedimentary origin. They lie on the eastern flank of the Cincinnati Arch and are dominated by this structure. Stratigraphically, they range from the Middle Ordovician age along the crest of the arch (axis trending from Cincinnati to Lexington) in the west to succeedingly younger Paleozoic formations in the east, reaching the axis of the Pittsburgh-Huntington syncline along the Permian boundary (Figure 3.2-3).

Within Ohio, the strata roughly follow a north-south lineation of parallel outcrop bands and become progressively younger from west to east. The generalized geologic column is shown on Figure 3.2-4. Along the Ohio River, owing to a regional eastward dip of about 35 feet per mile, Ordovician and Silurian limestones and shales crop out only in Adams County. Devonian, Columbus and Olentangy shales occur along the Adams-Scioto County line. Scioto County is comprised of both Mississippian Waverly and Maxville shales, sandstones and limestones. Pennsylvanian sandstones and limestones unconformably overlie the Mississippian strata in eastern Scioto, Lawrence, Gallia and Meigs Counties. Permian strata are found comprising the major portion of eastern Meigs, Washington, Monroe and Belmont Counties in southeasternmost Ohio.

The bedrock outcrop pattern continues into northeastern Kentucky, following the structural trend determined by the Cincinnati Arch with a similar west to east development of progressively younger strata. Ordovician limestone and shale outcrop along the Ohio River from the crest of the arch eastward through Mason County, bordered by a narrow bank of Silurian limestone and Devonian limestone and shale in western and northern Lewis County. Mississippian limestones and shales outcrop primarily in Lewis and parts of Greenup Counties and are unconformably overlain by Pennsylvanian shale, limestone, sandstone and coal in eastern Greenup and Boyd Counties.

Pennsylvanian strata continue into West Virginia throughout Wayne County and comprise the major portion of the bedrock in the southwestern part of that state. Permian strata (Dunkard Series sandstones, limestones and shales) are brought up on the southern terminus of the Pittsburgh-Huntington syncline and outcrop along the Ohio River bordering counties from Cabell and Mason northward.

The bedrock exposed in Lawrence County is entirely of Pennsylvanian age and ranges from near the base of the Allegheny Formation through the Conemaugh to the middle of the Monongahela Formation (Table 3.2-1 and Figure 3.2-4). The older Pennsylvanian formations (Pottsville and Allegheny) crop out in the western part of the county, while younger Conemaugh rocks are exposed in the central part and youngest Pennsylvania rocks of the Monongahela Formation occupy the eastern portion. This outcrop pattern is due to the position of Lawrence County on the eastern flank of the Cincinnati Arch. Underlying the Pennsylvanian surficial deposits is a thick sequence of middle to lower Paleozoic rocks. A Precambrian metamorphic basement complex completes the stratigraphy of the area.

Soils that overlie the bedrock in Lawrence County generally belong to the Gilpin-DeKalb Association. The topography of this association is characterized by steep slopes, more than half of which are forested in the site area. Gilpin-DeKalb soils are well-drained, unglaciated, deep and shallow upland soils. Figure 3.2-5 is a generalized soil map for the land in and around Lawrence County.

3.2.3 Geologic Structure

The most prominant geologic structural feature in the regional vicinity of the Alpha-Portland Cement Limestone Mine is the broad Cincinnati Arch, which extends northward from central Tennessee through Kentucky and into Ohio (Figure 3.2-6). It determines the pattern of bedrock outcrop throughout southern Ohio and northern Kentucky. All rock formations of central and eastern Ohio slope or dip to the east-southeast as a result of their position on the flank of the arch and, in some cases, thicken eastward with minor structures into the thick, sedimentary, Appalachian geosynclinal trough underlying the Appalachian Highlands. Reflecting the gentle trend of the arch, the rocks of southeastern Ohio show an average dip of about 30 feet per mile.

There are only two geologic structures of any size in eastern Ohio: the Cambridge Arch, and the Parkersburg-Lorain syncline. The Cambridge Arch is the northward extension of the Burning Springs anticline of West Virginia and is the most prominent structure in southeastern Ohio. This flexure can be traced from the Ohio River at Newport, Washington County, northwestward toward Cleveland. The strata on either flank of the arch have moderate dips that probably do not exceed 1°. The Cambridge Arch is evidenced on the geologic map of Ohio by the V-shaped outcrop pattern of the Pennsylvanian strata in Guernsey, Noble, and Washington Counties. The Parkersburg-Lorain syncline lies a few miles to the west and parallels the Cambridge Arch. The structure is best developed along its southernmost extremity in the vicinity of Marietta and is rather poorly defined in its northern area.

There are numerous other small structures in eastern and southeastern Ohio that are insignificant or only locally important as minor traps for the accumulation of oil and gas. However, they are of importance in delineating coal that is accessible for stripping operations and may be of importance in the proper planning of underground mines.

Continuing into West Virginia, the Pittsburgh-Huntington syncline forms a significant structure lying to the east-northeast of the mine site. Trending in a northeast-southwest direction, the syncline is located in the western portion of the Monongahela Drainage Basin. The syncline has an elongated axis approximately parallel to the trend of regional Appalachian folding to the east (Valley and Ridge Province), or about north 30° east. Bedrock strata dip gently toward the central axis of the structural basin; formations of Permian age are exposed throughout the central part. The Pittsburgh-Huntington syncline is continued into northeastern Kentucky and is known as the Eastern Kentucky geosyncline. In Johnson, Magoffin, Lawrence, Morgan, and Floyd Counties, the syncline is crossed by the Paint Creek uplift, which shows a general north-south axis.

The Lexington-Maysville Fault Zone extends from Lexington, Kentucky, in the vicinity of the Lexington River Fault, northward to Maysville, Kentucky, located approximately 100 miles to the west of the mine site.

3.2.4 Regional Seismicity

Earthquake activity in south central Ohio has historically been mild. The earliest recorded earthquake in the area occurred in 1776; the most recently recorded was in 1974. Only 7 quakes have been recorded within 100 miles of the Alpha-Portland Cement site, and only one of these exceeded Intensity VI (see Table 3.2-2, Modified Mercalli Intensity (MMI) Scale). The closest recorded earthquake to the site was in southeastern Cabell County, West Virginia, about 25 miles away. The closest significant shock occurred north of Pomeroy, Ohio, in Meigs County; its intensity was measured between VI and VII.

Since 1776, 46 earthquakes with intensities of V or greater have been recorded within approximately 200 miles of the site. These are listed in Table 3.2-3; their epicenters are plotted on Figure 3.2-7.

The major activity closest to the site occurred near New Madrid, Missouri (395 miles to the southwest), in 1811-1812, when the 3 largest earthquakes in the central and eastern United States were recorded. Reportedly, these shocks (about Intensity XI) were felt over a 2 million-square-mile area and changed the surficial topography over an area of 30,000 to 50,000 square miles. Although the shocks were recorded in the Ohio Valley, their strength in the vicinity of the Ironton Mine was interpreted as being less than Intensity V.

Another zone of relevant seismic activity is approximately 125 miles to the southeast of the site in the central Appalachians. With the exception of the 1886 Charleston, South Carolina earthquake, which showed an intensity of IX-X, this region has had only moderate and low-level earthquake activity.

The maximum intensity earthquake expected to affect the site is similar to that caused by the 1811-1812 New Madrid event; site intensity generated by such an event probably would not exceed Intensity VI. In addition, the site could have some small ground movements (Intensity III or less) from time to time in response to distant Intensity IV-VI earthquakes.

3.2.5 Mineral Resources

The mineral resources of the Ohio Valley region surrounding the mine site are of two general types: 1) mineral fuels, including coal, crude oil, and natural gas; and 2) nonmetals, including limestone, cement, common clay and shale, fire clay, sand and gravel, salt, and sandstone (Figure 3.2-8). Production of mineral fuels, particularly coal, is centered in areas generally 45 or 50 miles from the site vicinity. However, three strip mines are located in the western and southwestern parts of Lawrence County in Decatur, Elizabeth, and Perry Townships. Total 1975 production of coal from the county was 21,984 tons from one active strip mine (Wilgus seam).

The eastern half of the state of Ohio comprises the major portion of Ohio's oil and gas production. The large oil and gas fields of northwestern Ohio (Lima - Indiana Field) are, for the most part, no longer producing. Little production of oil and gas occurs within 50 miles of the Ironton Mine site, although small scattered gas pools occur in a north to south distribution throughout the central part of Lawrence County (Figure 3.2-9). In 1970 one oil well and three dry holes were completed in the county; no new producing wells were drilled in 1971.

The commercially valuable minerals produced in Lawrence County are the nonmetals, particularly limestone, refractory clay, and sand and gravel. In 1973, the county had three active limestone mines, excluding the Alpha-Portland Cement Mine. The quarried limestone is used primarily for crushed stone, riprap, concrete, road material, and the manufacture of cement. Production was from the Vanport limestone in Elizabeth and Decatur Townships and from the Brush Creek limestone in Mason Township. Additional limestone resources are available from the Upper Mississippian Maxville Formation, which has a uniform thickness in excess of 100 feet in much of Union Township, the southern half of Rome Township, and the southern edge of Windsor Township.

Clay is an important Lawrence County mineral reserve, as shown by the 6 clay mines and 2 kiln complexes in operation in 1973. The clay is used primarily as refractory clay. It is mined from the Pottsville, Kittaning, and Clarion Formations in Decatur, Elizabeth, and Washington Townships. Numerous other clay pits and additional developable deposits are located over the northern part of the county.

Several sand and gravel operations are located along the Ohio River in Perry, Fayette, Rome, and Union Townships. Production coming from the recent alluvium totalled approximately 298,000 short tons in 1973; use of the resource is primarily for fill, building, paving, and as bank run.

Another potential mineral resource of the site area is salt and its products. Although there is no record of current production of either rock salt or brines from the area surrounding the site, geologic evidence strongly indicates that most, if not all, of the area is underlain by brines containing more than 15 percent dissolved solids within 2000 feet of the surface. Both natural and artificial brines are produced from several places in close proximity to the mine site. The present natural brine industry of Ohio is limited to Gallia and Meigs Counties. At Pomeroy, Ohio (Gallia County), salt making has relied on brines from the Big Injun (upper Waverly). Products include calcium chloride, sodium chloride, and bromide.

3.2.6 Site Geology

3.2.6.1 General

The large regional structures of southeastern Ohio, western West Virginia, and northeastern Kentucky (see section 3.2.3) have exerted minor effects on the local structure and stratigraphic sequence of Lawrence County. One of the most prominent effects of the Cincinnati anticline (arch) has been to give a gentle dip to the strata of the county off the eastern flank of the arch and also to create a thickening of the beds to the east. The general attitude of the beds is that of a moderate slope amounting to 26.7 feet per mile in a direction 20° 48' south of east. Although not perceptible in a single outcrop, the dip becomes evident in tracing a bed over a considerable distance.

The presence of several low structural noses in southeastern Ohio tends to break up the continuity of the regional slope from the crest of the Cincinnati Arch to the axis of the Parkersburg-Lorain syncline, and also the slope from the eastern edge of the Cambridge Arch toward the axis of the Appalachian basin. The axes of these anticlinal noses have a general northwest-southwest trend and range in length from 2 to 20 miles. Best known in the eastern half of Ohio, they extend in a belt from western Holmes County on the north to Lawrence County on the south. They are especially numerous from southern Lawrence County to southern Hocking County and show an axial trend around 35° to 40° west of north. At depth they are of importance in localizing accumulations of oil and gas.

Local deviations from the regional dip may occur occasionally, though relatively infrequently, across the county. Dip angles of the strata may increase up to 10 or 15 degrees as a result of differential compaction of the beds during consolidation, differential sedimentation, or the original dip of the surface of deposition. This is primarily true of the Mississippian rocks, with the exception of the Maxville limestone, which are of the elastic varieties such as shale, sandstone and conglomerate.

3.2.6.2 Mine Geology

Limestone from the upper part of the Maxville Group was mined for several years at the Alpha-Portland Cement Mine in Ironton. The mine property shows numerous depositional breaks and reflects the area's proximity to the Cincinnati Arch. The most significant break in the sequence is the regional disconformity at the base of the middle member of the Jonathan Creek Formation, the Ironton Shale. Chute (1955) noted the disconformity, citing nearly 10 feet of relief on this surface at one locality in the mine. This disconformity is present throughout the mine between the Maxville and its overlying strata.

The rock overlying the Maxville Formation is the Sharon sandstone, which is the base unit of the lower Pennsylvanian age Pottsville Group. This sandstone is in direct contact with the mine roof in the southern part of the mine. At the northern end, about 15 feet of limestone has been left in the roof below the sandstone interface.

Mine overburden increases in thickness from approximately 420 feet in the south and southeastern parts of the mine to nearly 680 feet in the north-northwest portions. (This is assuming an average mined thickness of approximately 40 feet and elevations of the mine floor ranging from 74 feet MSL at the shafts to about 81 feet in the northern part of the mine and 61 feet in the southern part.)

Lithologic descriptions of the 4 stratigraphic units comprising the Maxville Group at the site are given on Figure 3.2-10. Strata of the Ste. Genevieve Formation comprise the base portion. The Ste. Genevieve is approximately 30 to 32 feet thick and is the approximate equivalent of the Loyalhanna limestone to the northeast. In gross lithology, it is a calcareous sandstone, an arenaceous calcarenite, or a pure calcarenite. It is disconformably overlain by younger Mississippian carbonates. The disconformity is immediately overlain by a coarse quartz sandstone a few inches to 1-1/2 feet thick, or more commonly by a paleosol represented by a green sandy shale up to 1/2 foot thick.

Post-Ste. Genevieve stratigraphic units identified by Uttley (1974) in the mine include the Paoli limestone, the Ironton Shale ("Pencil Cave"), and the Beaver Bend limestone. The Paoli limestone is a light olive-gray uniformly fine-grained, crystalline, high-calcium limestone. The upper part grades into a brecciated, discontinuous dolomitic limestone and coarsely crystalline dolomite unit with abundant discontinuous patches of green shale; the uppermost 1 foot is entirely green shale. It shows an approximate thickness of 24 feet in the mine proper.

Disconformably overlying the Paoli limestone is the "Ironton Shale". It is vertically divisible into 2 units of different composition: the lower unit is composed of dark green sandy shale containing residual fragments of limestone; the upper unit of a very dark gray dolomitic and calcareous shale. The thickness in the mine is approximately 5 feet but is variable, depending on the topography of the underlying erosional surface.

The Beaver Bend limestone, which is 14 to 16 feet thick, conformably overlies the "Ironton Shale" and consists of alternating thin-bedded layers of medium- to coarse-grained salmon pink limestone and fine-grained light gray dolomitic limestone. Coarse-textured zones are composed of numerous fossil fragments.

Approximately 18 feet of the Reelsville-Beech Creek limestone (upper Jonathan Creek Formation) is also present in the mine. It consists of a massively bedded cream-colored styolitic pure limestone and shows a medium-grained texture resulting from a partial recrystallization of abundant oolites and fossils (Uttley, 1974).

The mine itself follows the bedding attitude of the high calcium Maxville, which gently dips on the order of 1^{o} or less slightly upward toward the north. Shaft No. 2 (Figure 2.2-1) at the south end is a low point in the mine. There have been no faults or major structures observed in the mine, and all of the anomalies in bedding and roof thickness are attributed to variations in the depositional environments and the disconformity near the mine roof. No tectonic structures of any kind have been identified in the mine. Joint patterns are, for the most part, randomly oriented, ranging from vertical to about 75^{o} in dip and are not found to intersect more than one or two of the individual limestone beds. A major northeast-southwest trending joint, approximately 100 feet in length, appears in the mine ceiling in the vicinity of the machine shop in the north-central portion of the mine. Some slight ground water seepage (less than 1 gallon per minute) has been observed from this linear joint.

TABLE 3.2-1 Generalized section of Pennsylvanian strata outcropping in Lawrence County

		Ft.	In.
Pennsylvanian system			
Monongahela series			
Sandstone, shale, coal, clay, unclassified. Approximate thickness		260	0
Conemaugh series			
Clay, with a little nodular limestone		3	0
Shale, sandy, and thin-bedded sandstone		37	0
Sandstone, coarse-grained, <u>Connellsville</u>		30	0
Coal streak, <u>Clarksburg</u>		-	-
Shale		18	0
Sandstone, shaly to massive		20	0
Clay shale, red		20	0
Limestone, nodular, <u>Elk Lick</u> (?)		1	0
Shale, sandy		8	0
Sandstone, <u>Morgantown</u>		30	0
Shale, sandy		12	0
Clay shale, red, with nodules of limestone and hematite. Replaced by shaly sandstone in some localities		36	0
Limestone, impure, fossiliferous, <u>Portersville</u>		-	8
Coal, thin, <u>Anderson</u>		-	-
Clay shale		37	0
Limestone, not persistent, fossiliferous, <u>Cambridge</u>		2	0
Shale, carbonaceous		2	0
Coal, <u>Wilgus</u>		2	0
Clay shale		17	0
Limestone, impure, fossiliferous, cherty in some localities	<u>Brush Creek</u>	2	0
Shale		14	0
Limestone, impure, fossiliferous, frequently missing		1	6
Shale, sandy, and flaggy sandstone		23	0
Coal, thin, <u>Mason</u>		-	-
Clay, pale red		8	0
Sandstone, shaly		15	0
Coal, thin, <u>Mahoning</u>		-	-
Sandstone		24	0

TABLE 3.2-1 Continued

	Ft.	In.
Allegheny series		
Coal, locally present, Upper Freeport or No. 7	3	5
Clay	2	0
Sandstone and shale, Upper Freeport sandstone horizon	38	0
Coal, local, Lower Freeport or No. 6a	1	8
Clay	2	6
Sandstone and shale, Lower Freeport sandstone horizon	38	0
Coal, with partings, Middle Kittanning or No. 6	2	0
Clay	3	6
Sandstone and shale	25	0
Clay, very local, Oak Hill	2	0
Coal, local, "Lost Seam"	1	0
Shale	3	0
Coal, with partings, Lower Kittanning or No. 5	3	3
Clay, gray	4	0
Limestone, generally gray, fossiliferous, Vanport	6	1
Coal, with partings, Clarion or No. 4a	3	9
Clay	5	0
Sandstone, Clarion	24	0
Coal, very local, Winters	1	0
Shale and sandstone	26	0
Coal, with partings, Brookville or No. 4	3	0
Pottsville series		
Clay	4	0
Shale and sandstone	28	0
Ore, Upper Mercer	1	0
Limestone, wanting, Upper Mercer	-	-
Shale	12	0
Ore, siliceous, Sand Block	-	8
Shale and sandstone	12	8
Coal, with shale partings, Upper Mercer or No. 3a	3	1
Shale	25	0
Ore, Lower Mercer	-	5
Limestone, local, Lower Mercer	1	0
Shale and sandstone	37	6
Shale, with thin ore bands, Boggs	3	0
Shale	3	0
Coal, Lower Mercer or No. 3	1	6

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 river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.

XI. Few, if any, masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown upward into the air.

TABLE 3.2-3 Earthquakes occurring within a 200-mile radius of Alpha Portland Cement limestone mine, Ironton, Ohio

Date	North Latitude	West Longitude	Locality	Intensi
1776	---	---	Muskingum River, Ohio	--
1779	---	---	Northern Kentucky	--
1791 or 1792	---	---	Northern and Eastern Kentucky	--
Aug. 6 & 7, 1827	38.3	85.8	New Albany, Indiana	6,6
Nov. 20, 1834	---	---	Northern Kentucky	5
Nov. 28, 1844	36.0	84.0	Knoxville, Kentucky	6
Feb. 10, 1874	35.7	82.1	McDowell County, North Carolina	5
June 18, 1875	40.2	84.0	Western Ohio	7
Sept. 19, 1884	40.7	84.1	near Columbus, Ohio	4 - 6
Aug. 6, 1885	36.2	81.6	Watauga County, North Carolina	4 - 5
May 3, 1897	37.1	80.7	Pulaski, Virginia	6
May 31, 1897	37.3	80.7	Giles County, Virginia	7
October 21, 1897	37	81	Southwestern Virginia	5
Feb. 5, 1898	37	80.1	Pulaski, Virginia	6
May 17, 1901	39.3	82.5	Ohio	5
Sept. 22, 1909	38.7	86.5	Ohio Valley	5
Apr. 20, 1911	35.2	82.7	North Carolina - South Carolina	5
Mar. 28, 1913	36.2	83.7	Knoxville, Tennessee	7
Aug. 26, 1916	36	81	Western North Carolina	5
June 21, 1918	36.1	84.1	Lenoir City, Tennessee	5
July 15, 1921	36.6	82.3	Mendota, Virginia	6

TABLE 3.2-3 Continued

Date	North Latitude	West Longitude	Locality	Intensity
Dec. 25, 1924	37.3	79.9	Roanoke, Virginia	5
July 8, 1926	35.9	82.1	South Mitchell County, North Carolina	6
Nov. 5, 1926	39.1	82.1	Southeastern Ohio	6 - 7
June 10, 1927	38	79	Charlottesville, Virginia	5
Nov. 2, 1928	36	82.6	Western North Carolina	6
Sept. 30, 1930	40.3	84.3	Ohio	7
Sept. 20, 1931	40.4	84.2	Anna, Ohio	7
Mar. 2, 1937	40.4	84.2	Western Ohio	7
Mar. 8, 1937	40.4	84.2	Western Ohio	7 - 8
June 20, 1952	39.7	82.2	Southeastern Ohio	6
May 13, 1957	35.75	82	Western North Carolina	6
June 23, 1957	36.5	84.5	East central Tennessee	5
April 23, 1959	37.5	80.5	Virginia - West Virginia border	6
April 15, 1960	35.75	84	Eastern Tennessee	5
Feb. 22, 1961	41.2	83.4	Northwestern Ohio	5
Oct. 28, 1963	36.7	81.0	Galax, Virginia	5
April 7, 1967	39.6	82.5	Ohio	5
April 8, 1967	39.6	82.5	Columbus, Ohio	5
Dec. 11, 1968	38.3	85.7	Louisville, Kentucky	5
Nov. 19, 1969	37.4	81.0	Southwestern Virginia	6

TABLE 3.2-3 Continued

Date	North Latitude	West Longitude	Locality	Intensity
Sept. 9, 1970	36.1	81.4	Northwestern North Carolina	5
Oct. 9, 1971	35.8	83.4	Northwestern North Carolina	5
May 30, 1974	37.4	80.4	Southwestern Virginia	5
Oct. 20, 1974	39.1	81.6	Wood County, West Virginia	5

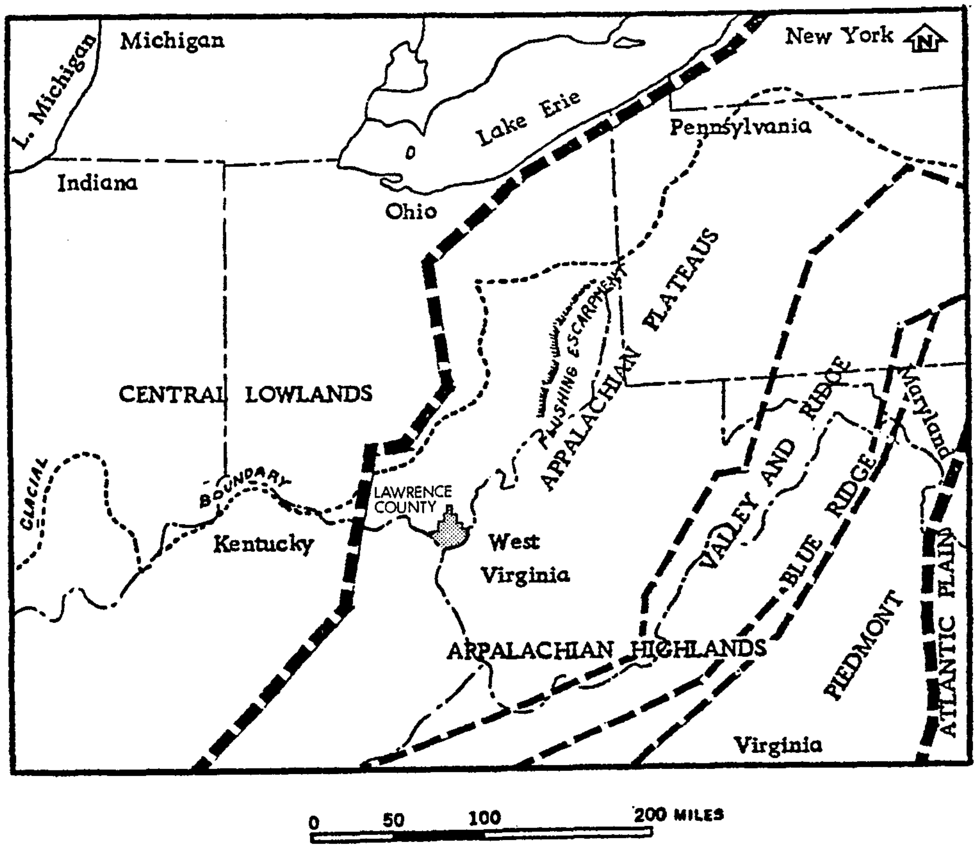


FIGURE 3.2-1 Map showing physiographic divisions of Ohio and adjacent regions

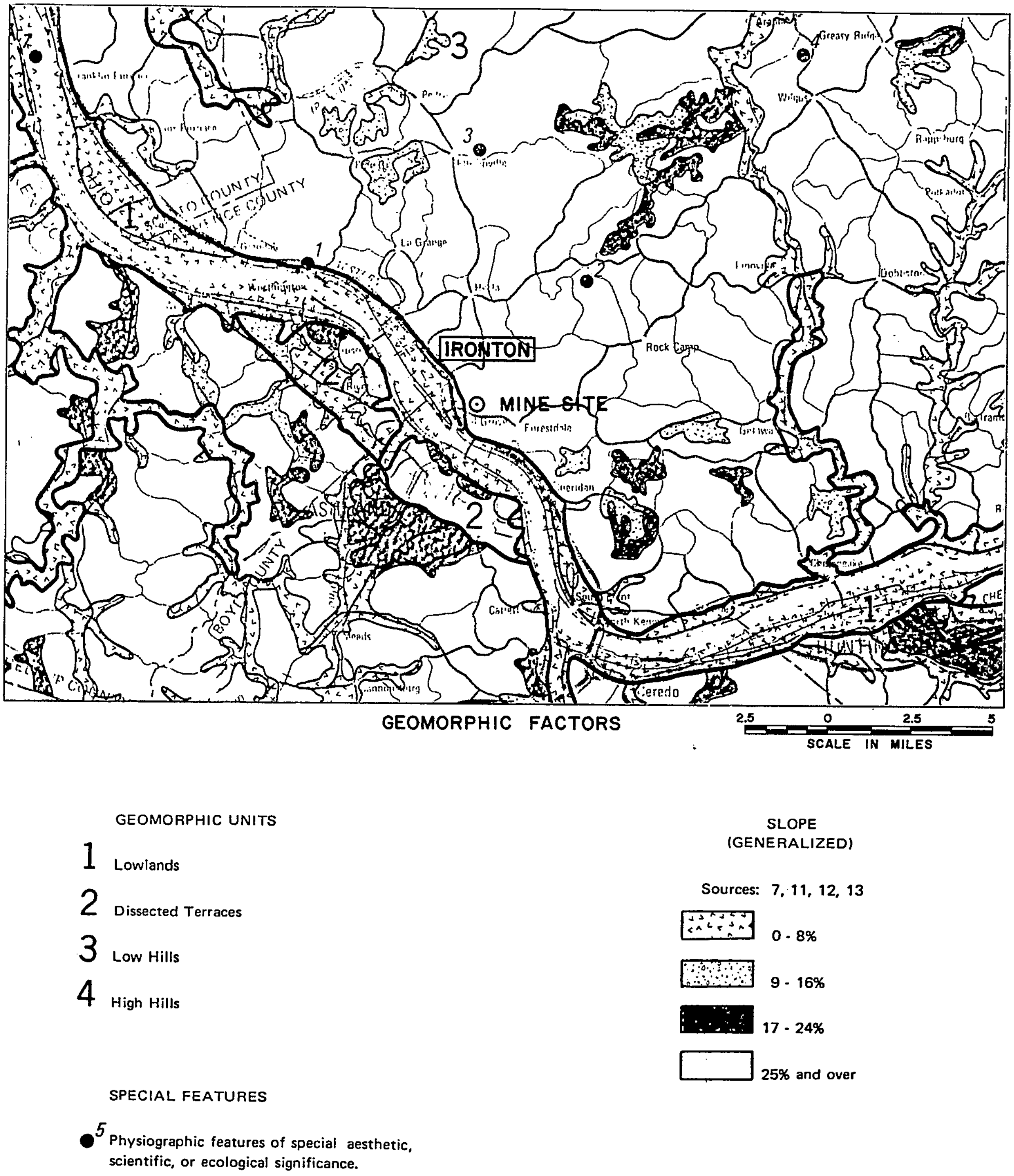


FIGURE 3.2-2 Local geomorphology and physiography of the Lawrence County area

CEN.	RECENT			Alluvium, landslide debris	
	PLEISTOCENE			Terrace deposits, till	
PALEOZOIC	PENNSYLVANIAN	U		Monongahela	130'
				Conemaugh	130-250
		M	Pottsville grp.	Breathitt	250
		L		Lee	0-130
	MISSISSIPPIAN	U		Pennington	0-36
				Newman (Maxville)	0-165
		L	Waverly grp. (Borden)	Logan	165
				Cuyahoga	250
				Sunbury	20
				Berea	35
				Bedford	85
	DEVONIAN	U		Ohio	300-600
				Olentangy	15-30
				Hillsboro	0-30
	SILURIAN	U	Bass Island grp.	Tymochtee	45
				Greenfield	0-40
		M		Peebles	50-100
				Lilley	20-35
				Bisher	23-84
				Crab Orchard (Alger)	36-160
				Dayton	2-7
		L		Brassfield	20-80
	ORDOVICIAN	U		Belfast	5-10
			Richmond	Elkhorn Whitewater Liberty Waynesville Arnheim	210
			Maysville	McMillan Fairview	200
			Covington grp.		
			Eden	Latonia (Kope)	200
		M		Cynthiana-Pt. Pleasant	

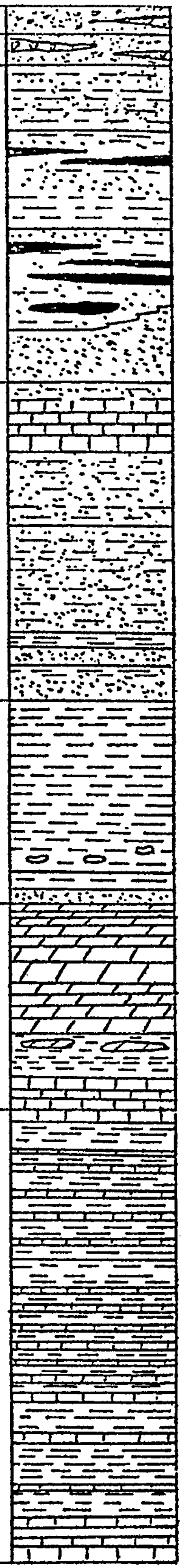
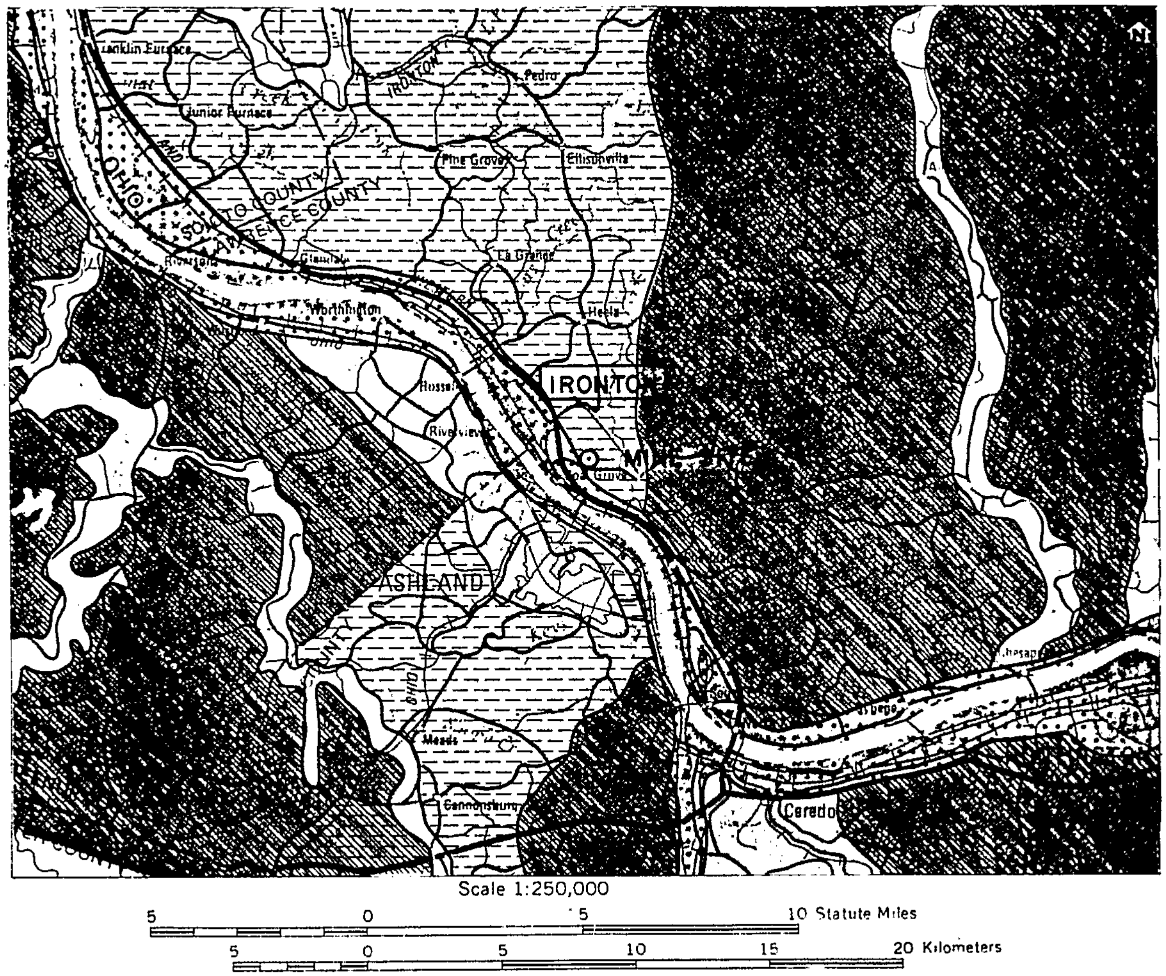


FIGURE 3.2-3 Stratigraphic units exposed in southern Ohio and northeastern Kentucky

TIME UNITS		ROCK UNITS			
SYSTEM	SERIES	GROUP	FORMATION *Units found in the subsurface only are indicated in italics*	PRINCIPAL MEMBERS OR BEDS	DRILLERS' OR INFORMAL NAMES
PERMIAN		Dunkard	Greene Fm		
			Washington Fm	Upper Marietta ss	
				Creston-Reds	
				Lower Marietta ss	
				Washington coal	No. 12 coal
				Mannington ss	
				Waynesburg ss	
PENNSYLVANIAN		Monongahela		Waynesburg coal	No. 11 coal
				Uniontown coal	No. 10 coal
				Benwood ls	
				U. Sewickley ss	Goose Run
				Meigs Creek coal	No. 9 coal
				Pittsburgh ss	
				Pittsburgh coal	No. 8 coal
		Conemaugh		Connellsville ss	Mitchell
				Morgantown ss	Wolf Creek
				Gaysport ss	Vincent
				Ames ls	
				Saltsburg ss	Peeker
				Cow Run ss	1st Cow Run
				Cambridge ls	
				Buffalo ss	Buell Run
				Brush Creek ls	
				Mahoning ss	Macksburg 300'
		Allegheny		U. Freeport coal	No. 7 coal
				U. Freeport ss	2nd Cow Run
				M. Kittanning coal	No. 6 coal
				L. Kittanning coal	No. 5 coal
				Clarion ss	Macksburg 500'
				Putnam Hill ls	
				Brookville coal	No. 4 coal
		Pottsville		Homewood ss	Macksburg 700'
				U. Mercer ss	Germantown
				L. Mercer coal	No. 3 coal
				L. Mercer ss	Schram
				Massillon ss	Salt
				Quakertown coal	No. 2 coal
				Sciotoville ss	Brill
				Sharon coal	No. 1 coal
				Sharon ss, cong	Maxton
MISSISSIPPIAN			Maxville Ls		Jingle Rock
			Logan Fm	Vinton Ss	
				Allensville Cong	Keener
				Byer Ss	
				Berne Cong	
			Cuyahoga Fm	Black Hand Ss	Big Injun
				Portsmouth Sh	Squaw
				Buena Vista Ss	Weir
				Henley Sh	Hamden
			Sunbury Sh		Coffee shale
			Berea Ss		1st Berea
			Bedford Sh	Cussewago Ss	2nd Berea

FIGURE 3.2-4 Stratigraphic position of Ironton Mine



REGIONAL SOIL MAP

MAP UNIT	SOIL ASSOCIATION
▒	TERRACES AND BOTTOMLANDS OF THE OHIO RIVER VALLEY WV: Ashton-Wheeling-Huntington Association KY: Elk-Huntington-Sciotoville OH: Wheeling-Sciotoville-Huntington
▓	RED CLAY SHALE, SILTSTONE AND SANDSTONE UPLANDS WV: Gilpin-Upshur-Vandalia Association (Cabell Co.) Gilpin-Upshur-Dekalb (Wayne Co.) KY: Vandalia-Upshur OH: Gilpin-Upshur-Dekalb
▤	GRAY CLAY SHALE, SILTSTONE AND SANDSTONE UPLANDS KY: Latham-Shelocta Association OH: Dekalb-Latham-Gilpin (Lawrence Co.) Muskingum-Berks (Scioto Co.)

FIGURE 3.2-5 Generalized soil map for the area around and including Lawrence County, Ohio

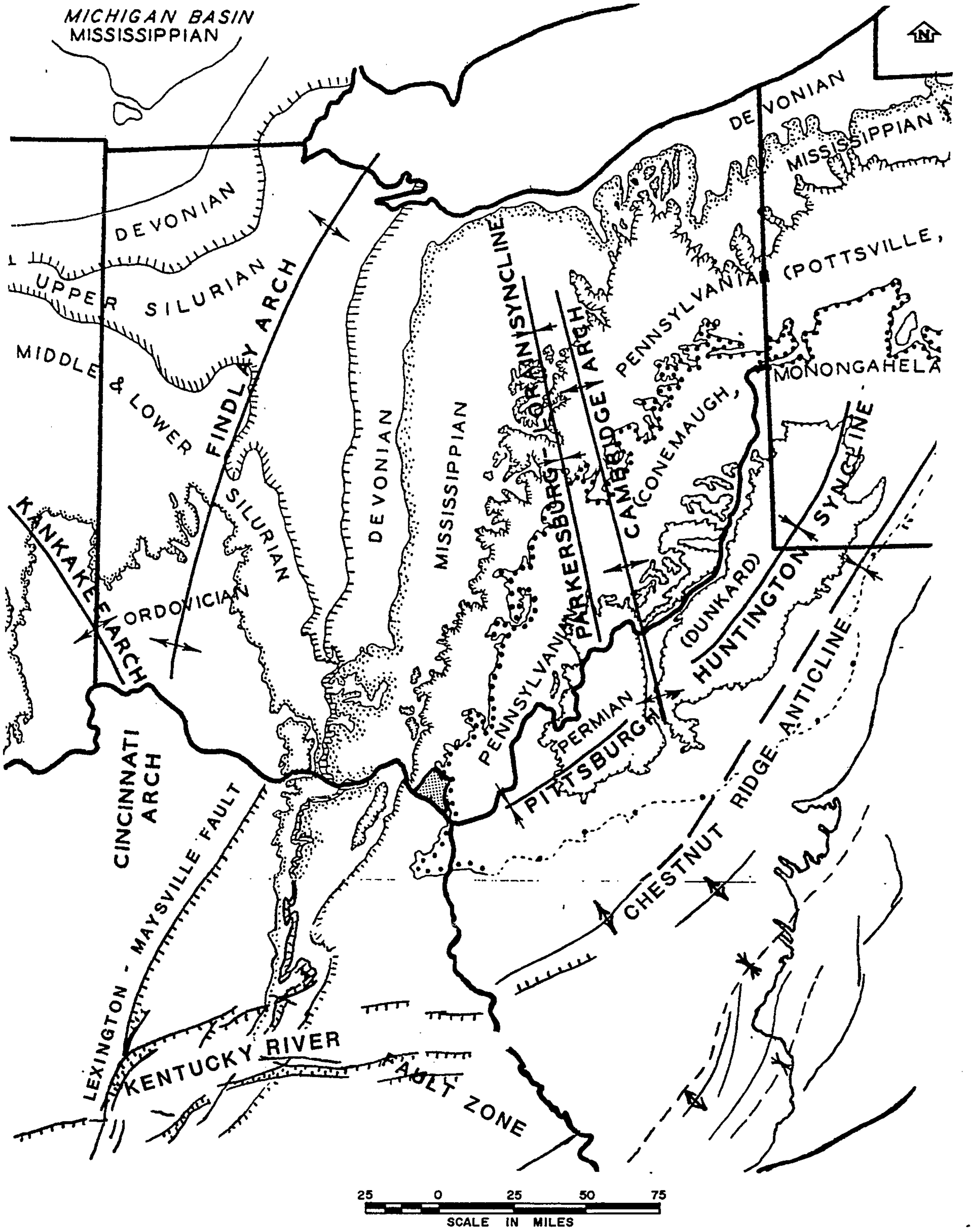


FIGURE 3.2-6 Regional structural features in vicinity of Ironton mine site

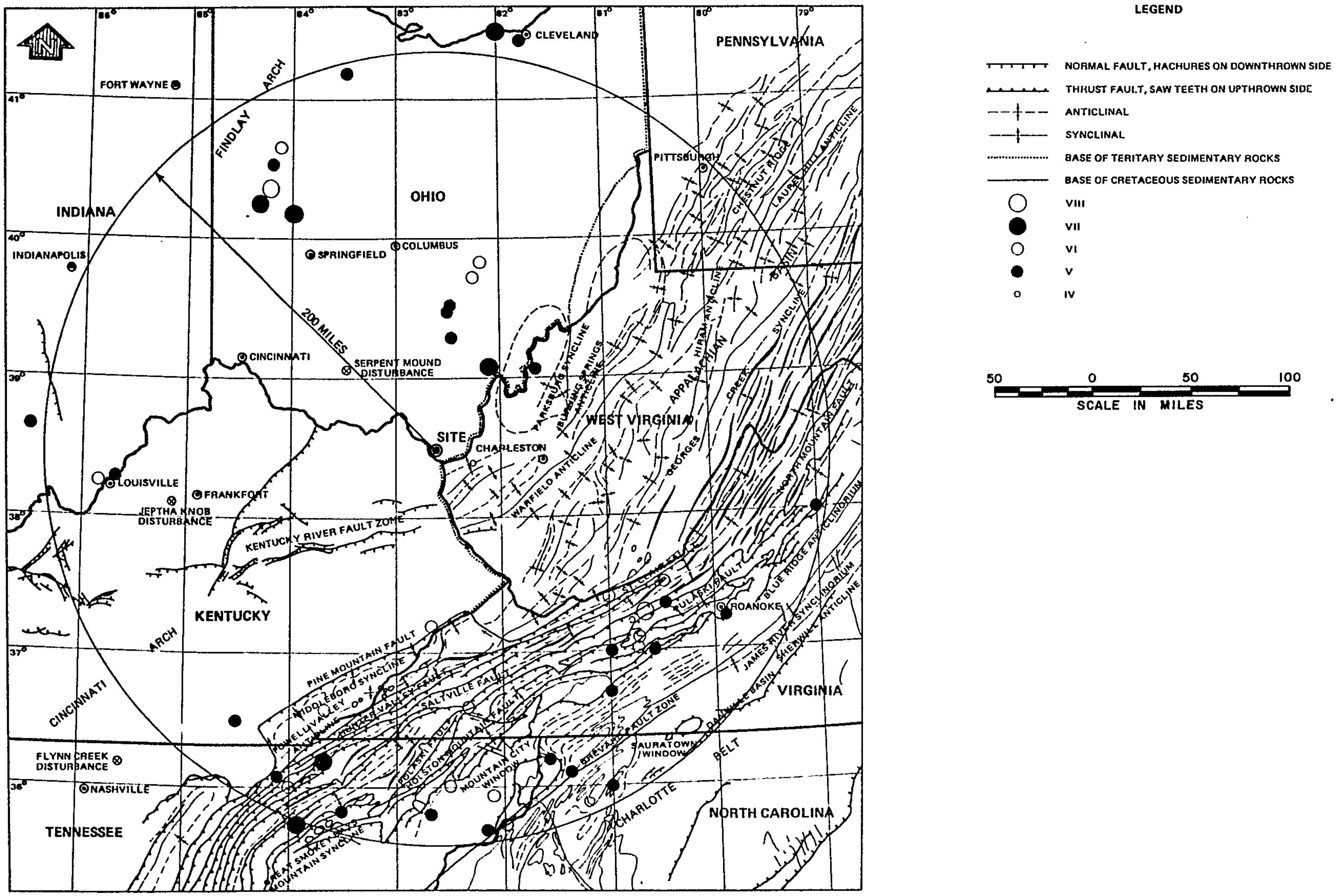


FIGURE 3.2-7 Earthquakes within a 200 mile radius of the Ironton Mine site.

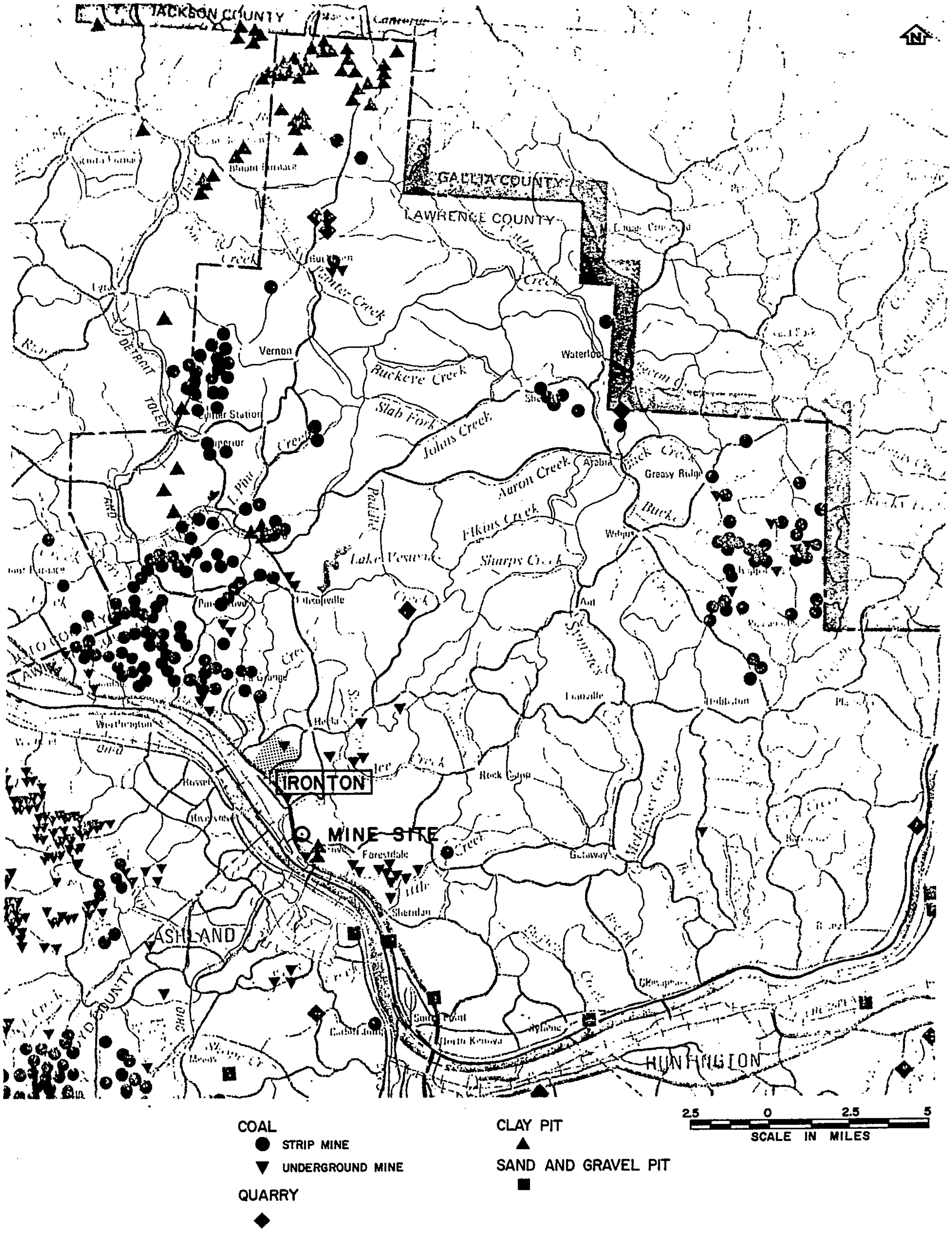


FIGURE 3.2-8 Mineral resources of Lawrence County (except oil and gas)

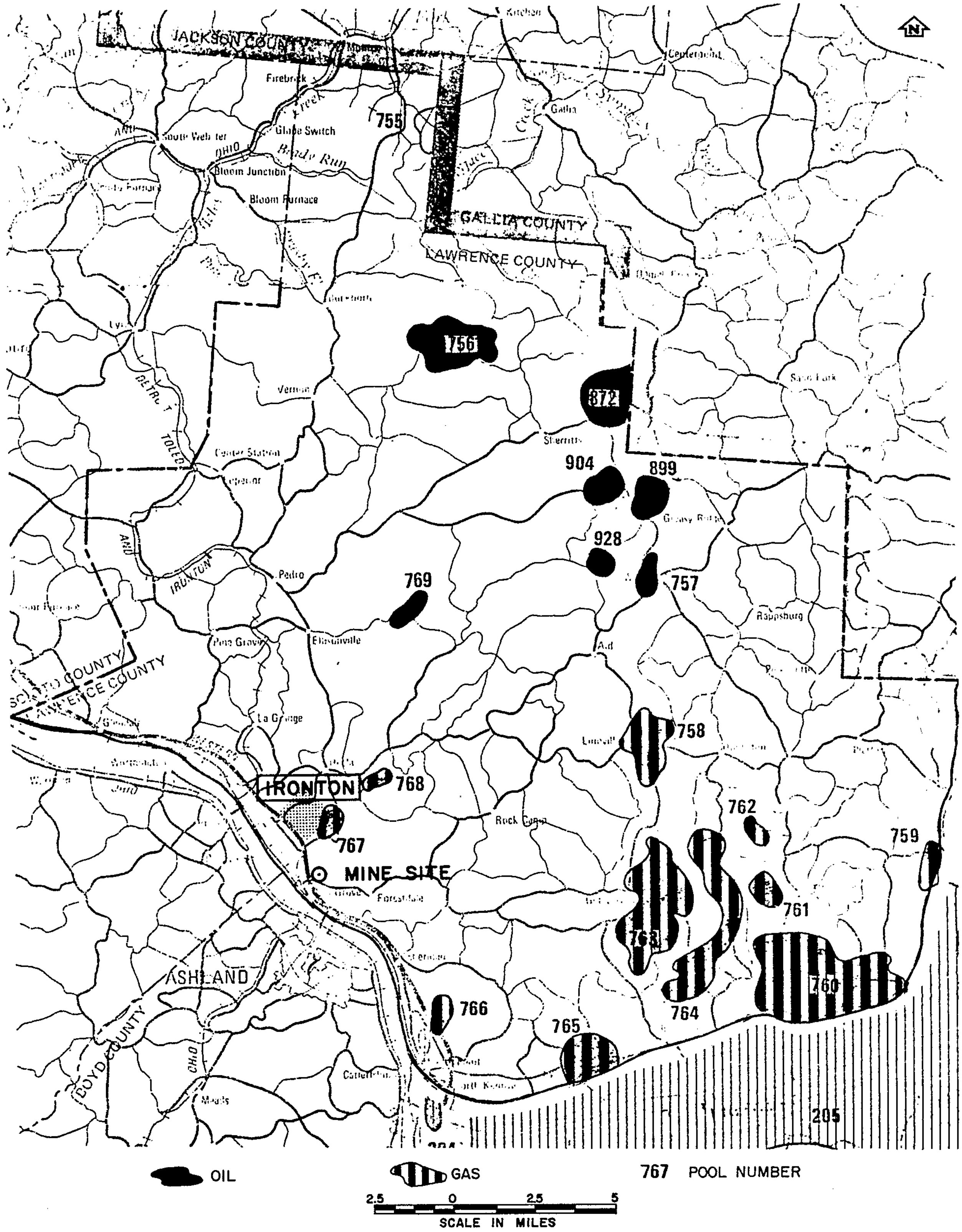
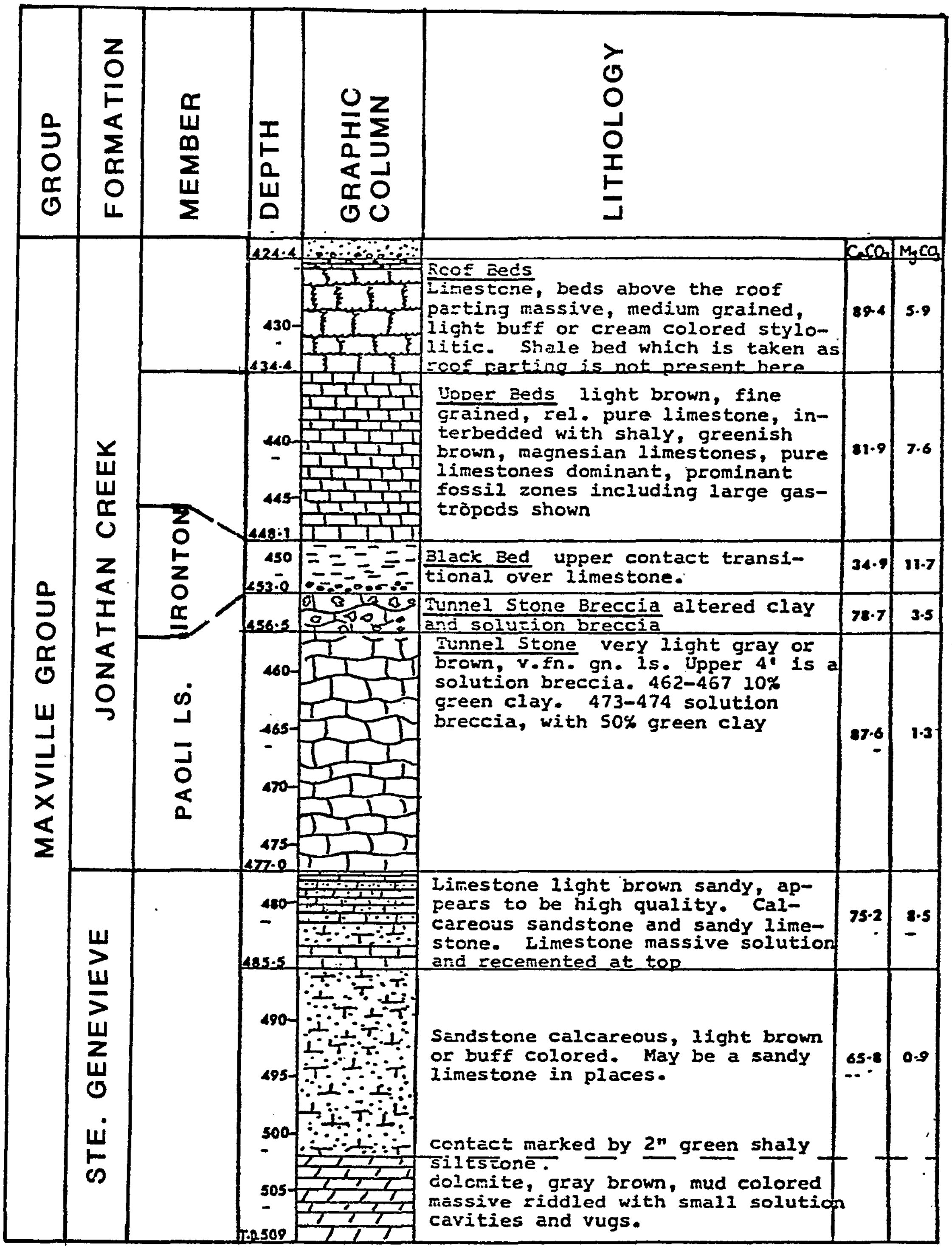
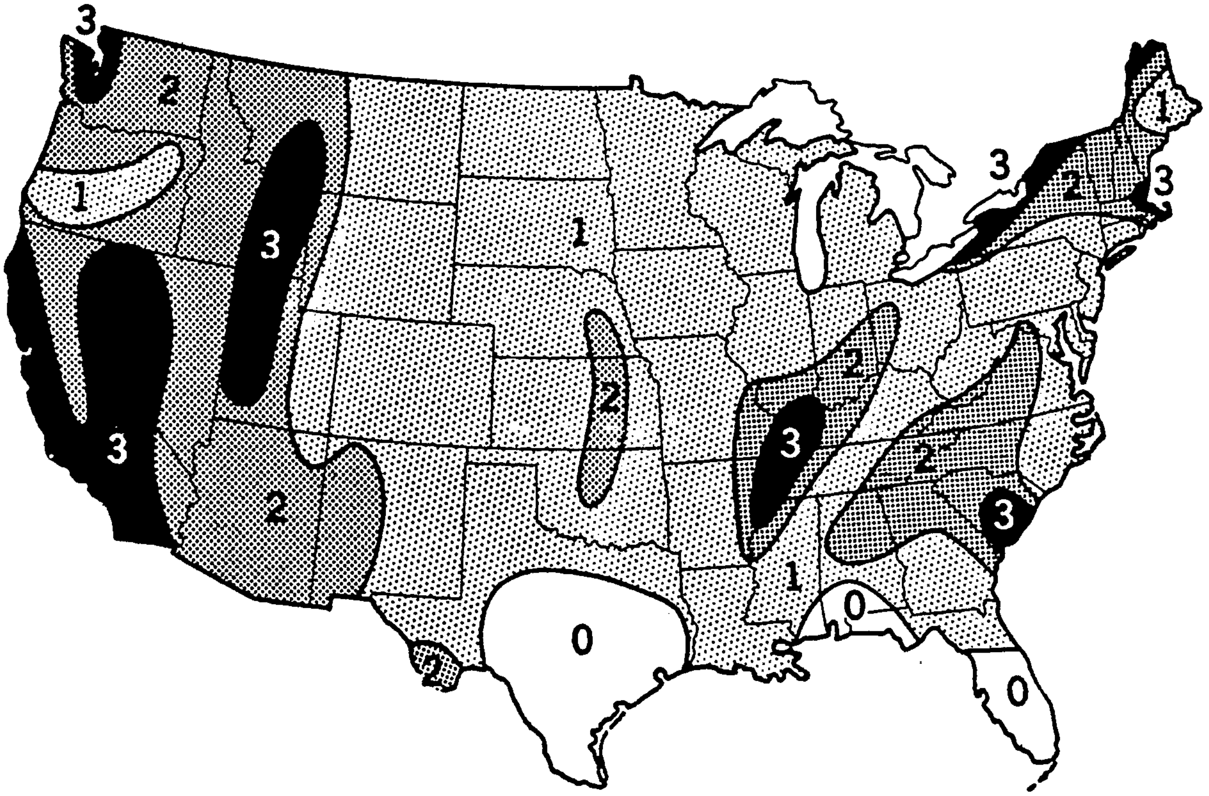


FIGURE 3.2-9 Oil and gas resources of Lawrence County



GROUP	FORMATION	MEMBER	DEPTH	LITHOLOGY	$CaCO_3$	$MgCO_3$
MAXVILLE GROUP	JONATHAN CREEK		424.4–434.4	Roof Beds Limestone, beds above the roof parting massive, medium grained, light buff or cream colored stylolitic. Shale bed which is taken as roof parting is not present here	89.4	5.9
			434.4–448.1	Upper Beds light brown, fine grained, rel. pure limestone, interbedded with shaly, greenish brown, magnesian limestones, pure limestones dominant, prominant fossil zones including large gastrŏpcds shown	81.9	7.6
		IRONTON	448.1–453.0	Black Bed upper contact transitional over limestone.	34.9	11.7
			453.0–456.5	Tunnel Stone Breccia altered clay and solution breccia	78.7	3.5
		PAOLI LS.	456.5–477.0	Tunnel Stone very light gray or brown, v.fn. gn. ls. Upper 4' is a solution breccia. 462-467 10% green clay. 473-474 solution breccia, with 50% green clay	87.6	1.3
	STE. GENEVIEVE		477.0–485.5	Limestone light brown sandy, appears to be high quality. Calcareous sandstone and sandy limestone. Limestone massive solution and recemented at top	75.2	8.5
			485.5–T.D. 509	Sandstone calcareous, light brown or buff colored. May be a sandy limestone in places. contact marked by 2" green shaly siltstone. dolomite, gray brown, mud colored massive riddled with small solution cavities and vugs.	65.8	0.9

FIGURE 3.2-10 Lithology of Alpha-Portland Cement Limestone Mine



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 3.2-11 Seismic risk map of the United States

3.3 HYDROLOGY

3.3.1 Surface Water

3.3.1.1 Watersheds

The Ironton Mine is near the junction of the three states of West Virginia, Ohio and Kentucky. The two major towns of the area, Ashland and Ironton, are located on the flood plain of the Ohio River. The proposed 18-inch pipeline connecting the mine to the refinery, located about 2 miles south of Catlettsburg, Kentucky, is about 13 miles long and will cross 8 minor watersheds of the Ohio River main stem, as well as the Ohio River itself (Figure 3.3-1).

The length of pipeline in each watershed is:

Ohio River	1.85 miles
Ice Creek	3.85 miles
Possum Hollow	1.00 miles
Lick Creek	1.15 miles
Salida Creek	1.35 miles
Catletts Creek	1.20 miles
Ice Dam Creek	0.60 miles
Paddle Creek	0.75 miles
Chadwick Creek	1.25 miles

Ohio River Watershed

The Ohio River Basin (excluding the area drained by the Tennessee River) has a drainage area of 163,200 square miles comprising parts of 11 states in the east, central and northeastern United States. The Ohio River is formed by the confluence of the Allegheny and Monongahela Rivers at Pittsburgh, Pennsylvania, the point customarily designated as River Mile zero on the Ohio River main stem navigation charts. The river flows in a northwesterly direction for about 25 miles, then turns westward where it becomes the boundary between Ohio and West Virginia. From there it continues in a southwesterly direction forming the northern boundaries of West Virginia and Kentucky and the southern boundaries of Ohio, Indiana, and Illinois. It joins the Mississippi River at Cairo, Illinois, 981 miles downstream of its origin at Pittsburgh.

The eastern part of the basin lies predominantly within the Appalachian Plateau, although portions of the drainage areas of the Monongahela and Kanawha Rivers are in the Appalachian Mountains. The western portion of the basin lies within the Interior Low Plateau and Central Lowland provinces. The bedrock throughout the basin is principally of sedimentary origin and varies from dense impermeable siltstones and shales through open textured limestone and sandstone.

The Ohio River drainage system is almost devoid of natural lakes and swamps. Natural lake areas are found only in the upper headwaters of the Wabash River drainage and are so limited in extent as to be of only local concern with respect to water supply sources and waste disposal. Water conservation reservoirs, ranging in size from farm ponds to municipal, state and federal developments of tens of thousands of acre-feet capacity, have been developed at many points throughout the basin. Navigation dams creating flow-through impoundments, with pools ranging in depth from about 6 to 45 feet, are located along the main stream and on reaches of 9 tributaries. Many of these serve as temporary storage facilities in the water supplies of communities and industries located adjacent to the pools, and all of them modify the natural assimilative capacities of the impounded streams.

The general flow direction of the Ohio River in the study area between River Miles 317 and 325 is northwest, and normal pool elevation (water surface elevation of the river) is 515 feet above MSL.

Minor Watersheds

The general topography of the region is quite consistent. It is defined as a naturally dissected upland of moderate to severe slope constraints. Between 60 and 80 percent of the general study area exhibits extreme topographic limitations to development, with slopes in excess of 17 percent. Average annual precipitation is about 45 inches; roughly 15 inches flow from the minor watersheds as runoff.

The following subsections will describe the watersheds crossed by the proposed pipeline, starting from the Ironton mine and ending at Catlettsburg Terminal.

Ice Creek - Ice Creek Watershed is the largest minor watershed of the area. The catchment area is about 38.0 square miles, most of which is covered with forest. The mine is located near the discharge point of this basin (Figure 3.3-1). General flow direction of the main stream is westward. Little Ice Creek is the main tributary of Ice Creek and joins it about 1.5 miles east of the mine site. The longest stream is 14.5 miles and the total length of the streams in the watershed is approximately 40.0 miles. The average slope of the Ice Creek channel is 0.17 percent.

Average annual runoff of the basin is 30,476 acre-feet. From this discharge the average flow velocity of the stream near the pipeline crossing is estimated to be about 2.45 feet per second (1.67 miles per hour). Before joining the Ohio River, Ice Creek enters into a small bay.

There are a few small ponds in the area; the largest one is located at the headwaters of Little Ice Creek.

Possum Hollow - Possum Hollow Watershed is a small watershed (0.63 square miles). The vegetation in this area is generally woodland. This basin has a single stream about 0.9 miles long with a stream channel slope of 1.08 percent. The direction of flow is southwest.

Average annual runoff of the basin is 505 acre-feet, corresponding to a flow velocity of 1.5 feet per second (1.02 miles per hour). The stream joins Lick Creek and flows northwestward about one mile before entering the Ohio River.

Lick Creek - The catchment area of the Lick Creek Watershed is about 3.30 square miles. The entire basin is part of the Wayne National Forest. Lick Creek is formed by the confluence of two small creeks. The length of the longest stream is 3.4 miles, and the total length of the streams is 5.6 miles. The average slope of the main stream channel is 0.84 percent. The general direction of flow is westward.

Average annual runoff of the basin is 2650 acre-feet, with an estimated average flow velocity of about 2.0 feet per second (1.36 miles per hour). About 0.5 miles before its confluence with Possum Hollow Creek, Lick Creek turns to the northwest, eventually discharging into the Ohio River.

Salida Creek - Salida Creek Watershed is the second largest watershed in the area (9.1 square miles). About 80 percent of the basin is in Wayne National Forest; the remainder is within the flood plain of the Ohio River. The longest stream length is 7.7 miles and the total length of the streams in the basin is 13.5 miles. For the first 4 miles, Salida Creek flows southward; after a tributary enters from the left, it turns to the northwest. The average slope of the creek channel is 0.24 percent.

Average annual runoff of the basin is 7300 acre-feet which results in an estimated flow velocity of 2.1 feet per second (1.43 miles per hour). The creek discharges into the Ohio River at River Mile 325.

There is one pond in the area, located at the headwaters of Willow Creek, a tributary of Salida Creek.

Catletts Creek - Catletts Creek is formed by the confluence of 3 forks near Eadson School. The catchment area is 4.18 square miles. The first mile flows northeast, then turns to the southeast. One mile downstream Twin Fork joins the creek from the right bank. From this point of confluence it turns to the northeast and then east, discharging into the Ohio River at River Mile 317.5, near Big Sandy Junction. The longest stream length is 4.6 miles and the total length of the streams in the basin is 7.2 miles. Average slope of the main stream channel is 0.5 percent.

Average annual runoff is 3700 acre-feet which corresponds to an estimated flow velocity of 2.3 feet per second (1.57 miles per hour).

There are a few small ponds in the basin. Before discharging to the Ohio River, the creek empties into a small pond which is located about 0.7 miles from the mouth of the creek.

Ice Dam Creek - Ice Dam Creek Watershed is a small watershed (1.06 square miles) with no tributaries. The length of its course is 1.7 miles; average slope of the stream is 1.07 percent. Its general direction of flow is eastward. It empties, together with Paddle Creek, into the Big Sandy River one mile upstream from the confluence point of the Big Sandy River with the Ohio River.

Average annual runoff is about 940 acre-feet which corresponds to a 2.0 feet per second (1.36 miles per hour) average flow velocity.

Paddle Creek - Paddle Creek Watershed has almost the same hydrologic characteristics as Ice Dam Creek Watershed, but it is smaller (0.65 square miles). The length and the slope of the stream are 1.7 miles and 1.07 percent, respectively.

Average annual runoff is 570 acre-feet and average flow velocity is about 1.0 foot per second (0.68 miles per hour).

Chadwick Creek - Chadwick Creek Watershed is the third largest watershed in the study area (4.84 square miles). The creek is formed by the confluence of 2 small creeks. It flows eastward, parallel to Interstate Highway No. 64, to the point of discharge into Big Sandy River, 2.3 miles upstream of the confluence with the Ohio River. The total length of the streams in the basin is 7.3 miles. The main stream is 3.6 miles long; its average channel slope is about 0.52 percent.

Average annual runoff is 3880 acre-feet and average stream flow velocity is estimated to be 2.3 feet per second (1.57 miles per hour).

There is only one significant pond (Lake Bonita) in this area, located at the headwater of Chadwick Creek. Catlettsburg Terminal, part of the proposed project, is in this watershed.

3.3.1.2 Floods

Major Ohio River floods are caused by excessive rainfall over the basin during widespread storms in the winter and spring months. Floods rise to their crests very slowly and remain above bankfull stage for extended periods. For example, the 1937 flood took 10 to 12 days to rise to its crest and remained out of banks for over 2 weeks. The maximum rate of rise during a major flood normally is less than 1/2 foot per hour.

The main flood season for the Ohio River is January through April. The highest floods have all resulted from general heavy rains. Intense local thunderstorms of the type usually occurring in the summer and fall do not contribute significantly to Ohio River flooding, but do cause flash flooding on smaller tributaries in the area.

The greatest Ohio River flood of record (period of 1884 to 1975) was in March - April, 1937; the Ohio River reached an elevation of 553.7 feet above MSL at the Ironton-Russel highway bridge and 555.2 feet above MSL at the Ashland-Coal Grove highway bridge. The 100-year flood at the mouth of Ice Creek is 547 feet MSL.

In the mine area, the lowest shaft entrance elevation is 580 feet above MSL, 24.8 feet higher than the elevation reached during the greatest recorded flood. It can be concluded that the mine is safe from the projected high water level for the 100-year flood of the Ohio River.

Ice Creek has a small watershed (38 square miles). Considering the mine elevation and the topography of the creek channel observed during field investigations, it can be concluded that any significant flood from Ice Creek would not flood the mine area.

3.3.1.3 Water Users

Within the study area, the significant water users from the Ohio and Big Sandy Rivers are as follows:

1. Huntington Water Corporation (upstream of project river crossings) - This is a private agency and serves some 29,000 customers (or 122,000 persons) in West Virginia. Treated water storage capacity is 6.2 million gallons, and the average daily consumption is 15.7 million gallons.

2. City of Ashland Water Works (downstream of project river crossings) - This city water system has a treatment plant with a designed treatment capacity of 8 million gallons per day (MGD). There is a 6-MG underground concrete reservoir, two 1-MG storage tanks, and a 26-MG settling basin. Present treatment and consumption is 5 MGD. Water is supplied to industry and approximately 14,000 other customers (50,000 persons).

3. Catlettsburg, Denova and Ceredo Water Company (downstream of a portion of the project) - This privately-owned company is located in Catlettsburg and draws its water from the Big Sandy River. Present average daily treatment is 1.3 MG. Storage facilities include a 1-MG steel tank at Catlettsburg, and one 0.5-MG steel tank in West Virginia. There are about 1500 customers (or 5000 persons) served in the town of Catlettsburg and the city of Kenova, West Virginia.

4. City of Ironton Water Works (downstream of project river crossings) - The Ironton water system draws its water supply from the Ohio River, with present treatment and consumption rated at 2.6 MGD. Reservoir capacity is 5 MG for treated water. Some 5300 customers (or 16,500 persons) are served within the corporate area and Coal Grove.

5. South Point Water Company (upstream of project river crossings) - This city-owned system obtains water from 4 wells located near the Ohio River shoreline having a total capacity of about 800,000 GD. The treatment plant design capacity is 1 MGD, with present treatment and use of 380,000 GD. Service is provided to about 1000 customers (or some 3500 persons).

3.3.1.4 Water Quality

The states of Kentucky and Ohio have set forth water quality standards, stream use classifications and minimum water quality conditions for all state waters (see Appendices A and B). The limiting values of water quality parameters are summarized in Table 3.3-1.

Many streams in the study area are degraded by drainage from coal mine workings; this includes strip mines as well as underground mines, both active and inactive. Mine drainage contributes undesirable quantities of dissolved solids, suspended materials, and acid waters to surface streams. A high content of total dissolved solids, especially iron, manganese, aluminum and sulfate, very hard water, and high sediment loads, received from mines may persist for long distances downstream.

In the study area, Ice Creek and Little Ice Creek are continuously and significantly affected by mine drainage. The portions of the Ohio River and the Kentucky streams in the study area are classified as "water quality-limited" streams. The Big Sandy River and the West Virginia streams in the area are classified as "effluent limited" streams.

The waters of the Ohio River main stem are classified as moderately hard to hard, depending on the season of the year. Concentrations show an inverse relationship to flow. When the flow is high in the winter and early spring, hardness values range from around 80 to 100 mg/l, with the higher values occurring in the downstream reaches. At low flow and high concentration periods of the year, maximum hardness may range from 200 to 275 mg/l, with the higher values occurring in the middle and upper stream reaches.

Immediately downstream from Pittsburgh, the Ohio is sometimes acid. The pH of the Monongahela at Pittsburgh during a recent year ranged from 4.1 to 7, while that of the Allegheny ranged from 3.7 to 7.2, with most values between 6.2 and 7.2. The pH was often below 7. Progressing downstream, the pH values gradually rose until at Evansville the range was from 6.8 to 9.0.

At times, there are very low chloride concentrations on the order of 5 to 15 mg/l. Maximum chlorides range from 70 to 140 mg/l, with the higher values being recorded at Huntington and Cincinnati. Values approaching 200 mg/l were observed at Parkersburg, West Virginia in 1964; this reflected the influence of a heavy salt load carried by the Muskingum River. High sulfate concentrations occur at low flows, again with the maximum observed values between 250 and 300 mg/l coming at the upstream stations. Concentrations observed during the high runoff season vary from 20 to 100 mg/l.

Changes in quality are also affected by the discharge of organic wastes from municipal sewerage systems and industrial outfalls. During periods of low flow in the main stem, low dissolved oxygen concentrations (less than 4.0 mg/l) have been recorded below Pittsburgh, Pennsylvania, and Huntington, West Virginia; Cincinnati, Ohio; and Louisville, Kentucky. Present treatment is less than secondary at all of these locations.

Water treatment problems associated with tastes and odor are encountered at times at Huntington, West Virginia; Cincinnati, Ohio; and Evansville, Indiana.

Some of the factors which affect water quality in the Ohio River are: mine drainage; discharge of ground water from limestone formations; extraction of brines for industrial processing and discharge of unwanted residues; oil field brine discharges; discharges from various industrial processes such as steel mill blast furnaces, inorganic and organic chemical manufacturing, and coking operations; and residual organic wastes discharged by municipalities.

3.3.2 Ground Water

3.3.2.1 Regional Aquifers

The largest regional ground water resources in south central Ohio occur in the alluvial and glaciofluvial sediments of the Ohio and Scioto River valleys (Figure 3.3-2). In addition, there is a widespread occurrence of smaller resources in the alluvium of smaller valleys and in certain bedrock aquifers. Maximum yields for the region's aquifers are obtained from the thick deposits of permeable sand and gravel underlying the Ohio and Scioto River flood plains. In most places, potential yields of 100 to more than 500 gallons per minute (gpm) are available from vertical screened wells 50 to 100 feet deep. Average potential yields are between 150 and 200 gpm. Yields exceeding 500 gpm are available where thick sands and gravels lie within the direct recharge influence of the rivers (1/2 to 1 mile); in these areas, single wells may yield up to 1,000 gpm or more, and large-diameter collector wells may yield 1500 to 3000 gpm.

Alluvium in the ancient Teays Valley and along the Big Sandy, Guyandotte, and lower courses of other principal tributaries to the Ohio and Scioto Rivers yield intermediate amounts of ground water. These deposits consist of layers of permeable sand and gravel interbedded with clay, silt, and fine sand. Potential yields range from 5 to 25 gpm and may be improved by inducing infiltration from nearby streams. Intermediate potential yields of 5 to 50 gpm are also available from valley bottoms of Pennsylvanian bedrock composed of Pottsville, Allegheny, and lower Conemaugh sandstones and conglomerates. This water is of secondary origin, and is obtained from joints and openings along bedding planes.

The more minimal regional yields are from two sources: alluvial sediments in small tributary valleys composed of relatively impermeable clay and silt with fine to very fine sand; and thick sequences of alternating shales, sandstones, siltstones, and limestones with coals, clays, and iron ores of Pennsylvanian, Mississippian, and Devonian Age. Both of these sources usually yield 5 gpm or less, making them adequate for domestic supply.

The estimated range of aquifer characteristics for aquifers in the Ohio Valley region are given in Table 3.3-2; Figure 3.3-2 shows the principal aquifers in the region with respect to their yields.

3.3.2.2 Local Aquifers

Within the immediate vicinity of the mine site, 3 aquifer units have have been defined: 1) the highly productive Ohio River valley alluvium, consisting of thick deposits of permeable sand and gravel underlying relatively thin layers of fine sand and clay; 2) recent alluvium along streams tributary to the Ohio River and consisting primarily of clay, silt, and fine sand, with thin beds of sand and gravel; and 3) bedrock aquifers of Pennsylvanian sandstones interbedded with shales, limestones, and coals.

The Ohio River Valley alluvium is the principal aquifer in the Ironton area and extends in a belt approximately 1 mile in width to the northeast of the Ohio River. Yields of drilled wells average 100 to 500 gpm, depending on the location of the well along the flood plain and on the amount of infiltration that may be induced from the Ohio River. A collector well, now abandoned, exists at the mine site. The aquifer at that location is 80 feet thick (also the well depth), below which is Pennsylvanian bedrock. At the time of usage, the well yielded approximately 300 gpm.

Bordering the mine site and extending for 1/2 mile to the northeast along Ice Creek are unconsolidated alluvial deposits of clay, silt, and fine sand interbedded with discontinuous layers of permeable sand and gravel. Thickness of the sediments ranges from 10 to 30 feet, from which intermediate yields of 5 to 25 gpm may be derived. Yields of 100 gpm or more may be derived by induced infiltration from wells favorably located along the stream.

Bedrock aquifers in the mine site vicinity are confined to Pennsylvanian strata, principally of the upper Pottsville and Allegheny Series. The Pottsville Massilon formation, a massive, poorly-cemented, fine-grained to coarse and pebbly-textured sandstone, forms one of the best water-bearing strata in the entire Pennsylvanian system. The Homewood sandstone, also of Pottsville age, is a source of water to farms and villages as the water is of good quality and low in common soluble salts. Good springs are found along its outcrop across Lawrence County. The Upper and Lower Freeport sandstones, composed of a loosely-bedded, medium-grained sandstone, provide moderate supplies of water for domestic uses. The Lower Pottsville Formation, including the Sharon Conglomerate, is not considered an aquifer in Lawrence County (Ohio Department of Natural Resources, 1962) due to the brackish nature of water contained in the unit. In general, water wells are seldom drilled below an elevation of 450 feet above MSL.

3.3.2.3 Local Ground Water Levels

Ground water level information is available from one observation well at the Crystal Ice Company plant located on the flood plain in Ironton. Drilled to a depth of 77 feet in an alluvial gravel aquifer, it shows a range of water levels from the years 1947 to 1964 between a (non-pumping) low of 53.1 feet and a high of 31.9 feet. Located at a distance of 2000 feet from the Ohio River, the well is at an elevation of 550 feet, approximately 30 feet above the stationary river level. It is reasonable to assume that most water levels in other wells located on the flood plain at approximate elevations of 550 feet show levels greater than 30 feet below ground surface. Prior to completion of the Greenup Lock Dam, levels were between 40.1 and 53.1.

There are no other well records available from Lawrence County; water levels in bedrock aquifers are unknown.

3.3.2.4 Local Ground Water Use

Ground water does not supply large quantities of water in Lawrence County except in the flood plain area on the Ohio River, where exceptionally large withdrawals are made for industrial and municipal use. In 1959, approximately 144 MGD were withdrawn in Lawrence County public and private wells, of which 140.5 MGD were used for manufacturing. Within the entire Racoon Creek Drainage Basin, which includes Lawrence, Gallia, and parts of Scioto, Jackson, Vinton, Hocking, and Meigs Counties, manufacturing accounted for a private withdrawal of 223.8 MGD (30% of basin total), and power production, 511.8 MGD (68% of total). Domestic, commercial, irrigation, and rural uses accounted for the remaining 14.2 MGD (7.2 MGD for public and 7.0 MGD for private uses) (Ohio Department of Natural Resources, 1959).

3.3.2.5 Local Ground Water Quality

For most uses, the chemical and physical quality of ground water in the vicinity of the mine is usually satisfactory. There are, however, local variations in the chemical character of the water which cause such problems as high iron, hardness, chloride, and hydrogen sulfide concentrations. In addition, there may be small amounts of local aquifer pollution from oil and gas operations, industrial wastes, domestic sewage, and mining wastes. These sources could create further chemical quality problems.

The character and amount of mineral matter dissolved in the ground water varies with the types of rocks and products of rock weathering through which the ground water has flowed, and the length of contact time. Differences in aquifer mineralogy, consequently, effect a change in the chemical character of the ground water. Many wells penetrate two or more water-bearing rock zones, so that the water produced is a composite or mixture. In general, the water shows an iron content varying from high to low in both sand and gravel, and sandstone. The chloride content is higher in water derived from sandstone than in water pumped from sand and gravel. The amount of dissolved solids in the samples of water from sandstone, although appreciably higher than that in the samples from sand and gravel, still is well below the recognized limit of 1000 ppm (parts per million). Hardness ranges from soft to very hard.

The chemical water quality of representative aquifers near the Ironton Mine is summarized in Table 3.3-3.

3.3.2.6 Ground Water at the Mine Site

The underground mine workings are at an elevation of about ± 74 feet MSL (Figure 2.2-2) within the Maxville limestone formation. In the upper area of the mined horizon a more shaly dolomitic bed exists. The natural ground surface has been extensively disturbed during the active mining history of Ironton. During the operational life of the mine, no significant ground water problems were encountered. Rate of water seepage during mine operation was approximately 20 gpm. Current estimates set the seepage rate at about 10 gpm, primarily surface drainage down the walls of the access shafts. The depth of accumulated water in the southeast section of the mine is estimated to be 15 feet; pump-out will be required prior to use of the mine for oil storage. No aquifers are presently being used in the vicinity of the mine.

Nearly vertical joints exist in the roof of the mine and periodic, low volume dripping occurs. At these points some hematite staining is evident, although the extent of the strike is limited.

During a site visit, the shaly dolomitic layer in the upper portion of the pillars was observed to be damp; however, no dripping water was present. Measurable water inflow appears to be related to surface drainage down the two access shafts, as previously indicated.

TABLE 3.3-1 Limiting parameters for water quality in Kentucky and Ohio

Water Quality Parameter	The Parameter Should Be for Kentucky	for Ohio
Temperature	< 89° F	< 93° F
Dissolved Oxygen	> 5.0 mg/l	> 5.0 mg/l
pH	> 5.0 or < 9.0	> 6.0 or < 9.0
Total Coliform	< 1000/100 mg/l	< 1000/100 mg/l
Fecal Coliform	< 200/100 mg/l	< 200/100 mg/l
Ammonia Nitrogen	< 2.0	
Conductivity	< 800 Microhms/cm	
Dissolved Solids	< 750 mg/l	< 750 mg/l

Source: Kentucky Department of Natural Resources, 1975.

Ohio Environmental Protection Agency, 1974, Ohio water quality standards, EP-1-02: The Bureau of National Affairs, Inc.

TABLE 3.3-2 Estimated characteristics for aquifers in the Ohio Valley region

Aquifer	Hydraulic Conductivity (gpd/ft^2)	Storage Coefficient or Specific Yield
Ohio River valley outwash and alluvial aquifer	400 - 8,400	0.05 - 0.20
Miami River, Scioto River, Upper Muskingum River, and Whitewater River alluvial aquifers	2,500 - 3,000	0.15 - 0.20
Alluvial aquifers in minor tributaries north of Ohio River	500 - 1,000	0.15
Pennsylvanian bedrock (Allegheny, Pottsville, Conemaugh, and Monongahela Formations)	< 20	0.01 - 0.05
Mississippian bedrock	< 20	0.01 - 0.05

Source: Bloyd, Richard M,, 1974. Summary Appraisals of the Nation's Ground Water Resources - Ohio Region; U.S. Geological Survey Professional Paper 813-A, p. A7

TABLE 3.3-3 Representative chemical analyses of fresh ground water in aquifers local to Ironton Mine

Chemical Elements (parts per million)	Ohio River Alluvial Sediments	Ice Creek (Tributary) Alluvium	Bedrock Aquifers (Pennsylvanian)
Hardness	50 - 400	50 - 500	50 - 400
Dissolved Solids	150 - 500	75 - 650	450 - 700
pH	7.0	7.0	7.0
Silica (SiO_2)	6 - 25	6 - 25	6 - 25
Iron (Fe)	0.1 - 5.0	0.1 - 15	0.05 - 15.0
Calcium (Ca)	up to 200	up to 200	up to 200
Magnesium (Mg)	up to 50	up to 50	up to 50
Bicarbonate (HCO_3)	50 - 300	50 - 300	50 - 300
Sulfate (SO_4)	up to 150	5 - 175	30 - 350
Chloride (Cl)	3 - 75	5 - 40	4 - 200
Depth to Fresh - Saline Interface	50 - 100'	---	100 - 200'

Source: U.S. Army Corps of Engineers, 1975.

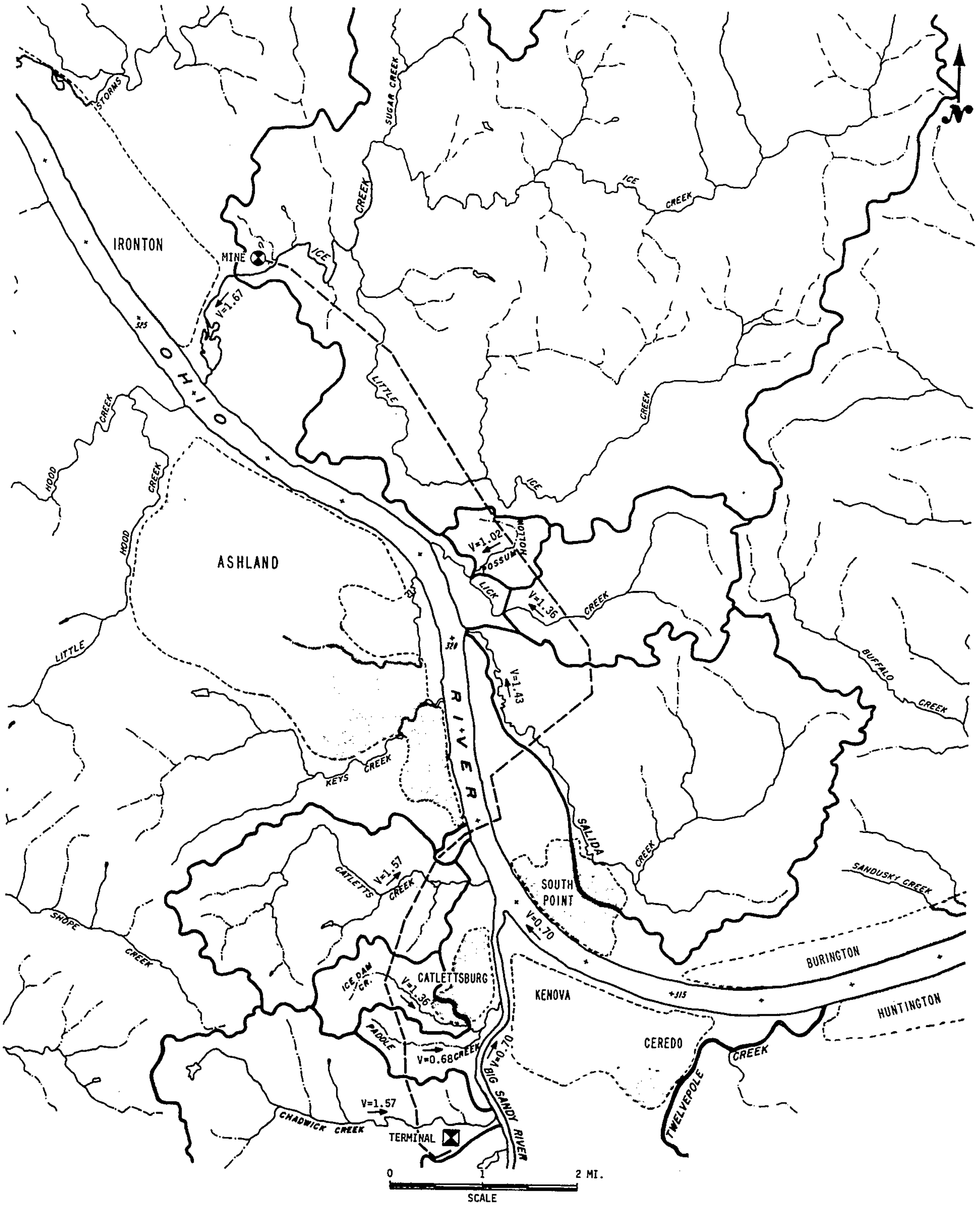
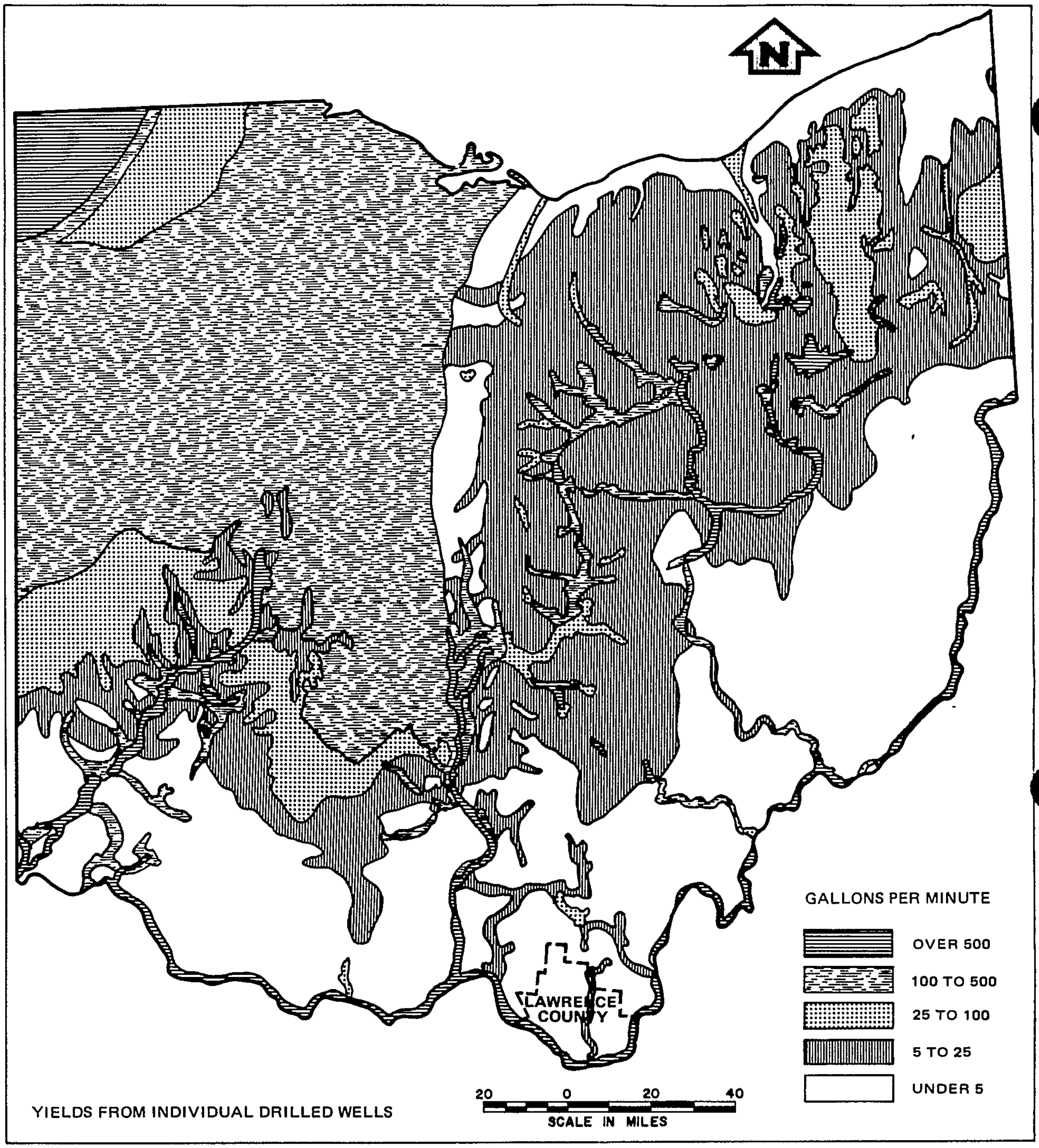


FIGURE 3.3-1 Watersheds crossed by proposed pipeline



SOURCE: OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER

NOTE: FOR MORE DETAILED INFORMATION, A COLOR MAP MAY BE OBTAINED FROM THE OHIO DNR

FIGURE 3.3-2 Regional aquifers

3.4 CLIMATOLOGY AND AIR QUALITY

3.4.1 Regional Climatological Conditions

3.4.1.1 Air Masses, Storm Systems and Local Terrain Characteristics Affecting the Area Climatology

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

The climate is classified as temperate. Continental warm humid summers and cool winters prevail. 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 Ironton to exert any effect upon the local climate. The most common air masses affecting the area are maritime tropical (MT) ones, which originate over the Gulf of Mexico, and continental polar (CP) ones, which originate in Canada and are characterized by relatively cold, dry air.

The MT air prevails during the later 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 always of short duration. Continental polar air affects southern Ohio primarily during the winter months, bringing the colder, drier air that is representative of the continental winters. The influence of the CP air mass during periods of southerly flow, which usually follows the passage of a well-developed high-pressure system. These situations bring mild midwinter temperatures and higher 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. Ironton is situated near the paths of the major storm tracks that migrate across the United States throughout the year. The frontal activity that is associated with these storms brings showers, thundershowers and occasional high winds. During the winter months when the storm tracks push to their southernmost positions, the Ironton 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.

Ironton is located on the Ohio River in Lawrence County, in southernmost Ohio. The elevation in the county varies between 500 and 1100 feet above MSL, and the terrain is entirely rolling hills. Because of the changes of land elevation, the surface features can produce small-scale meteorological phenomena such as up-slope and down-slope valley winds, and some orographic rainfall. The only large terrain features that exist near the Ohio-Kentucky-West Virginia border are the Appalachian foothills, which lie to the east. Because of the west-to-east movement of the major weather patterns at these latitudes, the surface features of the Appalachians do not affect the synoptic scale (100 km to 1000 km) meteorological phenomena such as low-pressure systems and squall lines.

3.4.1.2 Temperature

Ironton 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. The average temperature for winter is 35^{o}; spring, 59^{o}; summer, 74^{o}; and fall, 57^{o}.

Meteorological surface data recorded at the Huntington, West Virginia Airport (20 miles southeast of Ironton) are used to describe regional weather conditions (NOAA, 1974). Average and extreme temperatures for Huntington are presented in Table 3.4-1. January is the coldest month, with a monthly mean temperature of 32.9^{o} F (41.3^{o} F mean daily maximum, 24.5^{o} F mean daily minimum). July is the warmest month and has a mean temperature of 76.2^{o} F (86.4^{o} F mean daily maximum, 69.5^{o} F mean daily minimum). The record highest and lowest temperatures were 108^{o} F in July 1936 and -14^{o} F in January 1963, respectively. There is an average of 16 days per year when the minimum temperature falls below 0^{o} F.

3.4.1.3 General Wind Conditions

Table 3.4-2 presents the monthly mean and extreme wind speed and direction observed at Huntington (NOAA, 1974). The prevailing winds range from west-southwesterly during the winter and early spring to southwesterly during the late spring and early summer, and southerly the remainder of the year. The more westerly component of the wind during the winter latitude is due to the smaller influence of the Atlantic subtropical high-pressure circulation that produces a southerly component in the surface circulation over the Ohio River Valley region. The highest winds nearly coincide with the period of west-southwesterly flow. March is the windiest month, averaging 8.1 miles per hour. The high winds during this period are also related to the positioning of the polar jet 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.

There is a tendency of the surface winds to flow along the Ohio River Valley, which is indicative of channeling of prevailing winds by the valley walls. In this area, the valley shape and depth has an important influence on the transport and dispersion of the air pollutants (usually in a west to east direction at Ironton).

3.4.1.4 Precipitation

The precipitation is not evenly distributed throughout the year. The fall season (September, October, and November) experiences the least amount of rainfall, averaging 7.8 inches. July and March have the highest amount of precipitation, averaging 4.19 and 4.07 inches, respectively. Table 3.4-3 presents the mean monthly distribution as well as maximum rainfall at Huntington (NOAA, 1974). The early spring maxima is 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 rainfall data at Parkersburg, West Virginia, 75 miles northwest of Ironton (USWB, 1955). The Parkersburg data do not approach or exceed what would be a 100-year return period rainfall for the area. A maximum 24-hour rainfall of 4.27 inches was reported at Huntington in July of 1963 (NOAA, 1974), which is less than the probable maximum 24-hour rainfall for a 100-year return period of 5.5 inches (U.S. Weather Bureau, 1961). The monthly rainfall amounts at Huntington based on a 30-year climatic record ranged from 9.90 inches (July 1961) to a trace of rain (October 1963) (NOAA, 1974).

3.4.1.5 Ice and Snow

Annual snowfall amounts recorded at Huntington vary greatly from year to year. In the past 40 years, annual amounts ranged from 1.5 inches (1948-1949) to 60.9 inches (1935-1936). The mean annual snowfall is 23.1 inches. Table 3.4-4 lists the monthly mean and maximum snowfall amounts at Huntington. It shows that January and February experience the most snow, averaging 6.4 and 6.3 inches, respectively. The maximum snowfall ever recorded in a single month was 21.7 inches in December 1935 (NOAA, 1974).

Because of the moderate temperatures observed during the winter, the ground does not retain snow cover 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 icing conditions.

3.4.1.6 Evaporation

Ironton 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 48 inches. Approximately 75 percent of the annual evaporation occurs between the months of May and October, inclusive (NOAA, 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 and receives about 65 percent of possible sunshine. This increased sunshine reflects the dominance of the Atlantic subtropical high at this time.

3.4.1.8 Fog

Radiation fog is a frequent meteorological phenomenon in southern Ohio. It develops as a result of nocturnal cooling (to the dew point) of low-level air over land, particularly during relatively wind- and cloud-free nights when humidity is relatively high. Although heavy fog occurs on an average of only 62 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 over 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 late summer (80 to 90 percent), and the lowest during early spring, when readings between 60 to 70 percent are common (NOAA, 1974).

3.4.1.10 Severe Weather Conditions

Thunderstorms and Hail

Thunderstorms have occurred each month; they are most frequent in June and July, with thunder occurring about one-third of the days in each month. Thunderstorms are reported at Huntington on an average of 44 days per year. The average monthly distribution for this location is shown in Table 3.4-5. 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 southern Ohio, although large hail stones of a damaging nature rarely occur. Figure 3.4-2 gives the number 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 southern Ohio is rare. The proper combination of favorable weather elements such as warm moist advection and strong insolation that are conducive to tornadic activity are not often realized in eastern Kentucky and southern Ohio. 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 of the number of tornadoes observed by 1^{o} squares in the United States from 1955 through 1967 after Pautz (1969). In the 1^{o} square surrounding the site, there were just 4 tornadoes reported during the period of study.

Ironton, Ohio, 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 Ohio, it has undergone the transition to the extratropical storm stage with lesser winds but heavier than average amounts of rain. Only the rains are potentially damaging to the Ironton area.

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 southern Ohio exhibit fairly high wind speeds, the frequency of extreme winds is not as high 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 southern Ohio. Pautz (1969) determined that there were 11 reports of wind storms 50 knots or greater in the 1^{o} square surrounding the site between the years 1955 and 1967. The highest wind speeds occur during the months of February and March, when the monthly averages are greater than 8 miles per hour (mph). The strongest sustained wind reported (fastest mile of wind) at Huntington was 47 mph. The American National Standards Institute's (1972) annual extreme fastest-mile wind speed for southern Ohio is 75 mph for a 50-year recurrence interval, and 90 mph for a 100-year recurrence interval.

3.4.2 Climatological Factors Affecting Dispersion

3.4.2.1 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 Ironton 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 rolling topography of southern Ohio is not considered an important factor for reducing surface air flow.

Since air pollution is most often a city-related problem, Holzworth (1972) studied urban meteorological and pollution characteristics. His study was used to evaluate qualitatively the air pollution potential for the Ironton site relative to the rest 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	35
Spring	30
Summer	35
Autumn	38
Annual	35

Radiation inversions are usually eliminated by late morning due to 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 C. The higher the mixing height, the lower the pollution potential. Using U.S. radiosonde station temperature and wind data, Holzworth derived average urban morning minimum and afternoon maximum mixing heights (incorporating an urban nocturnal heat island effect), and mean wind speeds 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 (Table 3.4-6).

The results of Holzworth's study indicate that the area of northeastern Kentucky and southern Ohio is a less than favorable location relative to other locations in the United States for the 5 episode dispersion periods.

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 nonurban areas, stability classes f and g were combined into a single class.

Table 3.4-7 lists the seasonal and annual distribution of stability classes for Huntington (NOAA, 1975). 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 are realized. On a diurnal basis, most of the atmospheric instability occurs during the midday, 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 will 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. Ohio's Ambient Air Quality Standards are shown in Table 3.4-8; these are slightly more stringent than the Federal standards (Ohio EPA, 1975).

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 secondary standards; a priority III is indicative of concentrations generally below the secondary standards. Priority classifications in the Huntington-Ashland-Portsmouth-Ironton AQCR, which includes the Ironton site, are presented below:

	Pollutant				
	Sulpher Dioxide	Particulates	Nitrogen Dioxide	Oxidants	Hydrocarbons
Priority	III	I	III	III	III

The existing ambient air quality for several monitoring locations in Ironton is summarized in Tables 3.4-9 and 3.4-10 for particulates and sulfur dioxide, respectively. At present there are no monitoring stations measuring hydrocarbons near Lawrence County. The tables are based on data recorded in 1974 for the SO_2 measurements; data on suspended particulates was recorded in 1975 (Ohio EPA, 1975).

Table 3.4-9 presents the suspended particulate data from the South Point monitoring station situated approximately 10 miles southeast of the Ironton Mine site. Although there are numerous other stations measuring particulate levels in Lawrence County, the South Point data was chosen because it reported the highest level of pollutants for 1975. The data shows that the Ohio standards were exceeded for both annual mean (60 $\mu g/m^3$) and maximum 24-hour concentration (260 $\mu g/m^3$).

The monitoring station for sulfur dioxide levels is located in Ironton. The data (Table 3.4-10) reveal that the ambient levels are well below the Ohio annual standard of 60 $\mu g/m^3$ and 24-hour maximum of 365 $\mu g/m^3$.

TABLE 3.4-1 Monthly mean and extreme temperatures recorded at Huntington, West Virginia airport*

Month	Daily Maximum	Daily Minimum	Monthly Mean	Record Highest	Year	Record Lowest	Year
January	42.9	25.6	34.3	74	1967	-15	1963
February	45.4	26.8	36.1	76	1972	- 6	1970
March	54.7	33.8	44.3	85	1973	10	1969
April	67.5	43.8	55.7	90	1963	22	1972
May	76.2	52.7	64.5	92	1963	27	1966
June	83.4	61.3	72.4	95	1966	40	1972
July	85.7	64.8	75.3	96	1966	46	1968
August	84.6	63.1	73.9	100	1964	43	1965
September	79.0	56.3	67.7	96	1973	35	1974
October	68.8	45.4	57.1	86	1962	16	1962
November	55.4	35.6	45.5	79	1968	8	1964
December	44.6	27.4	36.0	76	1971	- 5	1963
Year	65.7	44.7	55.2	100	AUG 1964	-15	JAN 1963

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*Based on a 14-year (1961-1974) period of record.

TABLE 3.4-2 Monthly mean wind speed and direction observed at Huntington, West Virginia*

Month	Wind Speed (mph)	Prevailing Direction	Fastest Mile
January	7.3	WSW	38
February	7.6	WSW	41
March	8.1	WSW	37
April	7.6	SW	44
May	6.0	SW	47
June	5.3	SW	35
July	4.7	S	31
August	4.7	S	35
September	4.8	S	28
October	5.4	S	29
November	6.9	SW	35
December	7.3	SW	29
Year	6.3	SW	47

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*Based on a 13-year (1962-1974) period of record.

TABLE 3.4-3 Monthly mean and extreme precipitation recorded at Huntington, West Virginia airport*

Month	Normal	Monthly Maximum	Year	Monthly Minimum	Year	24 hrs Maximum	Year
January	3.15	5.57	1974	1.12	1970	2.63	1974
February	2.90	5.66	1962	0.53	1968	2.43	1966
March	4.07	7.54	1963	1.12	1966	3.43	1976
April	3.26	6.56	1966	0.86	1963	1.91	1966
May	3.82	9.26	1974	0.93	1965	2.60	1974
June	3.37	4.86	1974	0.41	1966	1.80	1974
July	4.19	8.57	1962	1.37	1974	4.27	1962
August	3.34	6.21	1964	0.68	1962	2.90	1964
September	2.86	5.64	1966	1.14	1968	2.74	1964
October	2.09	5.23	1970	T	1963	1.82	1970
November	2.86	5.17	1973	0.96	1965	2.28	1973
December	2.97	5.52	1972	0.31	1965	2.40	1972
			MAY		OCT		JUL
Year	38.88	9.26	1974	T	1963	4.27	1962

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*Based on a 14-year (1961-1974) period of record.

TABLE 3.4-4 Monthly mean snowfall measured at Huntington Airport

Month	Monthly Mean Snow Fall	Maximum Monthly Snow Fall	Year
January	6.4	19.1	1948
February	6.3	17.1	1960
March	3.9	14.6	1960
April	0.1	1.3	1944
May	T	T	1963
June	0.0	0.0	----
July	0.0	0.0	----
August	0.0	0.0	----
September	0.0	0.0	----
October	T	0.4	1974
November	1.7	19.6	1950
December	4.7	21.7	1935
Year	23.1	21.7	1935

Based on a 40-year (1935-1974) climatic record.

TABLE 3.4-5 Monthly mean number of thunderstorm days reported at Huntington, West Virginia

Month	No. of Days
January	*
February	1
March	3
April	5
May	7
June	7
July	10
August	7
September	3
October	1
November	1
December	*
Year	44

---

*Denotes less than 1/2.

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

TABLE 3.4-6 Average mixing heights and average mixing layer wind speeds for Huntington, West Virginia (1960-1964)

	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.

TABLE 3.4-7 Frequency distribution of stability by season at Huntington, West Virginia

Stability Class	Percent by Season				
	Dec/Jan/Feb	Mar/Apr/May	Jun/Jul/Aug	Sept/Oct/Nov	Annual
A	0	1.1	3.5	.3	1.2
B	.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

Based on 5 years (1960-1964) of meteorological observations.

TABLE 3.4-8 Ohio ambient air quality standards

Air Containment	Maximum Permissible Concentration
Suspended Particulate	60 $\mu g/m^3$ (annual geometric mean) 260 $\mu g/m^3$ (maximum 24-hr concentration not to be exceeded more than once per year)
Sulphur Dioxide (SO_2)	60 $\mu g/m^3$ or 0.02 ppm (annual arith. mean) 365 $\mu g/m^3$ or 0.14 ppm (maximum 24-hr concentration not to be exceeded more than once per year) 797 $\mu g/m^3$ or 0.30 ppm (maximum 1-hr concentration not to be exceeded more than once per year)
Hydrocarbons, (other than Methane)	126 $\mu g/m^3$ (0.19 ppm) (maximum 3-hr concentration between 6:00 a.m. and 9:00 a.m. not to be exceeded more than once per year) 331 $\mu g/m^3$ (0.49 ppm) (maximum 24-hr concentration not to be exceeded more than once per year)

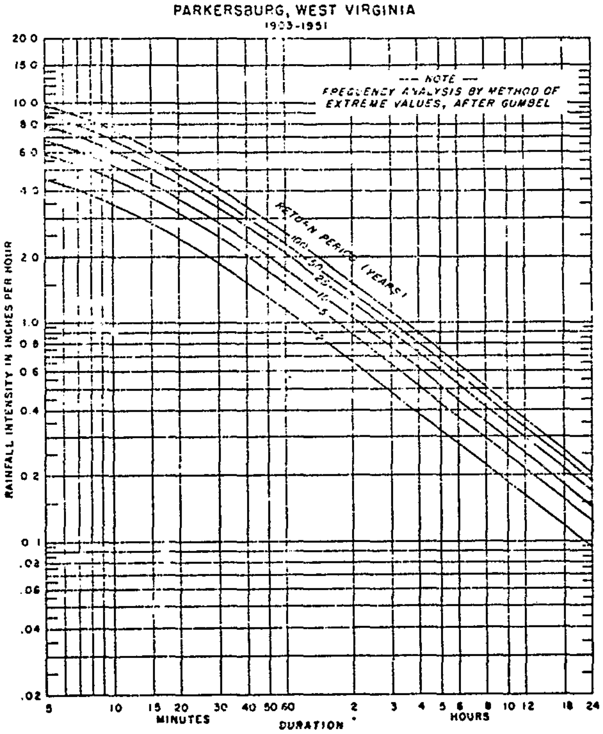
TABLE 3.4-9 1975 suspended particulate data for Lawrence County, South Point monitoring point

Month	Monthly Mean	24-hr Maximum
January	155 μg/m^3	383 μg/m^3
February	118 μg/m^3	193 μg/m^3
March	99 μg/m^3	191 μg/m^3
April	171 μg/m^3	380 μg/m^3
May	145 μg/m^3	239 μg/m^3
June	141 μg/m^3	247 μg/m^3
July	89 μg/m^3	109 μg/m^3
August	94 μg/m^3	215 μg/m^3
September	95 μg/m^3	177 μg/m^3
October	136 μg/m^3	288 μg/m^3
November	116 μg/m^3	236 μg/m^3
December	-----	-----
Annual Mean	123 μg/m^3	
Highest 24-hr sample	383 μg/m^3	

TABLE 3.4-10 1975 sulphur dioxide concentration levels for Lawrence County, Ironton monitoring station

Month	Monthly Mean	24-hr Maximum
January	20.8 μg/m^3	33.8 μg/m^3
February	18.2 μg/m^3	28.6 μg/m^3
March	10.4 μg/m^3	41.6 μg/m^3
April	18.2 μg/m^3	49.4 μg/m^3
May	18.2 μg/m^3	28.6 μg/m^3
June	18.2 μg/m^3	26.0 μg/m^3
July	18.2 μg/m^3	33.8 μg/m^3
August	18.2 μg/m^3	33.8 μg/m^3
September	2.34 μg/m^3	46.8 μg/m^3
October	20.8 μg/m^3	39.0 μg/m^3
November	5.2 μg/m^3	15.6 μg/m^3
December	----	-----
Annual Mean	15.6 μg/m^3	
Highest 1-hr sample	49.4 μg/m^3	

FIGURE 3.4-1 Rainfall rates versus duration at Parkersburg, West Virginia



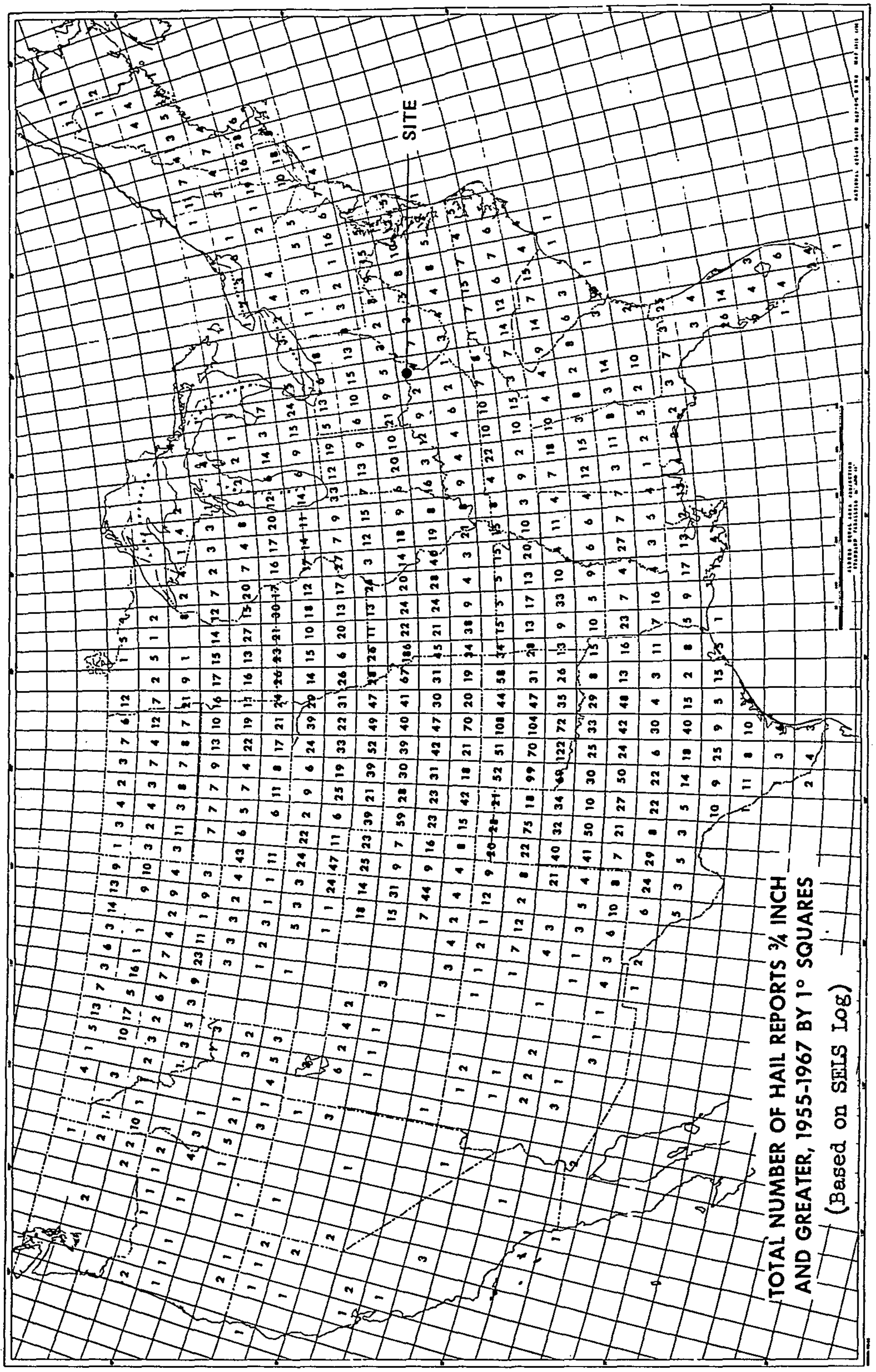


FIGURE 3.4-2 Total number of hail reports 3/4 inch and greater, 1955 - 1967, by 1^{o} squares

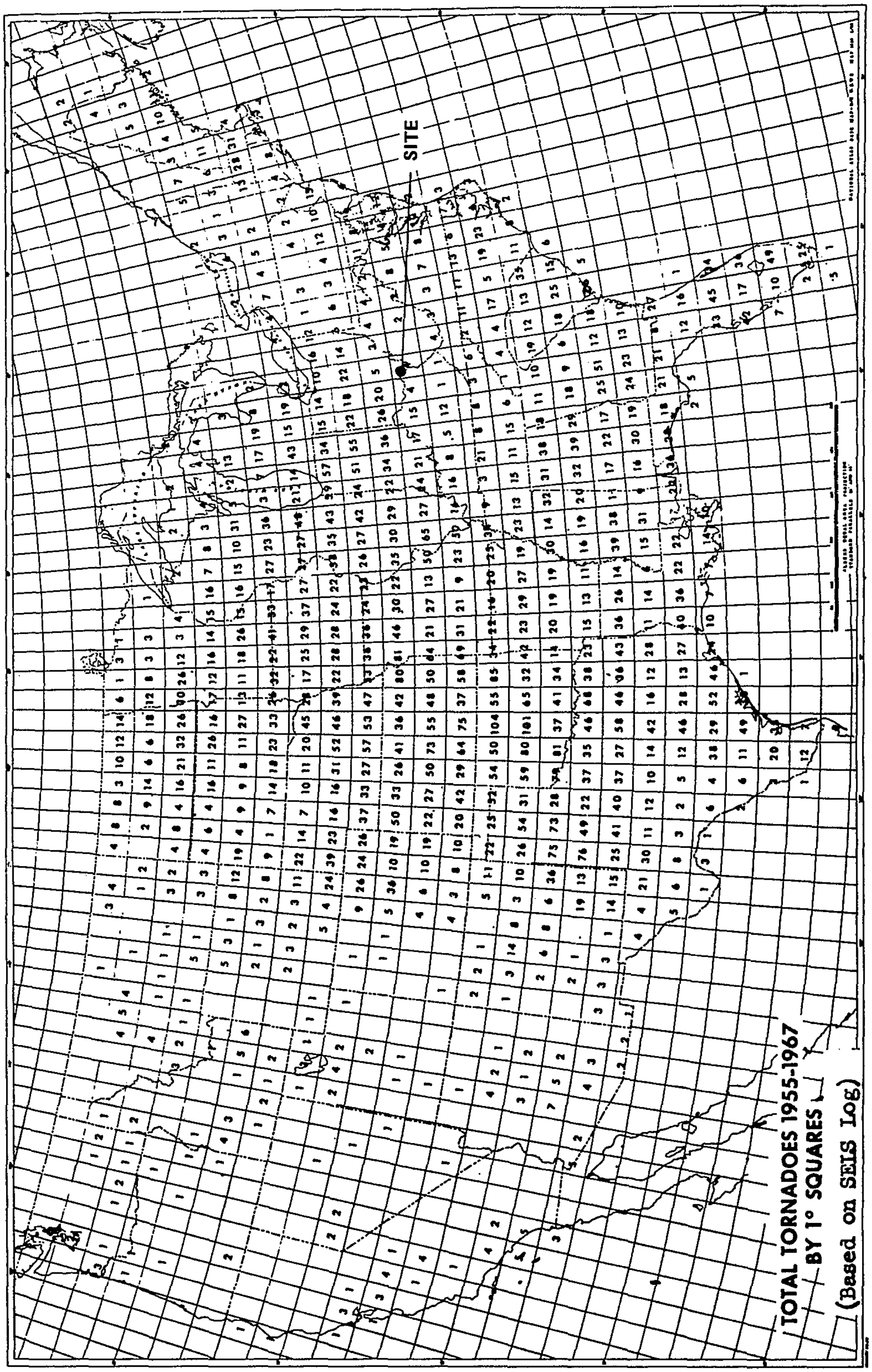


FIGURE 3.4-3 Total tornadoes 1955 - 1967 by 1° squares

3.5 BACKGROUND AMBIENT SOUND LEVELS

The proposed storage facility is located east of the center of Ironton at the abandoned Ironton Limestone Mine site (Figure 2.1-2). Oil from the storage facility will be transported by pipeline to Catlettsburg Terminal and then through Ashland's 24-inch pipeline (Figure 2.1-4). The proposed pipeline route passes through sparsely populated pastureland, woods and shrubs (see section 3.6). Nearby noise-sensitive land-use areas include the towns of Coal Grove and Catlettsburg.

Background ambient sound levels at the site and along the proposed pipeline route are estimated using data from measurements at a similar site (Dames & Moore, 1972) and published data relating ambient sound levels to population distribution (Galloway, 1973). Background ambient sound levels in terms of L_d (daytime), L_n (nighttime), and L_{dn} (day/night) (see Appendix D for definition of terms), are estimated at the following locations:

1. Center of site
2. City of Ironton
3. Pasture lands
4. Noise-sensitive land uses along pipeline route.

Results are presented in Table 3.5-1. Sound levels recommended by the EPA for protection of public health and welfare are presented in Appendix D.

TABLE 3.5-1 Summary of estimated background ambient sound levels - dB

	L_d	L_n	L_{dn}
Center of site	55*	45*	55*
City of Ironton	55	45	55
Pasturelands	45	35	45
Noise-sensitive land uses along the pipeline route	50	42	51

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*Background ambient sound levels; no activity on site.

3.6 BIOLOGY AND ECOLOGY

3.6.1 General Characterization of the Region

The Hill Country of Ohio includes that portion of the state which remained unglaciated during the last ice age. The Ironton Mine site and pipeline route are situated entirely within this unglaciated plateau of the Appalachian Plateaus, which are part of the larger Appalachian Highlands (Figure 3.6-1). The area is a highly dissected upland, underlain with nearly horizontal rock of the Pennsylvanian and Mississippian ages. Locally, the Ironton Mine is situated in low hills which are about 900 feet above sea level. The average relief in the area ranges from approximately 320 to 520 feet.

The unglaciated plateau section is classified as lying within the Cumberland and Allegheny Plateau section of the mixed mesophytic forest region by Braun (1947, 1950), Heffner (1939), and Küchler (1964). Core (1966) includes the area within the Western Hill section of the Central Hardwood Forest type. Wharton and Barbour (1973) consider the Ironton area to be situated within the Cumberland Plateau section (with regard to Kentucky lands adjacent to the site). The vegetation of this portion of Ohio and Kentucky is largely a monogeneous aggregation of species which have remained relatively undisturbed through glacial action (Clagg, 1959). Presently and historically, the most prominent influences on the vegetation of the unglaciated plateau section have been natural fires, disease and insect damage, and logging activities to obtain a source of charcoal for the numerous early iron furnaces of the area (Gordon, 1966, 1969). Land clearing for farming and grazing has influenced the valleys and gentle side slope areas. The more rugged, steep slopes of the area have been lumbered off since before 1876 (Crandall, 1876).

The hill country, of which the Ironton Mine site is a part, covers slightly more than 1/3 of Ohio's total land area. Commercial forest land accounts for 24 percent of 6,405,300 acres of land statewide. Within Lawrence County, well over 71 percent of the land area is in commercial forest production (208,100 acres out of 291,500). In 1968, the net volume of growing stock in the county, including softwoods and hardwoods, was 162.2 million cubic feet. Saw timber in 1968 accounted for 544.7 million board feet. (Kingsley and Mayer, 1970) Wayne National Forest, several miles to the north of the Ironton site, includes 160,000 acres, a significant portion of the total Lawrence County acreage.

The unglaciated plateau section of Lawrence County is composed predominantly of second-, third- and fourth-growth timber. There are virtually no old forest remnants remaining; however, individual old trees may be found in inaccessible areas which hindered or prevented their cutting. The predominant vegetation of the region is the oak-hickory forest association (Braun, 1950). The tree species of the area are generally widely spaced, with a canopy cover ranging from 10 to 35 percent.

The study area lies adjacent to the Ohio River in Lawrence County, Ohio and Boyd County, Kentucky. This region of the Ohio River is termed the Greenup Pool. Because of the hilly topography, numerous small streams drain directly into the Ohio River. The largest of these is Ice Creek, which drains approximately 38 square miles of Lawrence County. The larger size of this creek results from a prominent ridge, approximately 4 miles long, adjacent to the Ohio River.

The major tributary of the Greenup Pool is the Big Sandy River. It drains 2,280 square miles of northeastern Kentucky, 985 square miles of adjacent West Virginia, and 1,015 square miles of Virginia (Clay, 1975). Big Sandy also receives drainage from several small streams in the study area.

Industrial and urban development in the study area is restricted primarily to the flood plains of the various water courses. Residents in the flood plains of the small streams rely on septic tank-field line systems for sewage disposal. Nutrient enrichment of all surface waters within the area from point and nonpoint sources is common.

3.6.2 Mine Site and Pipeline Corridor

Land surrounding the Ironton Mine site includes residential development in the city of Ironton to the northwest, industrial development to the west, residential-urban development to the south, and rural-agricultural and forested lands to the north, east and southeast (Figure 2.1-2). The abandoned mine is situated on the southwestern portion of the property, with an abandoned cement plant to the southeast of the mine location (Figure 3.6-2). Areas in the vicinity of the mine site which are ecologically important include the mixed mesophytic forest vegetation (coves and slopes) and the upland hardwood vegetation, located generally to the north and east of the site (Figure 3.6-2).

The proposed 13.1-mile oil transport pipeline between the Ironton Mine site and the Catlettsburg Terminal (Figure 2.1-4) will pass through a variety of ecosystems, including industrial, residential-urban, forest, pasture and cropland, streams, and the Ohio River. Forest and croplands are the most prominant land-use activities along the pipeline corridor route.

3.6.2.1 Terrestrial Biology

Vegetation

Upland hardwood vegetation accounts for 28 percent (112.9 acres) of the 397 acres of land around the mine. Mixed mesophytic hardwood vegetation covers 35 percent, or 137.8 acres. The remaining 37 percent (146.2 acres) includes the abandoned mine site, concrete plant, two ponds, transmission line corridors, railroad right-of-way and roads on the property.

The upland hardwood vegetation is generally located north of the mine, extending from east to west generally above and following the 740-760-foot elevation (Figure 3.6-2). The upland hardwoods above this elevation are situated on side slopes, hills and ridgetops. Large-diameter stumps on the upland areas are evidence of past logging activities. Overstory development (saw timber and pole timber) is pronounced. The dominant overstory species include northern red oak, chestnut oak, and pignut hickory, with black locust subdominant. The remaining overstory species are identified in Table 3.6-1.

Understory vegetation of the upland hardwoods includes both shrub and herb layer forms. Species of importance include redbud, trumpet creeper, honeysuckle, wild rose, and wild raspberry (Table 3.6-2). Most of the vegetation in the upland areas is of the oak-hickory forest type, indicating that these areas are relatively dry (Little, 1953, 1971). Where openings occur in the overstory, there is a rich understory development creating a bushy-thicket type of cover. Many of the overstory and understory species provide forage for a wide variety of wildlife (Ohio Dept. Nat. Res., 1966).

The mixed mesophytic hardwood vegetation type in coves and on lower side slopes is generally below the 720-foot elevation (Tables 3.6-3 and 3.6-4). This vegetation is in the central portion of the mine site (Figure 3.6-2). Generally, the mixed mesophytic hardwood vegetation is characterized by more moist habitats than those of upland types. The vegetation association is dominated by many broad-leaved deciduous species with no individual species occupying the major dominant position. Basically, the mixed mesophytic hardwood type is a co-dominant association.

Topographically, the slopes are gently-to-moderately rolling with an undulating relief. As in the upland hardwood areas, there is evidence of past logging. During its operation, the Ironton Mine had very little influence on the mixed mesophytic hardwoods on the site. The most dominant of the overstory species is sycamore, followed closely by pignut and shagbark hickory, tulip tree, red and black oak. Additional subdominant species include red maple, box elder, dogwood, hawthorn, beech, cottonwood, sassafras, basswood and American elm (Table 3.6-3).

An extremely wide range of species (73) make up the understory vegetation (Table 3.6-4). The major species include field garlic, trumpet creeper, redbud, dogwood, hawthorn, honeysuckle, pokeweed, cottonwood, staghorn sumac, poison ivy, willow, sassafras, greenbrier, and red elm.

The successional pattern of both the upland hardwood and mixed mesophytic hardwood areas of the site have progressed to an intermediate successional position in which regeneration of the dominant species is occurring. With progressive overstory development, the overstory canopy will gradually close, thus causing a decrease in the productivity of the understory by shading and competition. Continued successional development along this pattern will probably follow the past history of vegetation development in the region (Braun, 1928).

The urban setting and steep, rugged topography which characterize the project area play an important role in determining the distribution and abundance of wildlife. The status of most wildlife species known to occur in the project area has not been quantified. Unless otherwise noted in the following text, the presence of most species at the mine site is based on the known range and habitat requirements of individual species, combined with the known available habitat. All scientific nomenclature relating to wildlife is presented in the tables following the discussion section.

Insects

No detailed insect studies of note have been conducted for the mine site. However, on the basis of the type of host vegetation found in the vicinity, certain insect species can be expected to occur on or near the site. A predominant tree species of the area is the northern red oak, which is host to the red oak borer, succulent oak gall, gypsy moth and pin oak saw fly. Pignut hickory is subject to infestation by the hickory bark beetle, hickory spiral borer, hickory shuckworm, twig pruner and hickory gall aphid. Black locust is subject to the locust borer, carpenter worm and locust twig borer. Sycamore is injured by the hardwood stump borer, powder post beetle, bagworm, sycamore tussock moth, and sycamore lace bug. Red maple is affected by the cambium borer, maple callus borer and maple leaf cutter. Boxelder is influenced by the boxelder twig borer, boxelder gall midge and spring cancerworm. Dogwood is host to the dogwood borer, twig girdler, dark tussock moth and Japanese weevil. Red and black oaks are affected by the gouty oak gall, ribbed bud gall and oak webworm.

Reptiles and Amphibians

At least 27 species of reptiles and 35 species of amphibians (Table 3.6-5) are expected to occur in the Huntington, Ashland and Portsmouth metropolitan area. The relative abundance of these species is presented in Table 3.6-5.

Turtles - One easter box turtle was found in pasture land along the proposed pipeline route during a site visit in May 1976. This species is essentially terrestrial, inhabiting moist ravines, woods and cultivated fields (Nixon, et.al., 1974; Conant, 1958). It is common in the region (Table 3.6-5) and a likely resident in the mine site area. The only other common species of turtles in the region are the common snapping turtle and stinkpot. Both species are aquatic, favoring ponds, streams, and rivers (Conant, 1958). The distribution of these two species in the site area is limited to the ponds at the mine site and the rivers and streams crossed by the proposed pipeline route. Both species of turtles probably achieve their greatest abundance in the region in the Ohio River.

Lizards - Only 4 species of lizards are likely to occur in the Huntington, Ashland, Portsmouth metropolitan region (Table 3.6-5). They are the northern fence lizard, ground skink, five-lined skink, and broad-headed skink. These lizards inhabit woodland areas and are likely inhabitants of the mine site and pipeline corridor. The second-growth woods, moist areas near ponds and seeps, and rock piles at the mine site are some of the preferred habitats for these species (Nixon, et al., 1974). The forest edge (along the existing power-line corridor), rock outcrops, and woodlands where the pipeline route crosses creeks and streams also provide good habitat for these lizards.

Snakes - At least a dozen species of snakes are common in the Huntington, Ashland and Portsmouth metropolitan area (Table 3.6-5). Pond and stream borders and moist seep areas provide suitable habitat at the mine site and along the pipeline route for the northern water snake and rough green snake. The rocky wooded hillsides and large rock outcrops which are present at the mine site provide preferred habitat for the northern red-bellied snake, northern ringneck snake, black rat snake, black king snake, eastern milk snake, and northern copperhead.

Salamanders - Nineteen species of salamanders are known to occur in southeast Ohio (Seibert and Brandon, 1960). Ten species have been recorded for Lawrence County, 5 of which are considered very common

(Seibert and Brandon, 1960). They are the red-spotted newt, red-backed salamander, slimy salamander, northern dusky salamander, and northern two-lined salamander. These species are wide-ranging, but all prefer moist habitats: adjacent to seeps, streams and ponds; in damp woods under logs and rocks; and along moist hillsides. Their distribution in the project area is probably affected by local topography. The lower elevations through which the creeks and streams run, where seeps drain and ponds and moist woods are found, provide the habitat for these species. Other salamanders, which are fairly common and also known to occur in Lawrence County, include the marbled salamander, ravine salamander, and long-tailed salamander (Seibert and Brandon, 1960). Both the marbled and ravine salamanders inhabit hilly regions and valley slopes which characterize the mine site and pipeline corridor. The long-tailed salamander is another brookside salamander, living under litter and rocks along streams (Nixon, et.al., 1974; Conant, 1958). The preferred habitat requirements of all these salamanders are satisfied in part within the project area; their regional status is common and all are likely inhabitants within the study area.

Frogs - During the May site visit, many of the ponds, seeps, and scattered ditches and crevices where water accumulates were full of immature frogs. Several species of frogs, all common in the Huntington, Ashland and Portsmouth metropolitan area (Table 3.6-5), are likely residents within the project area. They are: the northern spring peeper, eastern gray tree frog, mountain chorus frog, bullfrog, green frog, eastern wood frog, and pickerel frog. All of these species are dependent upon some source of water and therefore largely restricted in distribution to the ponds, seeps, ditches, creeks, and rivers. Some species such as the spring peeper, gray tree frog, and wood frog inhabit woodlands, but are not often found far from water. The limited number of ponds and wetland habitats at the mine site adversely affects the abundance of most frog species.

Toads - Both the American toad and Fowler's toad are likely residents of the mine site area and proposed pipeline corridor. The American toad can be found in all habitats while the Fowler's toad is more restricted, favoring sandy areas and river valleys (Conant, 1958). The local topography probably affects the distribution of the Fowler's toad, limiting it to the stream valleys and pond edges. The American toad may be found on the wooded hillsides, in stream valleys or in deserted buildings at the mine site. Both species of toad are common within the region (Table 3.6-5).

Birds

The bird population in the site vicinity, although diverse in total number of species (230), is not abundant due to limited habitat. The local topography makes farming impossible in most areas. Wetlands such as swamps and marshes are absent. Lakes and large rivers are extremely limited in the region. (The Ohio River receives heavy traffic and has highly developed banks used for industry.) The regional status of all species is presented in Appendix E. Ninety-five of the 230 species known to occur in the region have been observed during Audubon Christmas counts (Arbib, 1975) conducted near the project area.

Birds that have adapted to living around human habitations are common at the mine site and along the pipeline route. Among them are the common nighthawk, chimney swift, purple martin, mourning dove, rock dove, blue jay, common crow, American robin, starling, common grackle, cardinal, and song sparrow.

Typical common inhabitants of the second-growth timber, which is the most abundant habitat type in the region, include the ruffed grouse, red-bellied woodpecker, downy woodpecker, tufted titmouse, Carolina chicadee, Carolina wren, wood thrush, white-eyed vireo, and rufous-sided towhee.

Waterfowl (including shorebirds and wading birds) - Waterfowl are limited in the region due to an absence of suitable habitat. The mallard, black duck and woodduck are the major resident species; the remaining species are migrants (U.S. Army Corps of Engineers, 1975). The Ohio River, several larger streams, and a few scattered ponds provide the only suitable habitat for waterfowl in the project area. Woodducks are probably the most abundant residents, inhabiting the wooded banks along the larger streams. The redhead and lesser scaup are two migratory species which pause to rest on the Ohio River during their north and southbound flights each year. The highly developed industrial and population centers located on the river, along with the heavy river traffic, undoubtedly discourage water birds from using the river.

The woodduck, killdeer, and spotted sandpiper may inhabit the mine site and portions of the pipeline corridor. The killdeer may be found in the stream valleys where farming and grazing are practiced. Two spotted sandpipers were seen at the mine site in May along the margin of a small pond. The pied-billed grebe, green heron, and American coot are considered common in the region and may also inhabit the project area; herons, sandpipers, and plovers are less numerous in the region, but also possible as local residents.

Birds of Prey - Several turkey vultures were seen at the mine site and along the proposed pipeline corridor during the May site visit. This species is common in the region, and is often encountered soaring over the hills and valleys in search of carrion, its main staple. The red-tailed hawk and red-shouldered hawk are the only common hawks in the region which may inhabit the mine site. Both species are woodland inhabitants and may be encountered on the wooded slopes and in stream valleys. The American kestrel is also common in the region but is largely restricted to open farming country and is therefore not expected to occur near the mine site. The golden and bald eagle and osprey are among the largest predators in the region. Although the cliffs and rock outcrops overlooking the streams and rivers in the region provide suitable habitat for these species, records of their occurrence are few and scattered. These species are presently migrants in the region and are seen only occasionally during the spring and fall. The screech owl and barred owl are the only commonly occurring species of owls in the region. While the screech owl mainly inhabits the woodland edges of farmlands, the barred owl prefers woodlands along stream valleys and extensive swamps (Barbour, et.al., 1973). Both species may inhabit the mine site area, but are more likely to occur on the wooded hillsides and in the stream valleys along the pipeline route.

Upland Gamebirds - The ruffed grouse, American woodcock, bobwhite quail, and mourning dove are all common residents in the Huntington, Ashland, and Portsmouth metropolitan area. All 4 of these species are likely residents within the project area; however, their abundance varies considerably depending upon availability and suitability of habitat.

The second-growth timber and scattered openings at the mine site, and the wooded edge along the pipeline route provide suitable habitat for the grouse. The forestland in the region has a carrying capacity in the spring of 1 grouse per 20 to 30 acres (Tartar and others, 1974; U.S. Dept. of Agriculture, 1971). This level of abundance is probably not attained at the mine site or along the pipeline corridor due to the encroachment of urban development and other human pressures which have disrupted wildlife habitat.

Woodcocks are migrants in the area, preferring moist woodlands adjacent to seeps, ponds, and streams. Limited suitable habitat for this species is present at the mine site.

During the May site visit, bobwhite quail were heard in the stream valleys where cleared land for agriculture and pasture land was present. These habitat types are very restricted in the project area as a result of local topography; consequently, quail are very restricted in their distribution. It is unlikely that this species inhabits the mine site. The cleared land habitats in the region have a carrying capacity of 200 to 300 quail per square mile. Better habitat in Ohio will support 1 quail per 4 acres or better during the fall (Dotson and Griffith, 1969; Green, 1952).

Mourning doves were commonly observed during the site visit in May at the mine site and along the pipeline corridor. The dove co-exists well with man in agricultural and urban areas, which it requires for nesting and brood rearing (U.S. Army Corps of Engineers, 1975). Doves are reported to be very common in the project area (Jenkins, 1976), which appears to provide the right combination of required habitat types. The carrying capacity in the region on cleared-land habitats is an average of 3.3 pair of doves per 100 acres (Brooks, 1944). Capacities may now be higher as a result of increased urban areas and other cleared land habitats in the region.

Songbirds - Most of the songbirds common in the Huntington, Ashland, and Portsmouth metropolitan area are likely to occur at the mine site and along the proposed pipeline corridor. The woods and woodland edges of the mine site also provide suitable habitat for migrating warblers. Several species of warblers were sighted during the May visit, including the blue-winged warbler, yellow-throated warbler, prairie warbler, Kentucky warbler and American redstart.

Others - Many species of pigeons, goat suckers, swifts, and woodpeckers are common within the region and the project area. Rock doves and chimney swifts are very common at the mine site, particularly around the deserted buildings. Other common species which are likely site residents include the common nighthawk, common flicker, red-bellied woodpecker and downy woodpecker.

Mammals

At least 40 species of mammals are known to occur in the Huntington, Ashland, and Portsmouth metropolitan area. The status of these species is presented in Table 3.6-6. The mammals likely to occur in the project area can be categorized as small rodents, bats, fur-bearers, and game animals.

Small Rodents - The second-growth stands of timber and rock outcrops at the mine site and along the pipeline corridor provide good habitat for several woodland rodent species: the short-tailed shrew, eastern chipmunk, white-footed mouse and southern flying squirrel. The short-tailed shrew is found in every county in Ohio and has an average population density of 5 per acre (Keener, et al., 1975). The chipmunk is found particularly in deciduous forests, but also inhabits cutover lands and limestone outcrops. Populations in Ohio of 2 to 3 chipmunks per acre are common (Keener, et al., 1975). The white-footed mouse is one of the most common forest-inhabiting mammals in Ohio (Keener, et al., 1975). The project area provides ideal habitat conditions for this species.

The southern flying squirrel inhabits the deciduous forests and mixed hardwoods in the region. The average population density in Ohio is less than 2 per acre (Keener, et al., 1975).

The limited fields, fencerows, woodland borders and agricultural lands provide habitat for several cleared-land inhabiting rodents such as the least shrew, eastern mole, eastern harvest mouse, prairie deer mouse, and meadow mole. Although these species are unlikely residents of the mine site, they are common in the Huntington, Ashland, and Portsmouth metropolitan area (Table 3.6-6). Except for the eastern mole, all of these species are largely restricted to prairies, fields, and grasslands where grass species dominate the vegetative component. As a result, their distribution in the project area is spotty. Two introduced species, the Norway rat and house mouse, are also common in the region, particularly near deserted buildings at the mine site and near urban areas.

Bats - Bat species which are common in the Huntington, Ashland, and Portsmouth metropolitan area, and are likely to inhabit the mine site, include the little brown myotis, eastern pipistrelle and big brown bat (Table 3.6-6). Preferred habitats for these species in the project area include woodlands and woodland edges, rock crevices, and old buildings.

Fur-bearers - Signs of raccoon and opossum were observed at the mine site during the site visit in May. Both these species and the gray fox, which inhabits extensive forest areas, are reported to be common in the project area (Jenkins, 1976). Several other fur-bearers are likely to inhabit the streams, creeks and wooded banks of the project area; they are the muskrat, long-tailed weasel, and mink. Muskrat are reported to be common in the streams in the project area (Jenkins, 1976). Striped skunks can be found in the woodland margins near agricultural land where both natural and cultivated food products are available. The rock cliffs, outcrops and forested hilltops provide suitable habitat at the mine site and along the pipeline corridor for the bobcat; however, this species is considered very rare throughout most of Ohio and is an unlikely resident in the project area.

Game Animals - The most numerous and important game species in the region are the gray squirrel and cottontail rabbit (U.S. Army Corps of Engineers, 1975). The woodlands found at the mine site and along the pipeline corridor provide good habitat for the gray squirrel. The regional average carrying capacity for the deciduous woodlands is 1 to 2 squirrels per acre (Tarter and Taylor, 1974). A more common average is 1 squirrel per 2 to 4 acres (Ohio Dept. of Nat. Res., undated b). The fox squirrel, which also occurs in the region, is very restricted in distribution as a result of limited suitable habitat. This species favors the open forests and fencerows along pastures and cultivated fields (Barbour and Davis, 1974). Rabbits are also common in the project area (Jenkins, 1976). They prefer the cleared-land habitats, particularly field borders, oldfields, pastures, brushy areas, and urban locations. Suitable habitat for this species at the mine site is limited. The average carrying capacity for cleared-land habitats in the region for rabbits is 1 to 3 animals per acre in good range, 5 to 6 per acre under ideal conditions (Tarter and others, 1974; U.S. Dept. of Agriculture, 1971).

Signs indicating the presence of the white-tailed deer near the mine site were observed during the site visit in May. Local game protectors have indicated that the white-tail is fairly common in the project area (Jenkins, 1976; Redwine, 1976). The second-growth timber, woodland edges and scattered agricultural areas provide fair habitat for white-tails in the project area. The regional average carrying capacity for white-tails in deciduous forests is 1 deer per 200 acres or less on good range in eastern Ohio (Tarter and Taylor, 1974). The deer population in the Ironton district has increased over the last 5 years (Jenkins, 1975).

3.6.2.2 Aquatic Biology

Pond Habitats

Water resources on the mine property include 2 ponds (Figure 2.1-2). Both ponds were formed by dams of concrete aggregate material. The smaller pond was created by a 10- to 12-foot dam and covers approximately 1.1 acres. Dense vegetation around the pond results in good shoreline cover. This cover diminishes wind action which results in very clear water.

Selected water quality parameters of the smaller pond were measured around 10:00 EDT on 6 May 1976 and are as follows:

Air Temperature	$21^{o}C$
Water Temperature	$18^{o}C$
Specific Conductance	700 microhms/cm
pH	8.3
Dissolved Oxygen	13.2 mg/l

Specific conductance is quite high and indicates the potential for dissolved solids to be outside the range for supporting a diverse aquatic community (National Academy of Sciences and National Academy of Engineering, 1972). Dissolved oxygen values were supersaturated, which indicates significant algal activity. This activity could have been stimulated by nutrients released from the sediment during spring overturn.

The other pond on the mine site was created by an 8- to 10-foot dam and covers approximately 1.6 acres. Water clarity is reduced slightly by wind action as shoreline cover is limited to the southwest side. Selected water quality parameters were also measured at this pond on 6 May 1976. They were as follows:

Air Temperature	$21^{o}C$
Water Temperature	$18^{o}C$
Specific Conductance	460 microhms/cm
pH	7.7
Dissolved Oxygen	7.6 mg/l

These values suggest that the larger pond has more acceptable water quality based on the limited number of parameters measured. Specific conductance was lower and dissolved oxygen values were not supersaturated. Higher levels of turbidity probably suppress algal activity and thereby prevent supersaturation of dissolved oxygen.

Stream Habitats

The Ironton Mine site is located in an area divided by numerous small drainage basins. These basins are made up of 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 form a second-order stream. Two second-order streams meet to form one third-order, and so forth. Downstream tributaries of an order lower than that of the receiving stream do not increase the order of that stream. In the study area, the first-order streams are very small (approximately 3 feet wide and 4 to 6 inches deep). The second-order streams are larger and average 10 feet wide, 1.5 feet deep. Ice Creek is the only third-order stream in the study area. It is approximately 20 feet wide, with a highly variable depth of 0.5 to 3 feet.

Within the study area, stream substrate type varies with stream order and between streams on the Kentucky and Ohio sides of the river. Stream substrates on the Ohio side are composed of rock and large gravel in first-order streams, large gravel and sand in second-order streams, and small gravel and sand in the third-order stream. Sand also becomes the dominant substrate type in second-order streams as they enter the Ohio River flood plain. Because of the porous nature of the alluvial soil, two factors determine flow in the second-order streams: headwater flow and the level of the Ohio River. During a May survey, no flow was detected in the second-order streams that transversed the Ohio River flood plain.

Stream substrates on the Kentucky side of the Ohio River are dominated by mud and silt at all stream order levels. However, gravel riffle areas do exist. More intensive land clearing in these drainage basins is the likely cause for the change in substrate characteristics.

Selected water quality parameters were measured in the small streams in the study area on May 6 and 7, 1976. Specific conductance was measured with a YSI model 33 SCT meter. A YSI model 51 D.O. meter was used for dissolved oxygen. A Taylor Instruments slide comparitor was used for pH measurements. The ranges for the measured parameters were as follows:

Air Temperature	14-22°C
Water Temperature	16-20°C
Specific Conductance	360-490 microhms/cm
pH	7.1-8.1
Dissolved Oxygen	8.0-10.4

Dense algal growths and supersaturated dissolved oxygen values indicate primary production is elevated in these streams. Effluent from septic tanks and activities associated with agriculture probably stimulated these high values.

Benthic Fauna

Benthic macroinvertebrate data from the numerous small streams within the study area are limited to observations of lower Ice Creek by personnel of the Ohio Department of Natural Resources (DNR). The observations were made while sampling fish in 1972 and 1975. Crayfish were termed abundant in 1972 and 1975. The presence of caddisflies was reported in 1975.

Harrel and Dorris (1968) have correlated species diversity of benthic macroinvertebrate communities with stream order. They observed that diversity increases with stream order up to fifth-order streams, and then decreases. This phenomenon is an expression of the associated increase and decrease in habitat diversity. Because the study area streams are primarily first- and second-order streams, diversity should be low. This is not meant to imply that the number of individuals will remain low, for this condition is generally governed by the available nutrient levels. Nutrient levels should be high, based on the use of septic tanks by stream basin residents and runoff from agricultural activities. On the basis of this assumption, the number of individuals could be expected to exceed 100 per square foot and be dominated by oligochaetes and chironomid larvae.

Benthic macroinvertebrates of the lower Big Sandy River should be similar to those collected by the U.S. Environmental Protection Agency in the Ohio River Greenup Pool in 1963, 1965, 1966, and 1967 (Mason, et.al., 1971). EPA collected benthic macroinvertebrates by both grab and basket (artificial substrate) samplers. Grab samples were dominated by pollution-tolerant and facultative oligochaetes and chironomid larvae. Also, insect larvae of facultative and pollution-sensitive mayflies, caddisflies and certain midges were present. Basket samples contained similar taxa, the one exception being the almost total absence of the oligochaete group.

Fish

The U.S. Army Corps of Engineers (1975) summarized fishery investigations in a six-county region, composed of Scioto and Lawrence Counties in Ohio, Cabell and Wayne Counties in West Virginia, and Boyd and Greenup Counties in Kentucky. The major tributaries of the Ohio River within this region include the Big Sandy and Scioto Rivers. Appendix F contains the U.S. Army Corps of Engineers (1975) summary, which provides a description of relative abundance of fishes in the region. All of the aquatic habitat present in this inventory of the region is not represented within the study area. Therefore, of the 107 species listed in Appendix F, only about 70 species are likely to occur in the study area. Of these, more than half will be present in the Ohio and Big Sandy Rivers.

Information on abundance and biomass of fishes in the Ohio River Greenup Pool is presented in Table 3.6-8. Of the species listed, 4 were not listed as present within the region by the U.S. Army Corps of Engineers (1975): the alewife, northern pike, orangespotted sunfish, and redear sunfish. Clay (1975) substantiates the presence of all the above species except the alewife. He reports only one species of the genus to which the alewife belongs as currently being present in Kentucky waters, which include the Ohio River: the skipjack herring.

Only the lower 2.6 miles of the Big Sandy River lie within the study area. Fishes in that stretch should be the same as those reported for the Ohio River (Table 3.6-8).

Data on the fishes of the numerous small streams in the area are restricted to samples taken by the Ohio DNR in the lower portion of Ice Creek (Tables 3.6-9 and 3.6-10). Their sampling was limited to a short stretch of the creek, only middle to late summer sampling, and the use of only one type of sampling gear. Therefore, this species list probably does not represent a complete list of fishes which inhabit Ice Creek. However, the presence of the creek chub, common shiner, and bluntnose minnow are an indication of no more than minor pollution in lower Ice Creek (Krumholz and Minckley, 1964). Dissolved oxygen data collected by Ohio DNR personnel were more than adequate to support a diverse fish fauna.

Fish species diversity based on stream order can be used to supplement fishing data of the Ohio DNR in estimating the fishery resources within the study area. Kuehne (1962) sampled numerous primary-order streams in the Buckhorn Creek watershed, a part of the Kentucky River drainage. The results of his June 22 to July 22, 1959 sampling are presented in Table 3.6-11. He reported only one species as being present in first-order streams; second-order streams contained a maximum of 9 species with almost equal representation of minnows and darters. Of the 9 species, 5 were termed rare in abundance. Third-order streams supported a more diverse population. In the 6 third-order streams sampled, a total of 17 species were collected. However, 13 was the maximum number collected at a single site. Of the total 17 species collected, 12 were rare in abundance. Creek chub was the only abundant species in third-order streams.

Neither Kuehne (1962) nor the Ohio DNR data confirmed the use of headwater streams as spawning sites for such species as the sucker family (Breder and Rosen, 1966). However, the small tributary streams within the site are probably used as a retreat from the Ohio River flood water, and thereby play at least a minor role in supporting the regional fishery resource.

3.6.3 Ecology

Every species of plant and animal is important to the overall interrelations found in an ecosystem. The Ironton site is an important component of a larger forested ecosystem. For that reason, the great diversity in flora and fauna found at the site is a significant resource, which is important to the mainstream of balance within the regional ecosystem.

The association 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 regional ecological associations near the Ironton Mine site is presented on Figure 3.6-4. This diagram gives a brief summation of the biological components of the region. The

"Pyramid of Biomass" (Figure 3.6-5) shows diagrammatically the various trophic levels, their relative contribution (qualitatively) to the total biomass of the system, and the influence of natural and man-made stresses on any or all levels of the pyramid.

3.6.3.1 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 DeKalb and Latham-Gilpin soils on hills in the site area, serve as the foundation for the "Pyramid of Biomass." These soils have not been significantly altered by man in hill and ridge areas. Within the site, the DeKalb soils have been graded and removed over a period of years in the vicinity of the mine and building complexes.

3.6.3.2 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 Ironton region such as acorn, beech, locust, tuliptree, mulberry, sycamore, elm, greenbrier, smooth sumac, maple seed, raspberry, strawberry, black walnut, and wild rose, 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 canopy clearings, pastures, croplands 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 that frequent these habitats.

3.6.3.3 Invertebrates

Invertebrates, especially insects, are an integral and essential component of every terrestrial ecosystem on the earth, and are abundant in the Ironton area. 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 the regional 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.

3.6.3.4 Amphibians and Reptiles

Many of the smaller reptiles and amphibians of the site region prey on insects. The five-lined skink and the ground and fence lizard, which may inhabit the forested areas, woodland edges and brushy area of the region, feed mainly on insects and other small invertebrates (Nixon, et al., 1974). Frogs and toads, which may occur near the ponds and seeps, and along the streams and creeks, are also largely insectivorous.

The grassy areas, pastures and oldfields may be inhabited by various species of snakes which often prey on small rodents. The garter and rat snakes may inhabit both the oldfield and wooded areas. The rat snake eats small mammals, lizards, skinks, baby birds--almost anything available, while the garter snake feeds on smaller prey such as earthworms, slugs, insects and small rodents (Nixon, et al., 1974).

The reptiles and amphibians are, in turn, prey to a number of larger species, such as hawks, crows, gray foxes, raccoons, minks, and many others.

3.6.3.5 Birds

A diverse community of bird species is likely to inhabit the site region. Some birds, like the white-throated, field and song sparrows, eat seeds and grains that are available in weed fields and various agricultural lands. Other birds are largely insectivorous, like the downy woodpecker, yellow warbler, cardinal, and red-eyed vireo. These birds may inhabit the woodlands or the field borders and fencerows. Predatory birds, like the red-tailed and red-shouldered 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 plan an important part in the dispersal of vegetative seeds, especially weed seeds. They contribute to the natural succession of vegetative communities.

3.6.3.6 Mammals

Mammal species of the site region are fairly diverse in number, yet restricted in distribution by the local topography. The short-tailed shrew and least shrew are regional residents (U.S. Army Corps of Engineers, 1975) which inhabit the woodlands and fields, respectively. The short-tailed shrew feeds on whatever is available, but definitely prefers animal matter. The least shrew feeds on a variety of plants and animals. Favored foods include beetles, bugs, crickets, grasshoppers, earthworms and snails (Barbour and Davis, 1974).

Most rodents are herbivorous, although some consume small amounts of animal matter. The white-footed mouse, a known regional resident, is a granivorous species, while the prairie vole, which probably inhabits the oldfields, feeds exclusively on grasses. The cottontail rabbit consumes a variety of herbaceous plant parts and agricultural products. During the winter, when snow covers the ground, the rabbits rely on the bark of trees and shrubs (Barbour and Davis, 1974). The white-tailed deer, a fairly common regional resident, is a browser that feeds on twigs and shrubby vegetation. The opossum, raccoon, and striped skunk feed upon a variety of plant and animal foods. All of these species are common within the region, inhabiting woodlands, stream banks, and farming country (U.S. Army Corps of Engineers, 1975).

Regional species which are largely carnivorous include the gray fox, bobcat, long-tailed weasel, and mink. Prey species for these animals range from opossum and rabbits to the smallest rodents, birds, reptiles and amphibians. Most of the top carnivores are preyed on only by man.

3.6.3.7 Man

Man is generally designated as a secondary or tertiary consumer and, as such, is found on the highest trophic level on the "Pyramid of Biomass." 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.

3.6.4 Rare, Threatened, and Endangered Species

3.6.4.1 Vegetation

The threatened and endangered plant species in Ohio and Kentucky are listed in Tables 3.6-12 through 3.6-15. Two of the plants observed at the site are listed as threatened by the state of Ohio (Department of Natural Resources, undated). They are the red trillium and the bloodroot. However, none of the species observed at the site were listed as rare or endangered in the unglaciated plateau section of Ohio or Kentucky (Ohio DNR, undated a; Kentucky Academy of Science, 1973). None of the recorded plant species appear in House Document No. 94-51 (Ripley, 1974) or in the Federal Register (1975).

3.6.4.2 Wildlife

The only species presently on the Federal Register's list of endangered fauna that could conceivably occur at the site is the Indiana bat (U.S. Federal Register, 1975). This species is nearly extinct in Ohio (Smith, et al., 1973). No records of its occurrence at the mine site are known to exist.

Several species of wildlife considered rare and/or endangered by the states of Ohio and Kentucky could inhabit the mine site area (Table 3.6-7). The only mammal on the lists is the bobcat. No recent sightings of it or any other rare or endangered wildlife have been recorded at the mine site, however.

Of the 15 species of birds listed as rare or endangered, most are unlikely site residents due to the lack of suitable habitat. The least bittern and short-billed marsh wren are mainly marsh species; the hooded merganser is a winter resident in the area (Barbour, 1971), but inhabits large rivers and impoundments; the pine warbler is a common summer resident in the Cumberland Mountains (Barbour, 1971), but inhabits pine stands; and the loggerhead strike prefers broad expanses of open country and is rarely seen in woods (Barbour, 1971).

The barn owl and Bewicks' wren have limited suitable habitat available to them in the project area and therefore have some chance of being found there. Bewicks' wren prefers farmlands and small towns; the barn owl inhabits open country, barns, old buildings, and towers (Barbour, 1971). The golden eagle, bald eagle, and osprey are all classed as migrants in the project area. Records for the golden and bald eagles are scattered and limited to migration periods. The osprey is a more likely site visitor as it is a consistent migrant in the region and has a known breeding site in Wayne County, West Virginia.

Species including the sharp-skinned hawk, Cooper's hawk, orchard oriole, prothonotary warbler, and northern parula have considerable suitable habitat available to them in the project area and therefore are more likely to occur there than most of the listed species. The sharp-skinned and Coopers hawk are woodland species; the orchard oriole inhabits forest edge, farms, and shady roadsides; prothonotary warblers inhabit riparian areas along creeks, streams, and wooded swamps; and the northern parula prefers mature stands of mixed mesophytic woodlands.

The false map turtle is the only reptile listed among the rare and endangered wildlife. This species may inhabit the larger streams that empty into the Ohio River in eastern Kentucky, but it is at the edge of its range in Ohio and therefore not a likely site resident.

3.6.4.3 Fish

A listing of the rare and endangered fishes likely to occur within the site area is presented in Table 3.6-16. Only one species, the tippecanoe darter, is considered rare in both states. No aquatic species of rare or endangered status could have withstood the habitat change from a first-order stream to a pond. Therefore, the presence of rare or endangered species in the two mine site ponds is extremely unlikely.

3.6.5 Commercially Important Species

Vegetation of commercial importance at the site is limited to tree species. Saw and pole timber which is present on the site and of commercial value includes: boxelder, red maple, hickory species, hackberry species, American beech, white ash, honey locust, black walnut, sycamore, black cherry, chestnut oak, northern red oak, sassafras, basswood and American elm (Kingsley and Mayer, 1970).

The only commercially important wildlife species in the mine site area are the fur-bearers. The most likely fur-bearing mine site residents include the gray fox, raccoon, opossum, striped skunk, mink, muskrat, and long-tailed weasel.

A limited commercial fishery is believed to exist in the Ohio 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.

3.6.6 Recreationally Important Species

Several species of wildlife inhabiting the region afford recreation to hunters, trappers, and bird watchers. Those wildlife species which are hunted include the gray and fox squirrel, cottontail rabbit, white-tailed deer, mourning dove, woodcock, ruffed grouse, and several species of waterfowl. Species sought by trappers include the raccoon, gray fox, muskrat, mink, long-tailed weasel, opossum, and striped skunk. As a result of the rapidly growing pastime of bird watching, all species of birds may also be considered as recreationally important.

The Ohio River and Big Sandy River are the primary sport fishing waters within the study area. Species of interest include carp, drum, sauger, channel, and flathead catfish. Within the study area the small streams offer sport at least seasonally for bream and suckers fishing.

TABLE 3.6-1 Upland hardwood overstory vegetation of the Ironton Mine site

Scientific Name	Common Name	Remarks
Acer rubrum L.	Red Maple	
Acer negundo L.	Boxelder	In drainageways
Canya ovata (Mill) K. Koch	Shagbark Hickory	
Celtis occidentalis L.	Hackberry	Valuable wildlife species
Crataegus spp.	Hawthorn	
Fagus grandifolia Ehrh.	Beech	
Gleditsia triacanthos L.	Honey Locust	
Juglans nigra L.	Black Walnut	Valuable veneer & furniture species
Liriodendron tulipifera L.	Tuliptree	
Morus rubra L.	Mulberry	Valuable forage species for wildlife
Platanus occidentalis L.	Sycamore	
Prunus serotina Ehrh.	Black Cherry	Good forage & veneer species
Quercus borealis Mich x.	Northern Red Oak	
Quercus macrocarpa Mich x.	Bur-Oak	
Quercus palustris Muenchh	Pin Oak	
Quercus prinus L.	Chestnut	
Robinia pseudoacacia L.	Black Locust	
Ulmus americana L.	American Elm	

Compiled during May 1976 field investigation.

TABLE 3.6-2 Upland hardwood understory and ground cover vegetation of the Ironton Mine site

Scientific Name	Common Name	Remarks
Achillea millefolium L.	Yarrow	
Agrostis alba L.	Red Top	In open areas
Asclepias syriaca L.	Common Milkweed	In cleared pastures & vacant land
Campsis radicans (L.) Seem	Trumpet Creeper	
Cercis canadensis L.	Redbud	
Dipsacus sylvestris Huds	Teasel	
Eragrostis spectabilis (Pursh) Steud.	Purple Love Grass	
Festuca obtusa Biehler	Nodding Fescue	
Lonicera japonica Thunb.	Japanese Honeysuckle	
Panicum lanuginosum L.	Panic Grass	
Parthenocissus quinquefolia (L.) Planch.	Virginia Creeper	As a vine or liana in wooded sites
Poa pratensis L.	June Grass	
Rosa carolina L.	Wild Rose	
Rubus odoratus L.	Wild Raspberry	
Trifolium repens L.	Clover	
Verbascum thapsus L.	Mullein	

Compiled during May 1976 field investigation.

TABLE 3.6-3 Mixed mesophytic overstory vegetation of the Ironton Mine site

Scientific Name	Common Name	Remarks
Acer rubrum L.	Red Maple	
Acer negundo L.	Boxelder	Prominent in drainageways
Aesculus hippocastanum L.	Horsechestnut	
Albizzia julibrissin Durazzini	Albizzia	
Carya glabra Mill.	Pignut	
Carya ovata (Mill.) K. Koch	Shagbark Hickory	Valuable strong wood
Catalpa bignonioides Walt.	Catalpa	In waste places
Cercis canadensis L.	Redbud	
Cornus florida L.	Flowering Dogwood	
Cornus alternifolia L.	Alternate-leaf Dogwood	
Crataegus spp.	Hawthorn	
Fagus grandifolia Ehrh.	Beech	Used in manufacture of clothespins & other wooden wares
Liriodendron tulipifera L.	Tuliptree	
Platanus occidentalis L.	Sycamore	Common on cove slopes
Populus deltoides Marsh.	Common Cottonwood	
Quercus rubra L.	Red Oak	
Quercus velutina Lam.	Black Oak	
Sassafras albidum (Nutt.) Nees	Sassafras	
Tilia americana L.	Basswood	
Ulmus americana L.	American Elm	

Compiled during May 1976 field investigation.

TABLE 3.6-4 Mixed mesophytic understory and ground cover vegetation of the Ironton Mine site

Scientific Name	Common Name	Remarks
Acer negundo L.	Boxelder	
Acer rubrum L.	Red Maple	Around water margins
Agrostis alba L.	Red Top	
Agrostis hyemalis (Walt.) BSP	Bentgrass	Canopy openings & edges
Allium canadense L.	Wild Garlic	
Allium vineale L.	Field Garlic	
Andropogon gerardi Vitman	Big Bluestem	
Andropogon scopanius Michx	Little Bluestem	Field openings
Aralia spinosa L.	Devil's-Walking Stick	
Asimina triloba (L.) Dunal	Pawpaw	
Bidens vulgata Greene	Common Beggar-Ticks	
Campsis radicans (L.) Seem	Trumpet Creeper	
Carya glabra (Mill.)	Pignut	
Cercis canadensis L.	Redbud	
Cirsium discolor Muhl.	Field Thistle	Clearings & meadows
Claytonia caroliniana Michx.	Spring Beauty	
Convolvulus sepium L. Willd.	Morning Glory	
Coreopsis major Walt.	Wood-Tickseed	
Cornus alternifolia L.f.	Alternate-Leaf Dogwood	
Cornus florida L.	Flowering Dogwood	
Crataegus spp.	Hawthorn	In wooded thickets & margins
Cyperus spp.	Sedge	Along streambanks & standing water
Daucus carota L.	Wild Carrot	
Digitaria ischaemum (Schreb.)	Smooth Crabgrass	
Dipsacus sylvestris Huds.	Wild Teasel	
Elymus villosus Muhl.	Wild Rye	
Equisetum arrense L .	Common Horsetail	Stream & pond edges
Eupatorium purpureum L.	Joe-Pye-Weed	
Festuca obtusa Biehler	Nodding Fescue	In edges
Fragaria virginiana Duch	Strawberry	
Fraxinus americana L.	White Ash	Openings

TABLE 3.6-4 Continued

Scientific Name	Common Name	Remarks
Geum canadense Jacq.	White Avens	Openings
Gleditsia triacanthos L.	Honey Locust	
Juniperus virginiana L.	Red Cedar	Limestone outcrops
Lactuca villosa Jacq.	Field Lettuce	
Lonicera japonica Thunb	Japanese Honeysuckle	
Medicago sativa L.	Alfalfa	Field borders, pastures
Melilotus officinalis (L.) Lam	Yellow Melilotus	
Panicum anceps Michx	Panic Grass	
Panicum lanuginosum L.	Panic Grass	
Panicum latifolium L.	Panic Grass	
Phlox maculata L.	Sweet William	In coves & wet slopes
Phytolacca americana L.	Pokeweed	
Plantago aristata Michx.	Bracted Plantain	
Platanus occidentalis L.	Sycamore	
Populus deltoides Bartr.	Cottonwood	Moist places
Populus tremuloides Michx.	Aspen	
Potamogeton foliosus Raf.	Pondweed	
Prunus virginiana L.	Choke Cherry	
Pycnanthemum flexosum (Walt.) BSP	Mountain Mint	
Pyrus coronaria L.	Wild Crab	
Ranunculus recurvatus L.	Hooked Crowfoot	
Rhus glabra L.	Smooth Sumac	
Rhus radilans L.	Poison Ivy	
Rhus typhina L.	Staghorn Sumac	
Rosa carolina L.	Wild Rose	
Rubus odoratus L.	Flowering Raspberry	
Salix interior Rowlee	Sandbar Willow	

TABLE 3.6-4 Continued

Scientific Name	Common Name	Remarks
Sanguinaria _canadense_ L.	Bloodroot	
Sassafras _albidum_ (Nutt.) Nees	Sassafras	
Smilax _glauca_ Walt.	Sawbrier	
Smilax _hispida_ Muhl.	Bristly Greenbrier	
Smilax _rotundifolia_ L.	Greenbrier	
Solanum _carolinense_ L.	Horse Nettle	
Solanum _rostratum_ Dunal.	Buffalo-bur	
Solidago _canadensis_ L.	Canada Goldenrod	
Sparganium _americanum_ Nutt.	Bur-reed	
Sysymbrium _officinalis_ (L.) Scop.	Hedge Mustard	
Taraxacum _officinale_ Weber	Common Dandelion	
Trifolium _repens_ L.	White Clover	
Trillium _erectum_ L.	Red Trillium	
Typha _latifolia_ L.	Cat-tail	
Ulmus _americana_ L.	American Elm	
Ulmus _rubra_ Muhl.	Red Elm	
Verbascum _thapsus_ L.	Common Mullein	
Vitis _labrusca_ L.	Fox-grape	

Compiled during May 1976 field investigation.

TABLE 3.6-5 Amphibians and reptiles likely to occur in the Ironton Mine site region[1]

Scientific Name	Common Name	Status[2]
Cryptobranchus alleganiensis alleganiensis (Daubin)	Hellbender	C
Ambystoma jeffersonianum (Green)	Jefferson Salamander	U
A. maculatum (Shaw)	Spotted Salamander	C
A. opacum (Gravenhorst)	Marbled Salamander[3]	C
A. texanum (Matthes)	Small-mouthed Salamander	N.A.
Notophthalmus viridescens viridescens (Rafinesque)	Red-spotted Newt[3]	C
Desmognathus fuscus fuscus (Rafinesque)	Northern Dusky Salamander[3]	C
D. monticola monticola (Dunn)	Appalachian Seal Salamander	U
D. ochrophaeus ochrophaeus (Cope)	Allegheny Mountain Salamander	U
Plethodon cinereus cinereus (Green)	Red-backed Salamander[3]	U
P. glutinosus glutinosus (Green)	Slimy Salamander[3]	C
P. richmondi richmondi (Netting & Mittleman)	Ravine Salamander[3]	C
Hemidactylium scutatum (Schlegel)	Eastern Four-toed Salamander	U
Gyrinophilus porphyriticus porphyriticus (Green)	Northern Spring Salamander	C
G. porphyriticus duryi (Weller)	Kentucky Spring Salamander	C
Pseudotriton montanus diastictus (Bishop)	Midland Mud Salamander[3]	C
P. ruber ruber (Sonnini)	Northern Red Salamander	C
Aneides aeneus (Cope and Packard)	Green Salamander[3]	R
Eurycea bislineata bislineata (Green)	Northern Two-lined Salamander[3]	C
E. longicauda longicauda (Green)	Long-tailed Salamander[3]	C
E. lucifuga (Rafinesque)	Cave Salamander	R

TABLE 3.6-5 Continued

Scientific Name	Common Name	Status
Necturus maculosus maculosus (Rafinesque)	Mudpuppy	C
Scaphiopus holbrooki holbrooki (Harlan)	Eastern Spadefoot	U
Bufo americanus americanus (Holbrook)	American Toad[3]	C
B. woodhousei fowleri (Hinckley)	Fowler's Toad[3]	C
Acris crepitans crepitans (Baird)	Northern Cricket Frog	C
A. crepitans blanchardi (Harper)	Blanchard's Cricket Frog	U
Hyla crucifer crucifer (Wied)	Northern Spring Peeper[3]	C
H. versicolor versicolor (LeConte)	Eastern Gray Tree Frog[3]	C
Pseudacris brachyphora (Cope)	Mountain Chorus Frog[3]	C
Rana catesbeiana(Shaw)	Bullfrog[3]	C
R. clamitans melanota (Rafinesque)	Green Frog	C
R. sylvatica sylvatica (LeConte)	Eastern Wood Frog[3]	C
R. pipiens pipiens (Schreber)	Northern Leopard Frog	U
R. palustris (LeConte)	Pickerel Frog[3]	C
Chelydra serpentina serpentina (Linnaeus)	Common Snapping Turtle[3]	C
Sternotherus odoratus (Latrielle)	Stinkpot[3]	C
Terrapene carolina carolina (Linnaeus)	Eastern Box Turtle[3]	C
Graptemys geographica (LeSueur)	Map Turtle	R
G. pseudogeographica (Gray)	False Map Turtle	R
Chrysemys picta marginate (Agassiz)	Midland Painted Turtle	C
Trionyx muticus (LeSeuer)	Smooth Softshell	U
Trionyx spinifera spinifera (LeSueur)	Eastern Spiny Softshell	C

TABLE 3.6-5 Continued

Scientific Name	Common Name	Status
Sceloporus undulatus hyacinthinus (Green)	Northern Fence Lizard[3]	C
Lygosoma laterale (Say)	Ground Skink[3]	C
Eumeces fasciatus (Linnaeus)	Five-lined Skink[3]	C
E. laticeps (Schneider)	Broad-headed Skink[3]	U
Agkistrodon contortrix mokeson (Daudin)	Northern Copperhead[3]	C
Crotalus horridus horridus (Linnaeus)	Timber Rattlesnake	U
Natrix sipedon sipedon (Linnaeus)	Northern Water Snake[3]	C
Storeria occipitomaculata occipitomacualata (Storer)	Storer Northern Red-bellied Snake[3]	C
Heterodon platyrhinos platyrhinos (Latreille)	Eastern Hognose Snake	C
Thamnophis sirtalis sirtalis (Linnaeus)	Eastern Garter Snake	C
Diadophis punctatus edwardsii (Merrem)	Northern Ringneck Snake[3]	C
Carphophis amoenus amoenus (Say)	Eastern Worm Snake	C
Coluber constrictor constrictor (Linnaeus)	Northern Black Racer	C
Opheodrys aestivus aestivus (Linnaeus)	Eastern Rough Green Snake[3]	C
Elaphe obsoleta obsoleta (Say)	Black Rat Snake[3]	C
Haldea valeriae valeriae (Baird & Girard)	Eastern Earth Snake	U
Lampropeltis getulus niger (Yarrow)	Black King Snake[3]	C
L. doliata triangulum (Lacepede)	Eastern Milk Snake[3]	C

TABLE 3.6-5 Continued

Scientific Name	Common Name	Status
Regina septemvittata (Say)	Queen Snake	R

---

[1] Source: U.S. Army Corps of Engineers Topographic Laboratories, 1975, Environmental Resources Inventory of the Metropolitan Region of Huntington, West Virginia, Ashland, Kentucky, and Portsmoith, Ohio.

[2] Status:
C - Common
U - Uncommon
R - Rare
N.A. - Not Available

[3] These species have been recorded for Lawrence County, Ohio.

TABLE 3.6-6 Mammals likely to occur in the Ironton Mine site region[1]

Scientific Name	Common Name	Status[2]
Didelphis virginiana	Virginia opossum	C
Sorex cinereus	Masked shrew	R
Sorex fumeus	Smoky shrew	U
Blarina brevicauda	Short-tailed shrew	C
Cryptotis parva	Least shrew	U
Parascalops breweri	Hairy-tailed mole	C
Scalopus aquaticus	Eastern mole	C
Myotis lucifugus	Little brown myotis	C
Myotis keenii	Keen's myotis	C
Myotis sodalis	Indiana myotis	U
Lasionycteris noctivagans	Silver-haired bat	R
Pipistrellus subflavus	Eastern pipistrelle	C
Eptesicus fuscus	Big brown bat	C
Lasiurus borealis	Red bat	U
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
Microtus ochrogaster	Prairie vole	U
Ondatra zibethicus	Muskrat	C
Synaptomys cooperi	Southern bog lemming	R
Rattus norvegicus	Norway rat	C
Mus musculus	House mouse	C

TABLE 3.6-6 Continued

Scientific Name	Common Name	Status
Napaeozapus insignis	Woodland jumping mouse	U
Vulpes vulpes	Red fox	R
Urocyon cinereoargenteus	Gray fox	C
Procyon lotor	Raccoon	C
Mustela frenata	Long-tailed weasel	C
Mustela vison	Mink	C
Spilogale putorius	Eastern spotted skunk	R
Mephitis mephitis	Striped skunk	C
Lynx rufus	Bobcat	C
Odocoileus virginianus	White-tailed deer	C

---

[1] Source: U.S. Army Corps of Engineers Topographic Laboratories, 1975, Environmental Resources Inventory of the Metropolitan Region of Huntington, West Virginia, Ashland, Kentucky, and Portsmoith, Ohio.

[2] Status:
C - Common
U - Uncommon
R - Rare

TABLE 3.6-7 Rare or endangered vertebrates of Ohio and Kentucky that may occur in the project area[a]

Common Name	Ohio Status[b]	Kentucky Status[c]
Mammals		
Bobcat	R	R
Birds		
Least bittern	R	
Hooded merganser	R	
Sharp-shinned hawk	R	
Coopers hawk	R	
Golden eagle	R	R
Northern bald eagle	E	R
Osprey	R	R
Barn owl	R	
Bewick's wren	R	
Short-billed marsh wren	R	
Loggerhead shrike	R	
Prothonotory warbler	R	
Northern parula	R	
Pine warbler	R	
Orchard Oriole	R	
Reptiles		
False map turtle	R	R

---

[a] Sources: Barbour, R.W. (Chairman) 1973. Kentucky Academy of Science ad hoc committee. A Preliminary List of Rare and/or Endangered Species in Kentucky.
Smith, H. G., et al., 1973. Rare and Endangered Vertebrates of Ohio.

[b] Ohio Status: Endangered (E)--An endangered species or subspecies is one whose prospects of survival and reproduction are in immediate jeopardy. The peril may result from one or many causes--loss of habitat, change in habitat, overexploitation, predation, competition, or disease. An endangered species must have help or extinction will probably follow.
Rare (R)--A rare species or subspecies is one that, although not presently threatened with extinction, exists in such small numbers throughout its range that it may become endangered if its environment worsens. Close watch of its status is necessary.

[c] Kentucky Status: All species on the Kentucky list are presented as rare and/or endangered.

TABLE 3.6-8 Ohio River Fish Study, Greenup L & D (M.P. 341.0), by U.S. Environmental Protection Agency, Wheeling Field Office, Wheeling, West Virginia

	1968		1969		1970	
Family Common name (Scientific name)	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.
Lampreys (Petromyzontidae)						
Silver lamprey (*Icthyomyzon unicuspis*)	---	---	1	0.03	---	---
Gars (Lepisosteidae)						
Longnose gar (*Lepisosteus osseus*)	---	---	25	10.35	7	3.26
Freshwater eels (Anguillidae)						
American eel (*Anguilla rostrata*)	---	---	---	---	3	0.30
Herrings (Clupeidae)						
Skipjack herring (*Alosa chrysochloris*)	25	4.49	19	1.20	84	3.43
Alewife (*Alosa pseudoharengus*)	---	---	---	---	2	0.11
Gizzard shad (*Dorosoma cepedianum*)	562	46.50	235	22.42	711	64.46
Mooneyes (Hiodontidae)						
Goldeye (*Hiodon alosoides*)	1	1.46	---	---	---	---
Mooneye (*Hiodon tergisus*)	2	0.49	---	---	---	---
Pikes (Esocidae)						
Northern pike (*Esox lucius*)	1	0.77	---	---	---	---
Minnows and carps (Cyprinidae)						
Goldfish (*Carassius auratus*)	---	---	---	---	1	0.63
Carp (*Cyprinus carpio*)	196	75.45	75	116.52	55	92.27
Silver chub (*Hybopsis storeriana*)	9	0.22	2	0.01	10	0.27
Emerald shiner (*Notropis atherinoides*)	90	0.24	93	0.26	32	0.13
River shiner (*Notropis blennius*)	---	---	---	---	3	0.02
Ghost shiner (*Notropis buchanani*)	1	0.01	---	---	10	0.02
Mimic shiner (*Notropis volucellus*)	234	0.34	29	0.04	23	0.04
Bluntnose minnow (*Pimephales notatus*)	---	---	1	0.01	---	---
Suckers (Catostomidae)						
River carpsucker (*Carpiodes carpio*)	---	---	---	---	24	21.69
Quillback (*Carpiodes cyprinus*)	2	0.51	4	4.16	---	---
White sucker (*Catostomus commersoni*)	---	---	---	---	1	0.38
Smallmouth buffalo (*Ictiobus bubalus*)	---	---	5	7.29	51	85.41
Black buffalo (*Ictiobus niger*)	---	---	---	---	2	3.35

TABLE 3.6-8 Continued

Family Common name (Scientific name)	1968		1969		1970	
	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.
Spotted sucker (Minytrema melanops)	---	---	1	0.74	3	3.45
River redhorse (Moxostoma carinatum)	---	---	---	---	2	2.55
Freshwater catfishes (Ictaluridae)						
Yellow bullhead (Ictalurus natalis)	---	---	---	---	1	0.02
Brown bullhead (Ictalurus nebulosus)	8	1.81	24	1.30	19	1.34
Channel catfish (Ictalurus punctatus)	363	75.21	305	64.47	646	175.87
Flathead catfish (Pylodictis olivaris)	1	5.70	---	---	1	0.01
Temperate basses (Percichthyidae)						
White bass (Morone chrysops)	---	---	5	2.51	11	5.30
Sunfishes (Centrarchidae)						
Green Sunfish (Lepomis cyanellus)	1	0.04	---	---	---	---
Pumpkinseed X (Lepomis gibbosus X)	---	---	---	---	1	0.10
Orangespotted sunfish (Lepomis humilis)	---	---	---	---	1	0.14
Bluegill (Lepomis macrochirus)	11	1.20	8	0.57	22	2.41
Longear sunfish (Lepomis megalotis)	---	---	---	---	1	0.12
Redear sunfish (Lepomis microlophus)	1	0.01	---	---	---	---
Spotted bass (Micropterus punctulatus)	2	0.83	---	---	5	0.91
Largemouth bass (Micropterus salmoides)	---	---	1	0.44	2	2.28
White crappie (Pomoxis annularis)	8	3.33	10	2.46	32	6.45
Black crappie (Pomoxis nigromaculatus)	42	4.24	1	0.32	4	0.31
Perches (Percidae)						
Sauger (Stizostedion canadense)	33	13.14	7	3.17	64	12.94
Walleye (Stizostedion vitreum vitreum)	---	---	2	0.81	---	---
Drums (Sciaenidae)						
Freshwater drum (Aplodinotus grunniens)	61	15.52	20	6.47	86	14.51
Totals	1654	251.51	864	245.54	1920	504.48

TABLE 3.6-9 Fishes collected by personnel of Ohio Department of Natural Resources in lower Ice Creek, 24 July 1972

Species	Number	Density/Acre
Gizzard Shad	2	58
Silverjaw Minnow	41	1191
Emerald Shiner	22	639
Common Shiner	33	958
Bluntnose Minnow	4	116
Creek Chub	6	174
Johnny Darter	1	29
Total	109	3165

TABLE 3.6-10 Fishes collected by personnel of Ohio Department of Natural Resources in lower Ice Creek, 10 September 1975

Species	Number	Density/Acre
Hog Sucker	1	29
Stoneroller	6	174
Silverjaw Minnow	29	842
Emerald Shiner	22	639
Common Shiner	4	116
Bluntnose Minnow	16	465
Spotted Bass	2	58
Johnny Darter	2	58
Total	82	2381

TABLE 3.6-11 Fishes of Buckhorn Creek arranged by stream order and abundance[1]

Species	Common Name	Stream Orders 1	2	3
Catostomus commersoni	White sucker			R
Hypentelium nigricans	Northern hog sucker			C
Campostoma anomalum	Stoneroller		C	C
Ericymba buccata	Silverjaw minnor		R	C
Hybopsis micropogon	River chub			R
Notropis ardens	Rosefin shiner			R
Notropis chrysorephalus	Striped shiner		R	C
Notropis spilopterus	Spotfin shiner			R
Notropis stramineus	Sand shiner			C
Pimephales notatus	Bluntnose minnow		R	C
Semotilus atromaculatus	Creek chub	C	A	A
Ambloplites rupestris	Rock bass			R
Lepomis megaloptis	Longear			R
Micropterus dolomieui	Smallmouth bass			R
Etheostoma blennioides	Greenside darter			R
Etheostoma caeruleum	Rainbow darter		R	R
Etheostoma flabellare	Fantail darter		R	R
Etheostoma nigrum	Johnny darter		C	R
Etheostoma sagitta	Arrow darter		C	C
Etheostoma sp.	undescribed darter			C
Total no. species/collections		1	9	20

---

[1] R (rare) = 1-4 individuals, C (common) = 5-14, A (abundant) = >14

Source: Kuehne, R.A., 1962. A classification of streams, illustrated by fish distribution in an eastern Kentucky creek. Ecology 43 (4): 608-614 pp.

TABLE 3.6-12 Threatened or endangered plant species in Ohio listed by the Ohio Department of Natural Resources

Scientific Name	Common Name
Cypripedium sp.	Lady's-slippers
Spiranthes sp.	Lady's-tresses
Gentiana crinita	Fringed gentian
Gentiana andrensii	Bottle gentian
Gentiana sp.	Rose-pink gentian
Lilium sp.	Wild lilies
Orchis spectabilis	Showy orchis
Iris cristata	Crested dwarf iris
Erythronium americanum	Fawnlily (Troutlily)
Trillium sp.	Trilliums
Uvularia sp.	Bellworts
Hepatica sp.	Hepaticas
Actaea pachypoda	White bane berry
Aquilegia canadensis	Wild columbine
Lobelia cardinalis	Cardinal flower
Rhodondron sp.	Rhododendrons
Dicentra canadensis	Squirrel corn
Dodecatheon meadia	Shooting star
Sanguinaria canadensis	Blood root
Campanula sp.	Bluebells
Anemone sp.	Anemones
Dicentra cucullaria	Dutchmans breeches
Arisaema stewardsonii	Jack-in-the-pulpit
Viola pedata	Birdfoot violet

Source: Ohio Department of Natural Resources (undated a)

TABLE 3.6-13 Plants listed by the Federal government as being endangered or threatened in Ohio

Species	Family	Status
Solidago shortii	Asteraceae	Endangered
Calamagrostis insperata	Poaceae	Endangered
Trollius laxus	Ranunculaceae	Endangered
Rhus trilobata var. *arenaria*	Anacardiaceae	Threatened
Oxypolis canbyi	Apiaceae	Threatened
Apios priceana	Fabaceae	Threatened
Plantanthera leucophaea	Orchidaceae	Threatened
Platanthera peramoena	Orchidaceae	Threatened
Auhlenbergia curtisetosa	Poaceae	Threatened
Poa paludigena	Poaceae	Threatened
Polemonium reptans var. *villosum*	Polemoniaceae	Threatened
Asplenium ebenoides	Polypodiaceae	Threatened
Asplenium kentuckiense	Polypodiaceae	Threatened
Potamogeton hillii	Potanogetonaceae	Threatened
Sullivantia ohionis	Saxifragaceae	Threatened

Source: Ripley, 1974.

TABLE 3.6-14 Rare or endangered plant species in Kentucky listed by the Kentucky Academy of Science

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
Rhodendron cumberlandense	Red azalea
Castenea pumila	Chinquapin

Source: Kentucky Academy of Science, 1973.

TABLE 3.6-15 Plants listed by the Federal government as being endangered or threatened in Kentucky

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
Rhodendron 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

Source: U.S. Congress House Document No. 94-51

TABLE 3.6-16 Rare and endangered fishes listed by Ohio and Kentucky which might occur within the site area

Ohio R & E[a]	Kentucky R & E[b]
Acipenser fulvescens (E) Lake sturgeon	*Percopsis omiscomaycus* Trout perch
Lepisosteus platostomus (R) Shortnosé gar	*Etheostoma tippecanoe* Tippecanoe darter
Clinostomus funduloides (E) Rosyside dace	*Percina macrocephala* Longhead darter
Notropis emiliae (E) Pugnose minnow	
Ammocrypta pellucida (E) Eastern sand darter	
Etheostoma tippecanoe (R) Tippecanoe darter	
Percina copelandi (E) Channel darter	
Percina phoxocephala (R) Slenderhead darter	

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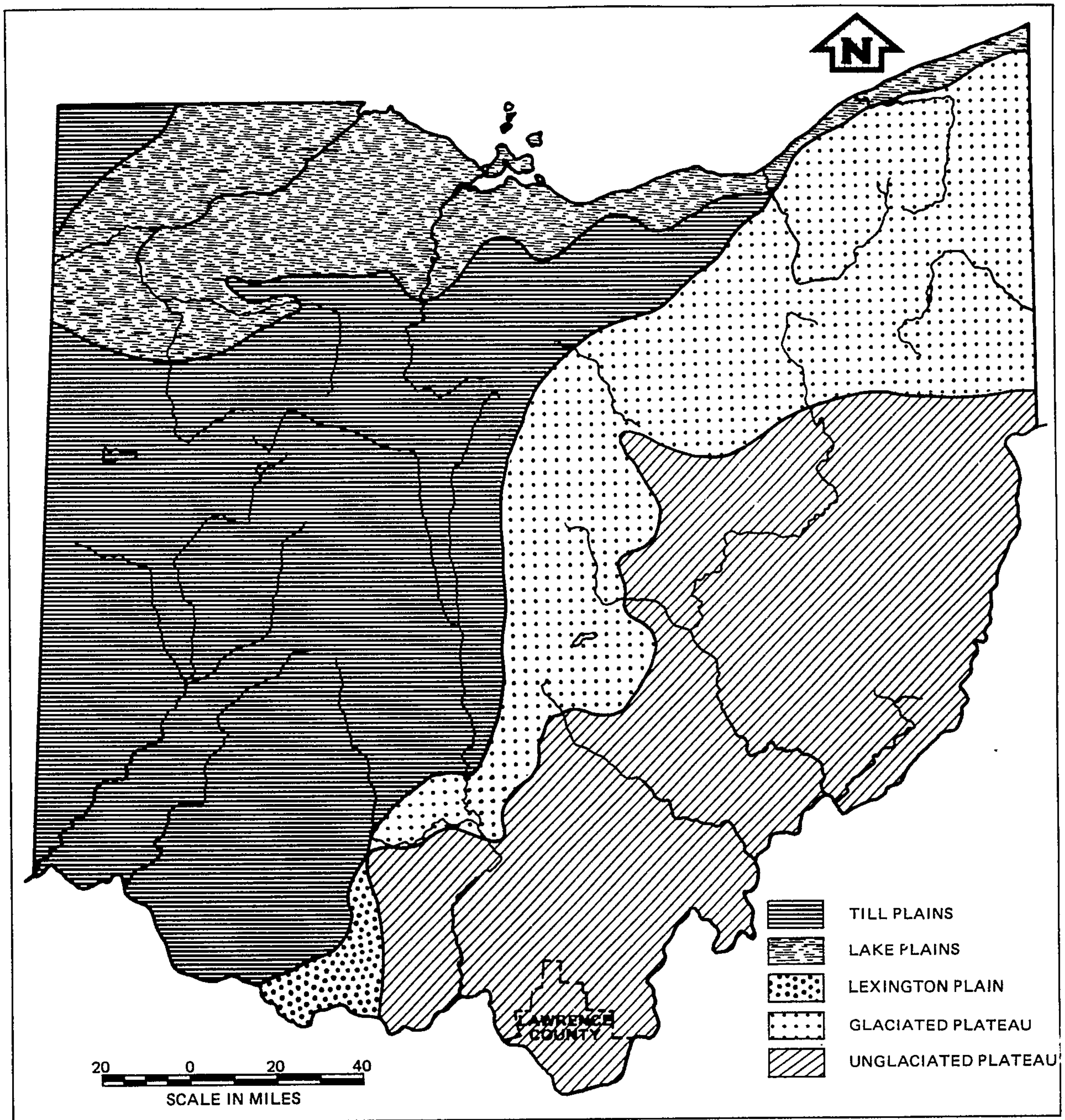
[a] Smith, H. G., and others, 1973.

[b] Redwine, 1976.



SOURCE: OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SURVEY

FIGURE 3.6-1 Physiographic sections of Ohio

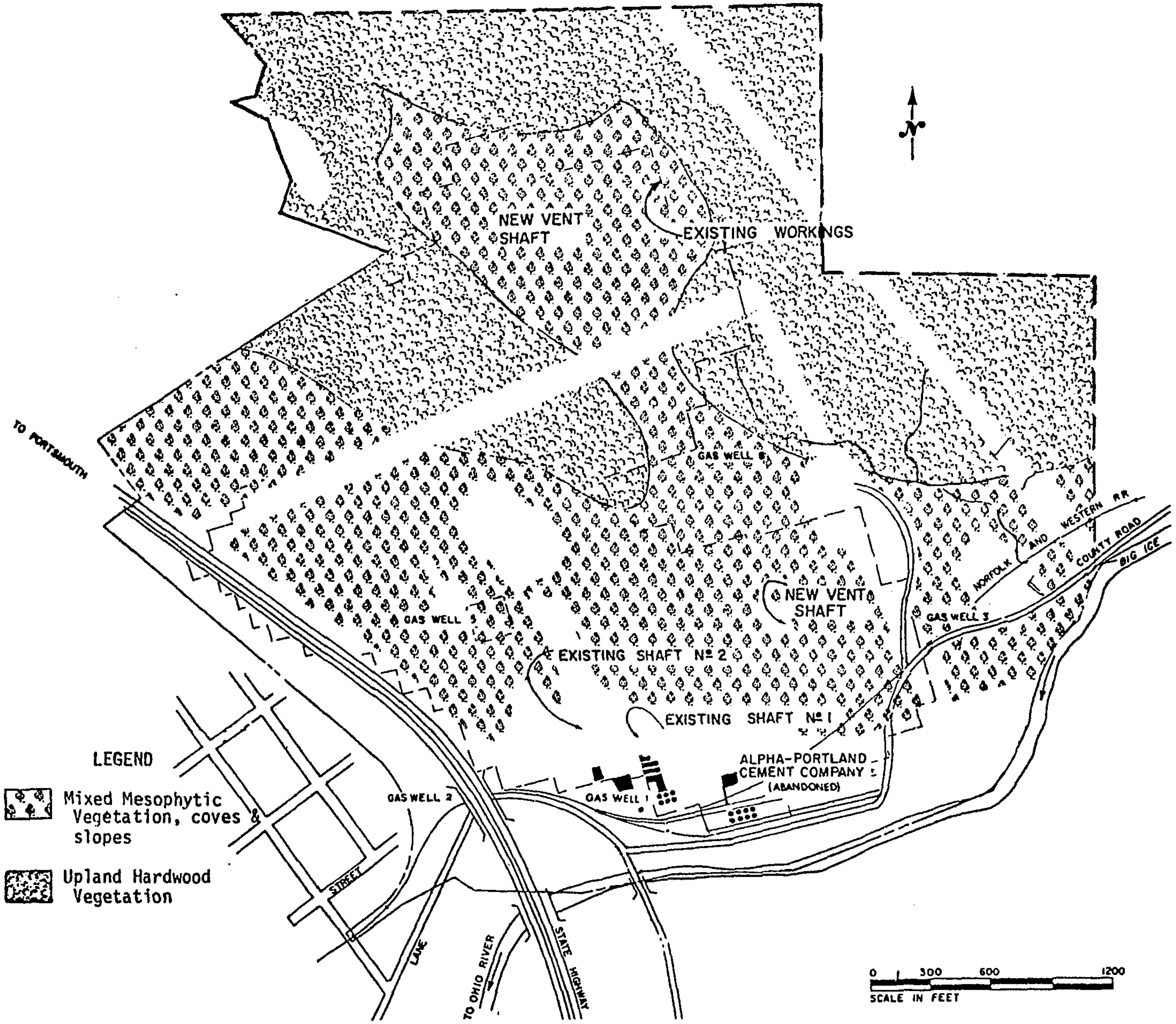


FIGURE 3.6-2 Vegetation types, Ironton Mine site

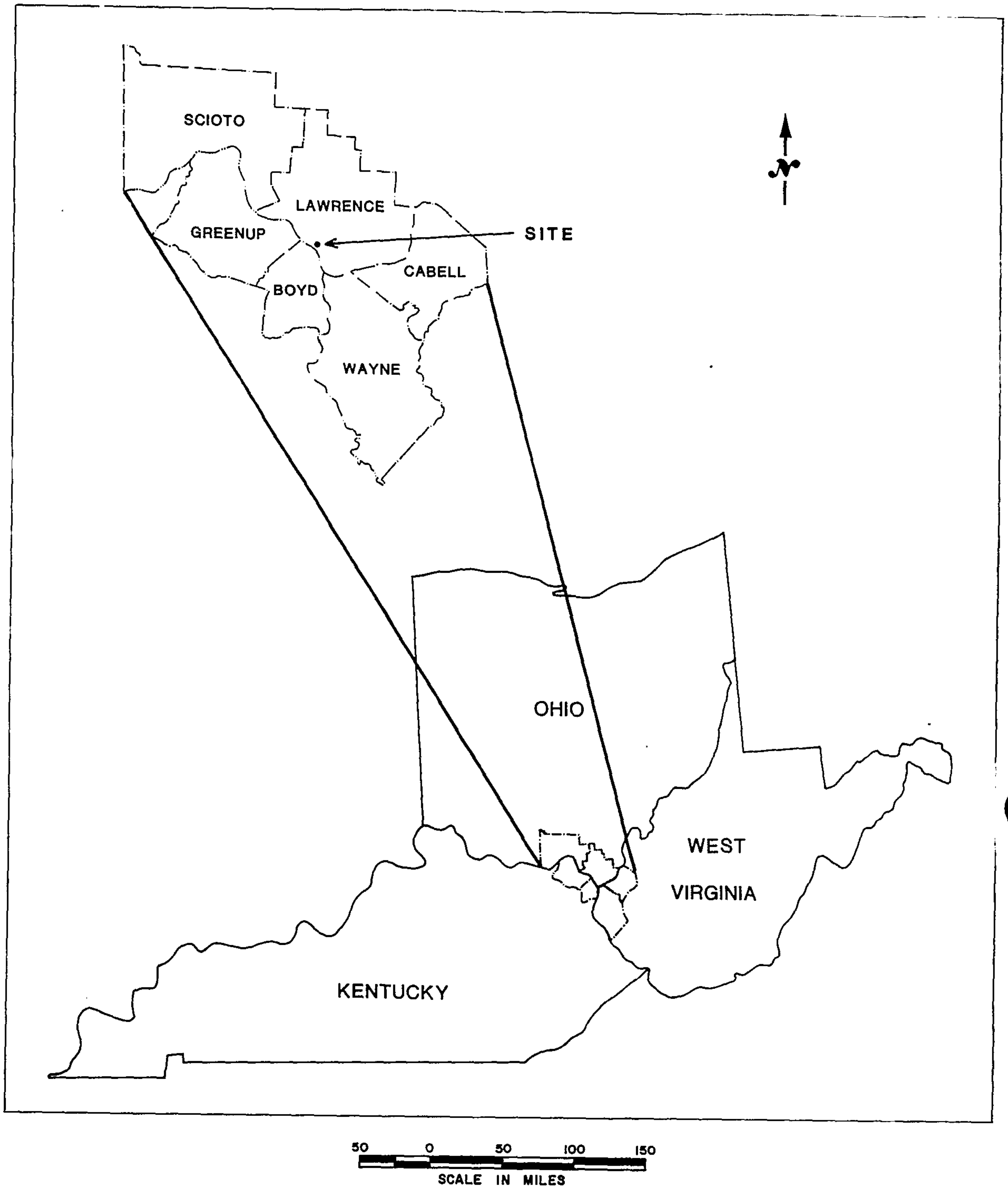
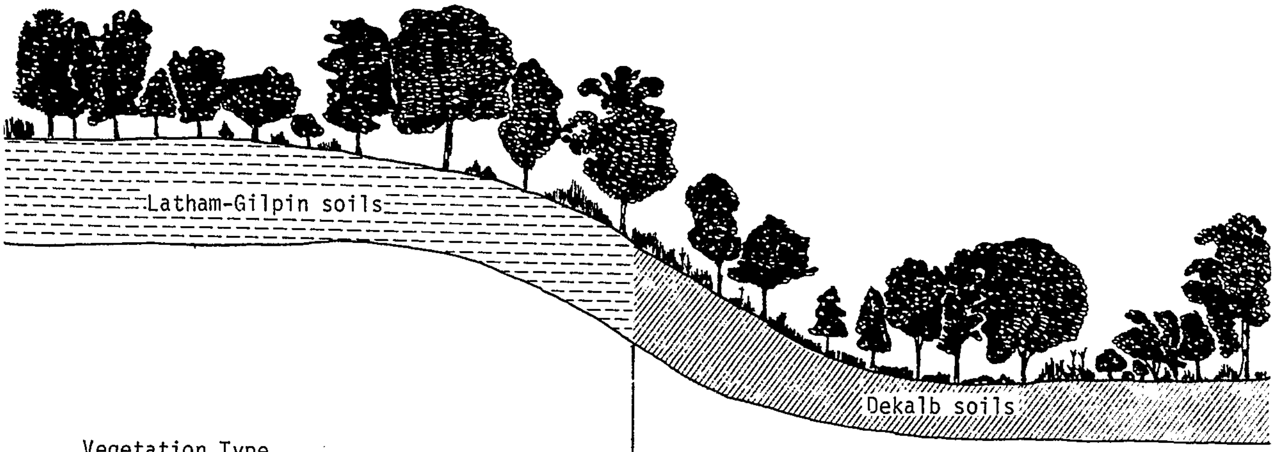


FIGURE 3.6-3 Ironton site in relation to Regional Natural Resources Inventory study area



Vegetation Type	Upland Hardwoods	Mixed Mesophytic Hardwoods
Vegetation	Bur oak Chestnut oak Shagbark hickory Black locust Redbud Wild raspberry	Tuliptree Basswood Red oak American elm Dogwood Virginia creeper
Reptiles and Amphibians	Marbled salamander Copperhead Eastern milk snake Northern red-bellied snake Ground skink	Slimy salamander Northern spring peeper Five-lined skink Eastern box turtle Garter snake
Avifauna	Ruffed grouse Wood thrushes Cardinals Wrens Woodpeckers Warblers	Red-tailed hawk Ruffed grouse Wood thrushes Goldfinches Cardinals Woodpeckers Whip-poor-will Warblers
Mammals	Gray squirrel Cottontail rabbit Gray fox White-footed mouse Short-tailed shrew White-tailed deer	Opossum Gray squirrel Cottontail rabbit Gray fox Raccoon White-footed mouse Short-tailed shrew

FIGURE 3.6-4 Major ecological associations of the Ironton Mine site

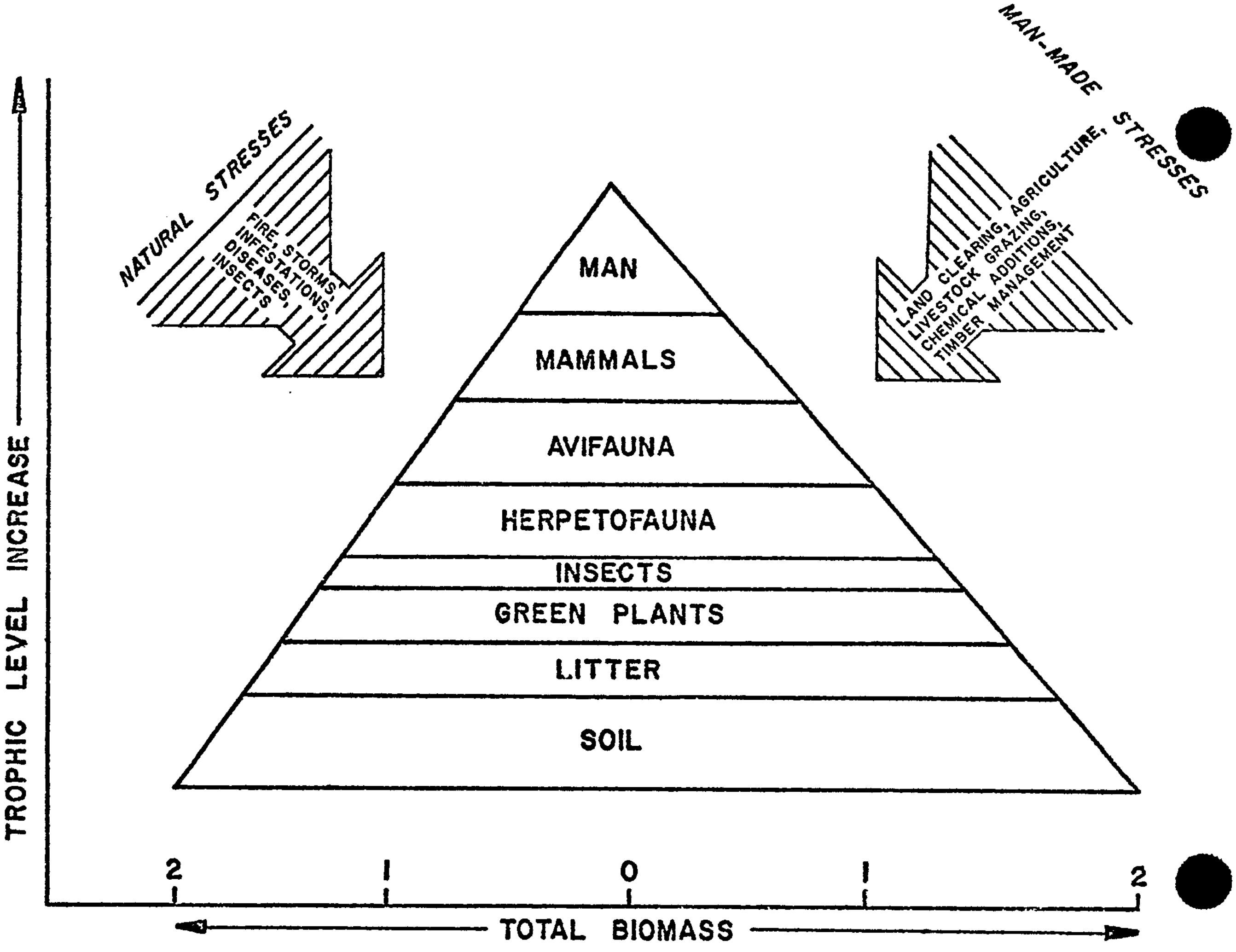


FIGURE 3.6-5 Pyramid of biomass

3.7 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

3.7.1 Regional Historical Places

Within the six-county area around Ironton (Figure 3.6-3), 148 historical sites have been reported (U.S. Army Corps of Engineers, 1975). Of this total, 17 are listed in the National Register of Historic Places; 131 sites were included in the Ohio, Kentucky, and West Virginia state plans to identify and improve historic places within their respective states. A list of historic places together with their locations and a brief description appears in Appendix H.

A total of 209 archaeological sites were recorded within the six-county area as of 1975 (U.S. Army Corps of Eingineers, 1975). In Lawrence County, 71 archaeological sites have been identified. In Boyd County, 23 archaeological sites have been discovered. Exact locations and individual descriptions of known archaeological sites have been omitted to avoid the possibility of harm to the sites that might result from broad publication of the data.

3.7.2 At The Ironton Mine Site

Based on present information, there are no known archaeological or historic sites within the site boundaries or within the pipeline corridor. In the event that such sites are discovered during surveys to be conducted prior to project construction, they will be investigated to determine their importance and possible qualification for inclusion in state or Federal historic preservation plans (see section 4.2.6).

3.8 SCENIC, NATURAL AND CULTURAL RESOURCES

3.8.1 Regional

Within Lawrence County, there is 1 national forest, 1 state forest, 2 research and education areas, and 1 national recreation area. Within the town of Ironton, there are 26 parks and playground recreation areas. Appendix H includes a list of these resources. Wayne National Forest covers a large percentage of the county with approximately 47,760 acres of land. Dean State Forest covers 1796 acres of the county and provides natural areas for camping, hiking and fishing. The two research and educational areas are Kitts Hill (55 acres) and Wiseman-Clark Woods (260 acres), both of which are natural areas. Lake Vesuvius is a natural recreation area in Wayne National Forest and offers a broad spectrum of activities for the outdoor enthusiast.

In Boyd County, Kentucky, there are 29 parks and recreation areas, the more notable ones being Armco Park (250 acres), Grandview Lake (25 acres), Wildwood Park (56 acres), and the Boyd County Fairgrounds and Exhibition Center (240 acres).

The proposed pipeline route was carefully selected to avoid passing through any known scenic, natural, or cultural resources.

3.8.2 At the Ironton Mine Site

Currently there are no parks, recreational or official open space facilities existing on or immediately adjacent to the Ironton Mine site. However, there are two proposed areas that lie adjacent to portions of the site. The first of these is the Ice Creek Pond, located to the east of the site, which has been proposed as a recreational facility for the city of Ironton. The second is a proposed state natural landmark to consist of 5000 acres of mixed oak forest to the north of the site. Neither proposed site will be within the area affected by the oil storage facility. Appendix H contains a list of these and other proposed recreational facilities in the area (U.S. Army Corps of Engineers, 1975).

3.9 SOCIOECONOMICS

3.9.1 Study Areas

The Ironton Mine is located on the outskirts of Ironton, Ohio, in Lawrence County. It is part of the tri-state region where the Ohio, Kentucky, and West Virginia borders coincide (see Figure 2.1-1). The Huntington-Ashland SMSA (Standard Metropolitan Statistical Area) provides the regional boundaries for the socioeconomic assessment and now includes Wayne and Cabell Counties in West Virginia, Boyd and Greenup Counties in Kentucky, and Lawrence County in Ohio (see Figure 3.6-3). Prior to 1972, the SMSA did not include Greenup County, Kentucky.

The local boundaries used for the socioeconomic assessment are those of Lawrence County, Ohio, and the city of Ironton, located just across Highway 52 from the mine site. The following discussions deal with both the regional and local study areas, as appropriate.

3.9.2 Economic History

The Huntington-Ashland area has been heavily influenced both socially and economically by the coal and timber industries. During the coal field era, labor demands were greater than the local and regional supply of people. Consequently, there was a large influx of people, primarily immigrants from eastern and southern Europe. Between 1920 and 1930, the number of inhabitants increased 31 percent. This rapid growth was accompanied by the area's development into a regional center for commercial and industrial activities. After 1930 this rapid growth slowed, and during the period between 1960 and 1970 the population of the area declined for the first time in over 50 years.

The economic structure of the area is dominated by the extractive industries and industries associated with resource utilization in production processes. The spatial distribution of these resources, combined with the transportation provided by the Ohio River, spurred the area's rapid early industrialization and growth in durable goods manufacturing. At present, river barges loaded in the Huntington-Ashland area can travel to 22 states via inland waterways. The Ohio River system is an integral part of the Mississippi River inland waterways system, which connects to the Great Lakes and the Gulf Intracoastal Waterway.

Various economic activities and associated service sectors have provided a common bond to this area which would otherwise be divided by the Ohio River and various political boundaries.

Ironton is the southernmost city in Ohio and is the county seat of Lawrence County. The town was incorporated in 1851, having started as a railroad terminal city on the Ohio River when the Iron Railroad was built from the river to the 11 pig-iron furnaces in the hills. At the time of the Civil War, Ironton was a strategic center for iron production and at one time possessed the largest blast furnace in the world. In the late 1800's, the lumber industry came into prominence with saw and planing mills, and door and mantle factories developed along the river. During World War I, the iron industry again took the lead and, during the 1920's, the growth of the automobile industry brought about the development of the coke and malleable iron industries. After 1939, chemical industries became predominant, and today Ironton is a fairly diversified manufacturing city.

3.9.3 Land Use

The 5 counties in the Huntington-Ashland SMSA are organized into a regional unit called KYOVA (an acronym derived from Kentucky, Ohio and West Virginia, the 3 states represented by the counties) and are served by the KYOVA Interstate Planning Commission. Table 3.9-1 lists the current distribution of land in residential, commercial, industrial, and open space use for each of the subareas in the region. Also listed are the number of acres in each land use category proposed for 1990 (1985 for Wayne and Cabell Counties).

In the KYOVA region, development typically occurs along the Ohio River and its various tributaries. Industrial and manufacturing areas are located directly adjacent to the river where they have immediate access to the transportation facilities that use the Ohio River system. Residential areas spread back into the hills along the river and are interspersed with commercial areas.

There is considerable difference in land utilization among the geographic subareas within the region. Wayne County is predominantly residential in nature, generating a relatively large amount of commercial service land use in the neighborhoods. Cabell County is also predominantly residential (outside of Huntington) but has a disproportionately large share of commercial use and very little industry. Commercial land uses proliferate along the major corridors to service suburban areas in the county. Huntington is more oriented toward industrial land uses while still providing predominantly residential development. Commercial uses in Huntington account for a surprisingly low amount of land area and are primarily concentrated in a tight, well-defined Central Business District (CBD).

Over 90 percent of the land in Boyd and Greenup Counties is dedicated to residential uses, while less than 4 and 6 percent is devoted to commercial and industrial uses, respectively. The extreme topography in the suburban and rural portions of these counties dictates relatively low-density residential uses, while industrial and commercial uses, which require flat land, are confined to the extensive flood plain area adjacent to the Ohio and Big Sandy Rivers. The proportion of commercial uses nearly doubles and industry nearly triples in the urban Ashland area of these counties. The city of Ashland is quite comparable to Huntington in land utilization (compact CBD, emphasis on industry, and so forth) and performs a similar role in serving the needs of its citizens, although it has a much smaller population.

Lawrence County has the highest proportion of residential land in the region next to Wayne County; both serve as residential satellites to the remainder of the region. Ironton, however, has the most intensive concentration of industrial land use proportionate to total developed acreage. Nearly 27 percent of Ironton's developed area is designated industrial (which is nearly 80 percent greater in proportion than either Huntington or Ashland). Commercial development is also given a stronger emphasis than in the other two cities, whereas residential land use occupies the smallest urban proportion in the entire region. Ironton is therefore more a place of employment and services than one of residence.

Figure 3.9-1 shows the KYOVA Land Use Plan for 1990. Existing patterns of residential development are expected to continue into the future but with higher densities and more housing for low-to-moderate income and minority groups. The Huntington-Ashland-Ironton urban cores will continue as the region's major service areas, although smaller commercial hubs will be developed in outlying areas (mostly around the interchanges of I-64 and other noninterstate, limited access routes). Future industrial activity will continue to locate along the banks of the Ohio River, with a significant portion developing along the flood plains of the Big Sandy and Guyandotte Rivers and along I-64. The tendency of industry to decentralize from the urban centers is expected to continue, although existing industries will continue to expand near their present locations.

Recreation and open space development is planned for the most significant growth within the next 20 years. The following minimum recreation standards have been established for the region:

1. Regional or County Parks - Minimum size of 200 acres within 1 hour's driving time and based on 10 acres per 1000 persons served.
2. Community or District Parks - Minimum size of 100 acres within a 30-minute drive and based on 7 acres per 1000 persons in the larger municipalities or 5 acres per 1000 in smaller communities.
3. Neighborhood Parks - Minimum size of 8 to 10 acres within a 30-minute drive and based on 7 acres per 1000 persons in the larger municipalities or 5 acres per 1000 in smaller communities.
4. Playgrounds and Playfields - Minimum size of 1 to 2 acres for playgrounds and between 1.5 and 2 acres for playfields per 1000 persons. Playgrounds should serve a radius of 1/4 mile; ideal size is 4 acres. Playfield minimum size is 20 acres, with 40 acres the ideal size.
5. Golf Courses - Minimum of 18 holes per 54,000 persons.
6. Swimming Pools - Minimum size of 10,000 square feet (35,000 square feet is the ideal size) and 750 square feet per 1000 persons served.

3.9.4 Transportation

3.9.4.1 Roads

Figure 3.9-2 identifies the major transportation routes near Ironton. The main east-west highway is Interstate Route 64, which runs between

Lexington, Kentucky and Charleston, West Virginia. U. S. Route 52 runs from Cincinnati, Ohio to Huntington, Virginia along the Ohio side of the Ohio River, and passes between Ironton and the mine site. There are 3 toll bridges in the metropolitan area which generated over $2 million in gross revenues in 1971. By 1990 gross annual revenues are anticipated to approach $3.5 million (using current toll rates).

Prior to a strike in October 1971, a privately-owned mass transit system operated 56 buses (average age 18.7 years), carried 2.3 million passengers per year (a decline of 68 percent from 1956), operated 1.75 million bus-miles of service (a decline of 42 percent from 1959), and realized an operating loss of $19,000. Costs per mile of operation have continued to increase while revenue passengers per mile have decreased. Local government has been requested to initiate a public system and make up for revenue deficits through public funds. A 10-year mass transit bus plan and program has been prepared for the region by the KYOVA Interstate Planning Commission.

The KYOVA Interstate Planning Commission recently completed a detailed transportation study for the Huntington-Ashland-Ironton area. A new highway system proposed to meet travel demands of 1990 includes a balanced system of limited access facilities to augment existing freeways and expressways. The total recommended system consists of 544 miles of collectors, arterials, and freeway-expressway routes. The 20-year highway improvement program has been divided into four priority stages with high priorities given to improvements that will provide maximum service for present traffic demands. Nearly 3,700,000 vehicle-miles of daily travel are anticipated by 1990, an increase of 42 percent from 1966.

U.S. Highway 52 provides the major access to the mine site. The Ohio Department of Transportation reported the following total vehicle counts during an average day in 1975 on the highway near the site:

East of Old U.S. 52:	12,640 vehicles (~ 1/4 capacity)
West of Old U.S. 52:	15,977 vehicles (~ 1/3 capacity)

According to the regional transportation plan, increased traffic on Highway 52 near Ironton in 1990 will still be well below capacity (around 50 percent).

3.9.4.2 Waterways

The Ohio River system has been undergoing a modernization program since 1954, which is now very near completion. It is a vital part of the Mississippi River-Gulf coast inland waterway system. Traffic has grown steadily, and today the network is among the world's greatest in commercial importance. Pennsylvania, West Virginia, Ohio, Kentucky, Indiana, and Illinois all have direct access to Ohio River waterborne commerce. Principal commodities transported on the river are coal and coke, petroleum and refined products, sand and gravel, industrial chemicals, iron and steel, and grains. In 1969 the river transported over 126 million tons of freight.

Most of the Ohio River traffic goes through the port facilities at Huntington. Ironton has some mooring facilities for loading and unloading coal, gasoline, oil, cement, and coal tar. The KYOVA Interstate Planning Commission has proposed the creation of a regional port authority to deal with the growing complexity of transportation problems and to stimulate economic development.

3.9.4.3 Pipelines

There are scattered oil production fields in the area and numerous small crude oil pipelines that deliver oil to local markets. Ashland Oil Company operates the only major foreign crude oil processing refinery and pipeline system in the region. The refinery is located near Catlettsburg, Kentucky, just south of Ashland. The foreign crude oil is supplied to Ashland's 24-inch pipeline primarily by the Capline system (FEA, 1976).

3.9.4.4 Air and Rail

The Tri-State Airport, located between Huntington and Ashland, provides air transportation for the area. Commercial passenger service has nearly doubled, and air cargo movements have almost quadrupled in the time period from 1961 to 1970. Future projections anticipate similar growth to 1990.

During the period from 1940 to 1968, railroads declined in importance. In 1940 they moved 63 percent of the region's commodities; in 1968, only 41 percent. This decline is expected to stabilize in the near future.

3.9.5 Population Characteristics

3.9.5.1 Number and Density

The Huntington-Ashland SMSA had a 1970 population of 286,395. This represents a small increase from the 1960 count of 284,018. The total land area for the SMSA is 1758 square miles, giving an average population density of 163 persons per square mile in 1970. However, the bulk of the population is located in the Huntington-Ashland-Ironton urban areas of the SMSA. The nonwhite population in the region is less than 0.6 percent of the total and is predominantly black.

Huntington is by far the largest city in the study area. Its 1970 census population (74,315) is more than twice that of the second largest city, Ashland (29,245). Ironton is the next largest, with a 1970 census population of 15,030. Total SMSA population is expected to continue to increase moderately and follow the same geographic distribution patterns as those that exist now. The 1990 SMSA population is estimated at 276,680.

Lawrence County, Ohio has 456 square miles, with an average population density of 125 people per square mile. The total population was 56,868 in 1970, with blacks accounting for less than 3 percent (1682) of the population. The black population decreased by 6.5 percent between 1960 and 1970. The city of Ironton had a population of 15,030 in 1970 and an area of 6 square miles (U.S. Bureau of the Census, 1973). The population forecast for the county in 1990 is 60,316.

3.9.5.2 Occupation

There were 83,937 employed persons in the Huntington-Ashland SMSA in 1970, of which just over 1/3 (28,218) were women. The largest occupational group, comprised of craftsmen, foremen, and kindred workers, numbered 14,392. There were approximately 12,000 persons working as operatives, and similar numbers in clerical work, and professional or technical jobs. Table 3.9-2 gives employment by occupation in the SMSA for the years 1960 and 1970.

During the 1960-1970 decade, farmers, laborers, and private household workers experienced the largest declines in employment, although the declines all represented less than one percent of total employment. The largest increase in workers during the decade was in the services category. This increase is consistent with the national trend. Demands for food, health and other services are perhaps the fastest growing occupational group in the nation. Next to services, the clerical and professional/technical categories experienced the largest increases in employment--probably a result of increased automation that replaced non-skilled workers and upgraded semi-skilled jobs to technical ones.

Lawrence County had over 17,000 people in the various occupational categories in 1970. The largest group was craftsmen, foremen, and kindred workers, which accounted for 3500 employed people and represented almost 20 percent of the total. Operatives (except transport) was the next largest category, with over 3000 employed people. Clerical and kindred workers numbered over 2300 and represented 13 percent of the total. The city of Ironton showed a similar pattern, although the largest occupational group was the clerical and kindred workers, with 842 people representing 16 percent of the total for Ironton. Craftsmen, foremen, and kindred workers (807) and operatives except transport (724) were the second and third largest occupational groups, respectively. Table 3.9-3 shows the occupational breakdown for Lawrence County and Ironton, Ohio, for 1970.

3.9.5.3 Income

The 1975 Survey of Buying Power estimated the total Effective Buying Income (EBI) for the Huntington-Ashland SMSA in 1974 at approximately $1.2 billion. The average household EBI for the region in the same year was $11,831. Table 3.9-4 gives a breakdown of effective buying income by income groups for the SMSA and the counties within it. Boyd County, Kentucky, had the highest average household EBI ($13,125), followed, in order, by Greenup, Cabel, Wayne, and Lawrence Counties.

Lawrence County had an EBI of approximately $211 million in 1974. The average household EBI was $10,180 in that year--the lowest of the 5 counties in the SMSA. Over 26 percent of the Lawrence households were in the $10,000 to $15,000 income group, but the next largest group (almost 18 percent) was in the $0 to $3000 category.

3.9.5.4 Housing

Table 3.9-5 inventories the Huntington-Ashland SMSA housing stock for the years 1960 and 1970 through 1975. The 1970 housing units totalled 87,153, representing an increase of 7086 over the 1960 total. There were 5804 vacant units in 1970, which represented a 6.6 percent vacancy rate compared to the 7 percent vacancy rate in 1960. The KYOVA Interstate Planning Commission estimated in 1974 that the vacancy rate in the Huntington-Ashland SMSA would continue to decrease to an estimated 5.7 percent in 1975.

In 1970, 68 percent of the occupied housing units were owner-occupied, 9.9 percent were lacking some or all plumbing, and 7.8 percent were crowded (with 1.01 or more persons per room). Over 30 percent of the crowded housing units were lacking some or all plumbing facilities (U. S. Bureau of the Census, 1973).

It was estimated that between 1965 and 1970, 3500 new housing units were constructed within the metropolitan area to help meet an estimated demand for nearly 4000 units. An estimated 300 to 400 units were required to house new and/or relocated families, and the remainder were required to replace between 300 to 350 units lost as a result of demolitions, conversions, relocations, and mergers (KYOVA, 1974). According to the KYOVA Interstate Planning Commission, the greatest needs in the region are for low-to-moderate income housing, and the 1970-1975 housing plan was centered around the construction of new housing units primarily for low-to-moderate income families.

There was a total of 19,099 housing units in Lawrence County in 1970, representing a 12.8 percent increase over the 1960 total. The vacancy rate for 1970 was 1.5 percent for homeowner units and 10.0 percent for rental units. Of the county's 17,611 occupied housing units in 1970, approximately 72 percent were owner-occupied, and 15.6 percent were lacking some or all plumbing facilities. Ten percent of the housing was crowded (with 1.01 or more persons per room) and of these, 37 percent were without plumbing facilities (U. S. Bureau of the Census, 1973).

The city of Ironton had 5565 housing units in 1970, of which 306 were vacant (80 homeowner units and 226 rental units). Only 6 percent (309) of the occupied units were crowded and only approximately 3 percent were lacking some or all plumbing facilities (U. S. Bureau of the Census, 1970).

3.9.6 Economics

3.9.6.1 Economic Base

The Huntington-Ashland SMSA is a major market, production, and transportation center for the tri-state area of West Virginia, Ohio, and Kentucky. Its development is a result of its strategic location on the Ohio River and the local abundance of natural resources comprised principally of coal, natural gas, and iron. Steel, chemical, and glass manufacturers and governmental agencies are among the major employers. Table 3.9-6 shows employment by industry for the Huntington-Ashland SMSA for Census years 1950, 1960, and 1970, and projections for 1980.

Manufacturing is the most important segment of the economy and employed over 25,000 people in 1970 (representing almost 30 percent of the area's total employment). Primary metals and metal fabrication were a significant portion of the manufacturing sector, accounting for over half (almost 15,000) of the total manufacturing employees (KYOVA, 1974).

The various business and professional services employed over 18,000 people in 1970 and comprised the second largest sector in terms of employment. The rising demand for service functions by a growing population kept this sector growing steadily from approximately 13,000 in 1950 to its 1970 level of over 18,000 (KYOVA, 1974).

Employment in wholesale and retail trade totalled almost 17,000 in 1970. Increased population and consumer expenditures kept this sector growing also, with the movement of people from urban to suburban areas contributing to the growth. Retail trade accounted for approximately 80 percent of this sector's employment (KYOVA, 1974).

The extractive industries of lumbering, mining, clay, rock quarrying, and agriculture are essentially static or declining industries as measured by employment trends. Technological advancements and mechanization of these industries have contributed to the reduction of labor requirements in this sector. Coal mining is the most significant of these industries and should remain so due to the increasing demand for non-petroleum energy sources. The three states of Ohio, Kentucky, and West Virginia produced 289 million short tons of coal in 1973, representing almost half of the total coal production in the United States for that year (U.S. Bureau of the Census, 1975).

Table 3.9-7 shows that the economic bases in Lawrence County and Ironton follow patterns similar to that of the SMSA, with manufacturing playing the primary role. The principal manufacturing industries in the county in 1975 were primary metals and chemicals. Other industrial groups included stone-clay-glass, fabricated metals, paper, machinery, and printing and publishing. Commodities produced by local firms included anhydrous ammonia, nitrogen fertilizer solutions, methanol, formaldehyde, urea, melamine, oil, tar acid, coke, iron castings, cement, basketballs, baseball gloves and mitts, boxing gloves, and football helmets (Ohio Bureau of Employment Services, 1975).

Future economic development in the SMSA and locally depends to a large extent on the success of efforts to improve transportation and develop industrial parks, as well as expand public services. The KYOVA Interstate Planning Commission has recommended the formation on an Interstate Industrial Development Corporation to serve the entire tri-state area.

3.9.6.2 Employment

According to the KYOVA Interstate Planning Commission, the potential labor force population in the SMSA increased by almost 9000 between 1960 and 1970, whereas actual civilian employment only increased by 3500. Consequently, there was a sharp increase in unemployment. In 1970, there were 4500 unemployed people in the metropolitan area, representing an unemployment rate (5.1 percent) that was slightly higher than the national average (4.9 percent). A decline in the local economy resulted in decreased job opportunities and an increased unemployment rate of 11.6 percent in February 1972. This was well above the national average and was a 137 percent increase over the 1970 jobless rate (KYOVA, 1974).

In May 1975, the Lawrence County civilian labor force, based on place of residence, totalled around 20,600 persons. Of this number, approximately 18,900 were employed and 1700 (including 475 women) were unemployed. Unemployment represented 8.4 percent of the labor force at that time (Ohio Bureau of Employment Services, 1975). The U. S. Bureau of the Census reported in 1970 that more than two-fifths of the county's resident jobholders commuted to work in nearby counties; over one-third of all employed residents were on factory payrolls; and about one-eighth worked for federal, state, or local government agencies.

Future employment in the SMSA is expected to follow generally the same trends as those to date. Manufacturing will remain the most important sector; agriculture will continue to decline. Construction is expected to increase to some degree due to population and housing increases, and the trend away from cities to suburbs. Wholesale and retail trade, especially the latter, will continue to increase, as will the finance, insurance, and real estate sector, all in response to increasing population and an expected rise in income levels. Services are expected to respond even more rapidly. Table 3.9-6 includes expected employment levels by industry for 1980.

3.9.7 Government

3.9.7.1 Revenues

The KYOVA Interstate Planning Commission does not have any direct powers of taxation. It is funded primarily by U.S. Housing and Urban Development (HUD) monies. The Kentucky, Ohio, and West Virginia Highway Departments also reimburse KYOVA for all transportation projects in the region which would otherwise be their respective responsibilities. A

Federal Urban Mass Transit grant has been awarded KYOVA for a study of the Huntington/Ashland/Ironton transit systems. In addition, member counties and cities are assessed dues according to a formula based on their resident populations.

The mine site is subject to Ohio and Lawrence County taxes. It is located just outside the city limits of Ironton and could conceivably be annexed by the city.

Funds received and expended by Lawrence County increased approximately 42 percent between 1960 and 1970. This was dampened somewhat by the loss of some poor relief and aid funds that amounted to $1,690,000 in 1960. The general and road and bridge funds increased by $3.2 million (more than 4 percent per annum) during this period. Revenues for the Board of Education and the Health District increased at about half that rate. Assessed valuations increased over 2 percent per annum between 1960 and 1970. The assessed valuation in 1970 was $135.28 million for the county. Real property is assessed at about 43 percent of market value. Lawrence County's voted debt limit increased from $8.62 million in 1960 to $12.17 million in 1970 (KYOVA, 1974).

Lawrence County took in a total revenue of $18.2 million in 1974 and had expenditures totaling $16.6 million, leaving a balance of $1.6 million at the end of the year (Ironton Tribune, 1975).

3.9.7.2 Services

Health

The KYOVA metropolitan area has six general hospitals with a contract total of approximately 1506 beds, 260 medical doctors, and 113 dentists. There are three state hospitals and a VA hospital. The Lawrence County General Hospital in Ironton has a capacity of 185 beds and 23 bassinets. There are 19 nursing homes in the region, 7 of which are located in Lawrence County. Each county in the region has a public health department, but Ironton has the only city health department.

Education

Higher education for the region is available at Marshall University, located in Huntington, West Virginia. The Ohio University Ironton Branch College (with 42 part-time faculty members) used to provide educational services for over 400 students, but is being phased out in order to develop a new campus in the Portsmouth area.

Vocational training is not available near Ironton; trainees must travel to Jackson, Ohio. KYOVA has recommended that the possibility of a technical school in Lawrence County be re-evaluated.

The Briggs-Lawrence County Public Library is located in Ironton. Circulation was estimated to reach 250,000 (including a bookmobile) by the end of 1975.

Recreation

Lawrence County has a national forest and a state forest within the county. Wayne National Forest offers fishing, hiking, natural scenery, and riding trails. Included in the forest is the Lake Vesuvius natural environment area, which provides fishing, camping, boating, and related activities. Dean State Forest is a natural environment area offering fishing, hiking, hunting, picnicking, and riding trails. Research and education areas in Lawrence County include the 55-acre Kitts Hill natural environment area and the 260-acre Wiseman-Clare Woods.

The Ironton Board of Public Recreation and the Lawrence County Park Board both maintain and operate park and recreation facilities throughout the county. However, city- and county-owned facilities consist of only 99 acres (KYOVA, 1974). Ironton has a number of small parks, playgrounds, and boat-launching facilities (U.S. Army Corps of Engineers, 1975).

Historic sites in Lawrence County primarily include old iron furnaces dating back to the 1800's. The Norfolk and Western Railway Depot and Baggage Station is located in Ironton and, along with the various iron furnaces, the county jail, and the brick house, is listed in the Ohio Prehistoric and Historic Inventory (U.S. Army Corps of Engineers, 1975).

There are 29 Protestant and 2 Catholic Churches in Ironton. The city has an evening and Sunday newspaper and one radio station.

Police and Fire Protection

As of 1974 there were 21 local and state police departments in the region, with about 290 regular policemen in service. In Lawrence County, police protection is provided primarily by the Ohio Highway Patrol, the Lawrence County Sheriff's Office and the Ironton Police Department. There are other smaller departments in neighboring communities. There is a total of about 50 full-time police officers in the county. Half of these are on the Ironton police force. By 1990, 5 to 6 more policemen will be needed to serve the expected increased population.

The downtown area of Ironton is of high commercial value but does not lie within the optimal response distance of any fire station in the vicinity. The nearest station is in Coal Grove to the south (see Figure 3.9-2). The Ohio Inspection Bureau recommended in 1959 that two new fire stations be constructed immediately in the northern and southern portions of the community. As of 1974 these were still planned but not yet built.

Water and Waste Disposal

The City of Ironton Waterworks draws its water supply from the Ohio River with a present treatment and consumption rate of 2.577 million gallons per day (MGD). Reservoir capacity is 5 MG for treated water. Over 500 customers (or approximately 16,500 people) are served both within the corporate area and in Coal Grove. The system was constructed in 1959 and also supplies water to local industries (U.S. Army Corps of Engineers, 1975). The city's sewage treatment plant provides only primary treatment and will have to be upgraded to secondary treatment by 1977. The KYOVA Interstate Planning Commission is responsible for preparing the region's Water Quality Management Study (required by the EPA's section 208), which will include plans for all water and sewer districts in the region.

Lawrence County is the only county in the region with a county-wide garbage and refuse disposal district. Collection services are adequate in the urban corridor along the Ohio River, which includes Ironton, but are totally inadequate elsewhere in the county. Most waste is disposed of in a sanitary landfill near Hanging Rock in Hamilton Township. Because of convenience, some collectors in the southeast of the county use the landfill at Huntington, West Virginia. KYOVA has prepared a Solid Waste Collection and Disposal Plan for the tri-state region.

3.9.8 Aesthetics

The site is dominated by the remains of the Alpha Cement Plant, which is currently undergoing demolition. There is also a small collection of wrecked automobiles nearby. However, beyond the site, the rural areas of Lawrence County are typically rolling hills covered by deciduous hardwoods. The quiet rural setting contrasts with the relics of the iron furnace era, which still shows its mark near Ironton and the other industrial centers in the region.

TABLE 3.9-1 Summary of existing (1974) and future (1985, 1990) land use.

COMMUNITY	RESIDENTIAL Existing No. of Acres	RESIDENTIAL Proposed No. of Acres	RESIDENTIAL Total Proposed Acres	COMMERCIAL Existing No. of Acres	COMMERCIAL Proposed No. of Acres	COMMERCIAL Total Proposed Acres	INDUSTRIAL Existing No. of Acres	INDUSTRIAL Proposed No. of Acres	INDUSTRIAL Total Proposed Acres	RECREATION AND OPEN SPACE Existing No. of Acres	RECREATION AND OPEN SPACE Proposed No. of Acres	RECREATION AND OPEN SPACE Total Proposed Acres
Wayne County, W. Va.	3,209	735	3,944(1)	374	150	524(1)	366	104	470(1)	8,367	38,411	46,778
Cabell County, W. Va.	2,516	407	2,923(1)	590	160	750(1)	165	70	235(1)	804	983	1,787
City of Huntington, W. Va.(2)	3,378	552	3,930	247	82	329	699	628	1,327	532	186	718
Boyd-Greenup Counties, Kentucky (3) (4)	8,210	800	9,010	355	285	640	530	206	736	1,107	1,393	2,500
Ashland Planning District (4)	2,454	2,383	4,837	285	251	536	544	331	875	75	245	320
City of Ashland, Kentucky (5)	1,236	700	1,936	86	75	161	282	250	532	60	120	180
Lawrence County, Ohio	4,496(6)	4,653	9,149	466	188	654	500	174	674	2,429(7)	380(7)	2,809(7)
City of Ironton, Ohio (8)	665	147	812	94(9)	73	167(9)	274(10)	146	420(10)	58	78	136

Footnotes:

(1) Land Use totals for Wayne and Cabell Counties are acreages proposed to year 1985
(2) Figures taken from Huntington Comprehensive Plan, 1963
(3) Include portions of Greenup County, Kentucky and do not reflect county-wide totals for either county
(4) All existing land use totals are for 1968 with exception of Ashland District, Boyd County, Kentucky - where 1966 totals are used
(5) Figures taken from "Ashland Neighborhood Analysis Report," 1961
(6) Does not include City of Ironton
(7) Includes City of Ironton
(8) Figures taken from Ironton Comprehensive Plan, 1965 and subsequent update, 1972
(9) Combined "Commercial" and "Industrial" Non-manufacturing classifications
(10) Includes railroad rights-of-way

Source: KYOVA, 1974.

TABLE 3.9-2 Employment by occupation 1960 and 1970, Huntington-Ashland SMSA

	1960		1970	
Occupation	# Employed	% of Total	# Employed	% of Total
Professional, Technical & Kindred Workers	8,461	10.5	11,212	13.4
Farmers & Farm Managers	1,050	1.3	424	0.5
Managers, Officials & Proprietors, Except Farms	6,581	8.2	6,812	8.1
Clerical & Kindred Workers	10,399	12.0	12,479	14.9
Sales Workers	6,744	8.4	6,085	7.2
Craftsmen, Foremen & Kindred Workers	12,828	16.0	14,392	17.1
Operators & Kindred Workers	15,752	19.6	16,131	19.2
Private Household Workers	1,910	2.4	1,293	1.5
Service Workers, except Private Household	6,435	8.0	9,368	11.2
Farm Laborers & Farm Foremen	547	0.7	222	0.3
Laborers, except Farm & Mine	5,769	7.2	5,419	6.5
Occupation not Reported	3,928	4.9	100	0.1
TOTALS	80,404	100.0	83,937	100.0

Source: U.S. Bureau of the Census, 1960, 1970.

TABLE 3.9-3 Occupation for Lawrence County and Ironton, Ohio

Occupation	Lawrence Co.	Ironton
Professional, technical, and kindred workers	1,841	687
Managers and administrators except farm	1,120	453
Sales workers	1,108	426
Clerical and kindred workers	2,311	842
Craftsmen, foremen, and kindred workers	3,512	807
Operatives except transport	3,196	724
Transport equipment operatives	896	134
Laborers, except farm	1,376	358
Farmers and farm managers	152	---
Farm laborers and farm foremen	100	---
Service workers except private household	1,824	677
Private household workers	157	75
TOTAL	17,593	5,183

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

TABLE 3.9-4 Effective buying income - 1974, Huntington-Ashland SMSA

AREA	EBI ($000)	% Of U.S.	Per Capita EBI	Median Hsld. EBI	Avg. Hsld. EBI	% of Households by EBI Groups						
						$0 $2,999 Hslds.	$3,000 $4,999 Hslds.	$5,000 $7,999 Hslds.	$8,000 $9,999 Hslds.	$10,000 $14,999 Hslds.	$15,000 $24,999 Hslds.	$25,000 & Over Hslds.
HUNTINGTON-ASHLAND SMSA	1,178,380	.1205	4,036	10,349	11,831	15.5	10.1	13.2	9.4	23.5	22.4	5.9
Boyd, Ky.	232,313	.0238	4,485	11,863	13,125	12.3	9.8	12.0	8.0	22.5	27.1	8.3
Greenup, Ky.	132,395	.0135	4,049	11,916	12,854	12.1	9.1	11.3	8.4	25.3	27.1	6.7
Lawrence, Ohio	210,735	.0215	3,383	9,210	10,180	17.9	11.0	14.0	11.9	26.3	16.8	2.1
Cabell, W. Va.	475,151	.0486	4,432	10,511	12,374	15.4	9.8	13.4	8.9	21.6	23.2	7.7
Wayne, W. Va.	127,786	.0131	3,363	9,002	10,223	19.2	11.2	14.9	9.5	23.5	18.8	2.9

Source: Sales Management Magazine, 1975.

TABLE 3.9-5 Housing stock inventory in the Huntington-Ashland SMSA, 1960 to 1975

	YEARS						
	1960	1970	1971*	1972*	1973*	1974*	1975*
Total Units	80,067	87,153	87,850	88,625	89,475	90,500	92,000
Occupied Units	74,452	81,349	82,150	82,915	83,775	85,000	86,800
Vacant Units	5,615	5,804	5,700	5,719	5,700	5,500	5,200
Vacancy Rates	7.0%	6.6%	6.5%	6.4%	6.4%	6.1%	5.7%

Source: KYOVA Interstate Planning Commission, 1974.

*Estimates

TABLE 3.9-6 Employment by industry, Huntington-Ashland SMSA, 1950-1980

Industry Category	1950	1960	1970	1980*
Agriculture, Forestry & Fisheries	5,646	1,796	1,081	950
Mining	2,108	890	1,014	989
Contract Construction	4,977	5,050	5,904	6,761
Manufacturing:	21,349	23,947	25,116	28,500
Food and Kindred Products	1,152	1,517	780	761
Textile Mill Products	57	28	25	50
Apparel & Other Fabric Products	1,424	1,167	1,256	1,245
Printing & Publishing	679	1,008	630	715
Chemicals & Allied Products	1,708	2,282	2,223	3,414
Lumber Products & Furniture	1,671	1,016	697	789
Machinery (All)	1,345	1,136	1,461	1,491
Transportation Equipment			2,191	2,930
Other Manufacturing	12,246	14,211	15,853	17,105
Transportation, Communications & Utilities:	10,986	8,795	8,304	9,311
Transportation	8,811	6,580	5,570	5,970
Communications	801	1,014	1,046	1,255
Utilities (Elec., Gas & Sanitary)	1,374	1,201	1,688	2,086
Wholesale & Retail Trade	15,873	15,844	16,975	18,760
Finance, Insurance & Real Estate	1,803	2,488	2,968	3,754
Services:	13,507	15,946	18,582	24,4[illegible]
Business Services	6,669	6,733	8,372	9,231
Professional Services	6,838	9,213	10,210	15,262
Government:	2,760	2,782	2,753	3,482
Civilian Government	2,642	2,680	2,600	3,307
Armed Forces	118	102	153	175
Industry Not Reported	921	2,866	---	---
TOTAL	79,940	80,404	83,937	97,000

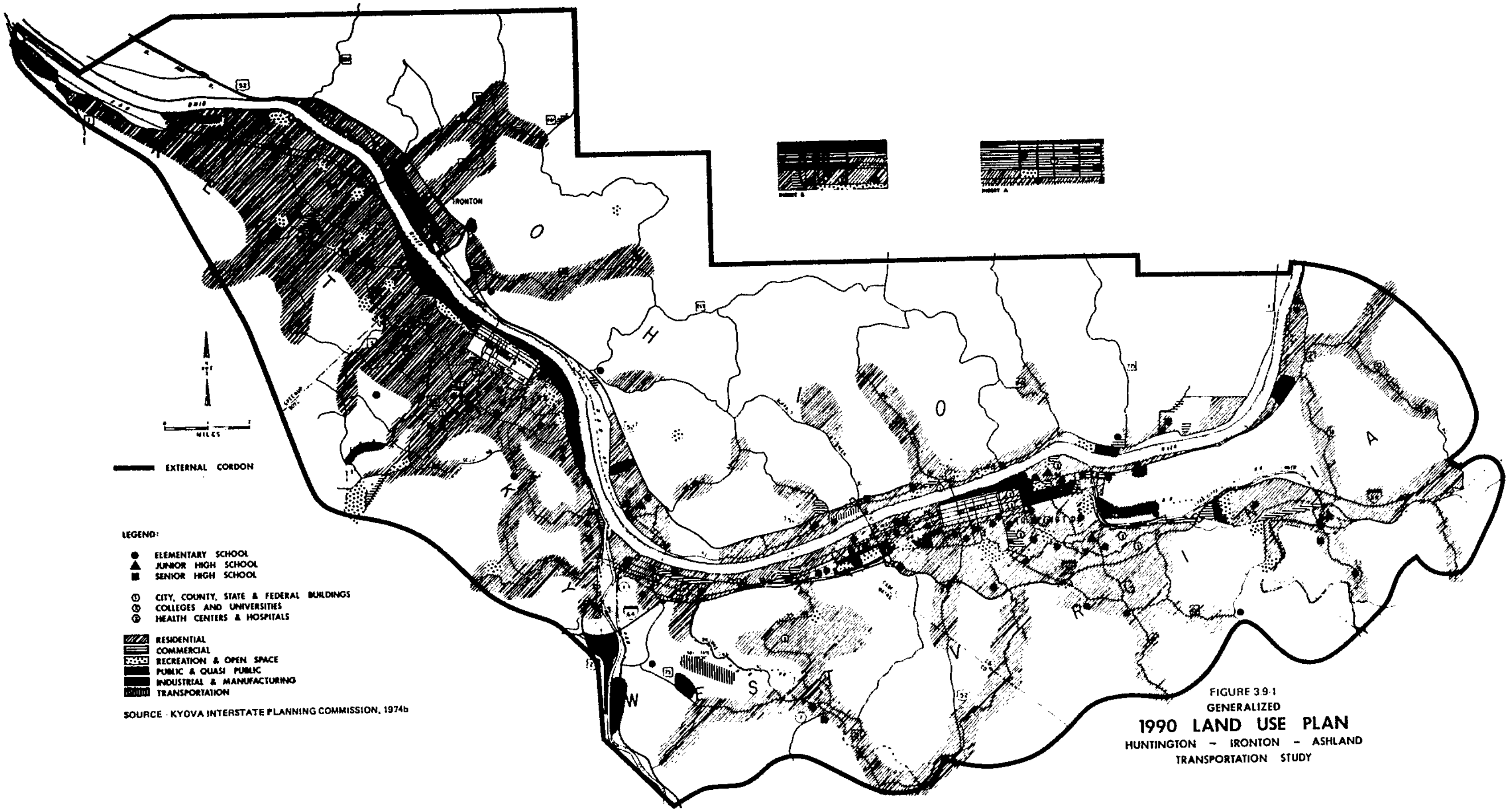
Source: KYOVA, 1974.

*Projections

TABLE 3.9-7 Industry of employed persons in Lawrence County and Ironton, Ohio - 1970

Industry	Lawrence Co.	Ironton
Agriculture, forestry, and fisheries	368	29
Mining	217	43
Construction	1,129	240
Manufacturing	6,306	1,526
Railroads and railway express service	695	275
Trucking service and warehousing	335	67
Other transportation	199	25
Communications	244	109
Utilities and sanitary services	287	105
Wholesale trade	526	77
Food, bakery and dairy stores	604	189
Eating and drinking places	478	215
General merchandise retailing	311	66
Motor vehicles retailing and service stations	607	164
Other retail trade	905	360
Banking and credit agencies	286	111
Insurance, real estate, and other finance	290	103
Business services	145	74
Repair services	182	
Private households	140	67
Other personal services	578	184
Entertainment and recreation services	109	29
Hospitals	459	173
Health services, except hospitals	265	106
Elementary and secondary schools & colleges	874	292
Other education and kindred services	23	13
Welfare, religious and nonprofit organizations	209	131
Legal, engineering, and miscellaneous professional services	243	125
Public administration	579	285
TOTAL	17,593	5,183

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



SOURCE - KYOVA INTERSTATE PLANNING COMMISSION, 1974b

FIGURE 3.9-1
GENERALIZED
1990 LAND USE PLAN
HUNTINGTON - IRONTON - ASHLAND
TRANSPORTATION STUDY

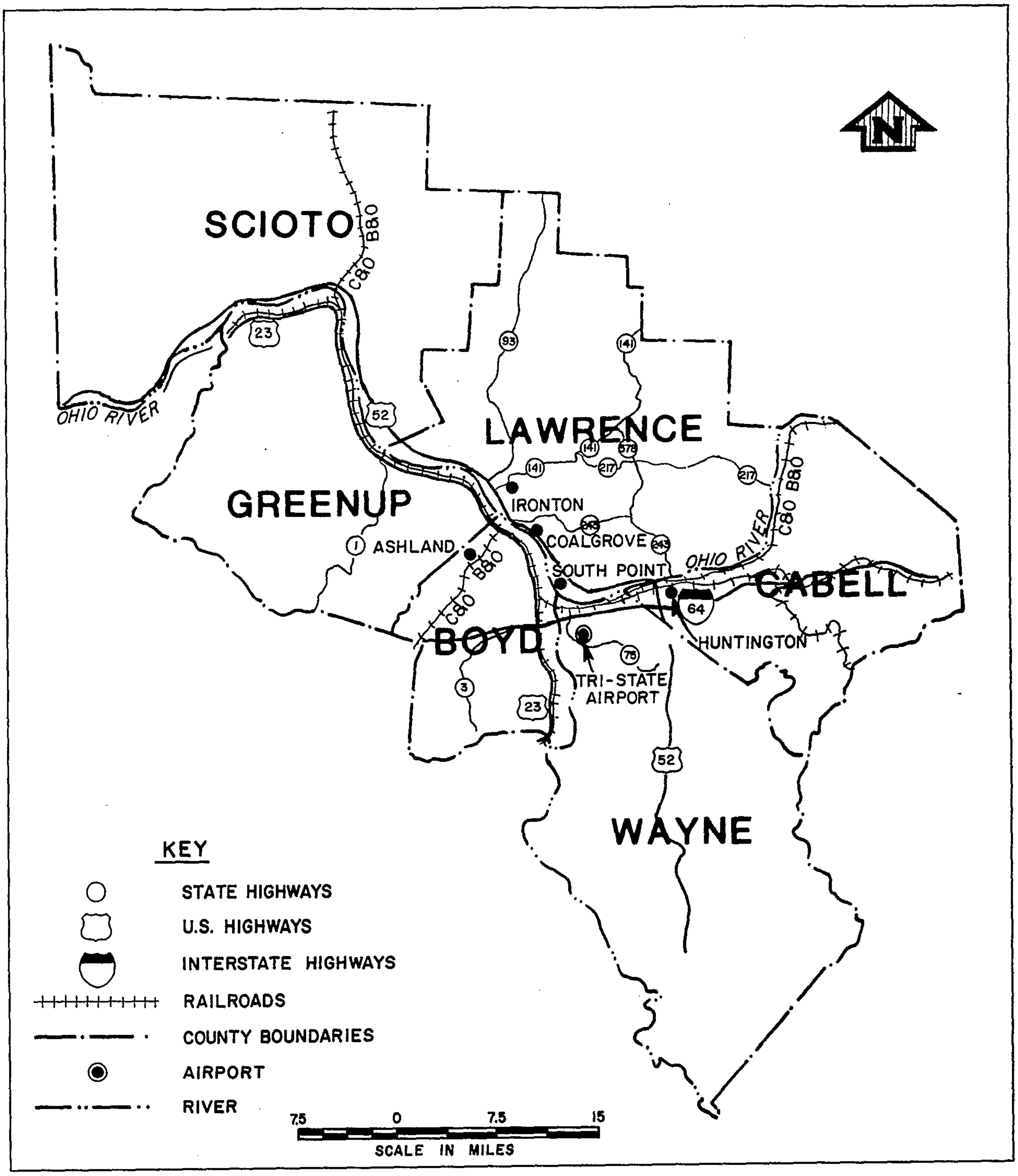


FIGURE 3.9-2 Major transportation routes near Ironton

3.10 Environmental Setting of Oil Transportation Route

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

The distribution system of either the foreign or domestic crude oil to be stored at Ironton Mine is expected to originate at the Gulf Coast. The method of transportation is assumed to be as follows (See Figure 2.3-9):

(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 the Ashland 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 industrialized. 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. Department 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 Ironton Mine.

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 5000 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 pipelines cross 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 parks or wildlife refuge lands. It does cross the northern section of Daniel Boone National Forest in Rowan County, northeast Kentucky. Aquifers along the route 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 3.2-11.

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 emission 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 proposed actions that may cause environmental or social impacts are construction and operation of the proposed oil storage facility at Ironton, construction of a pump station adjacent to the Catlettsburg terminal and construction of 13.1-mile pipeline connecting these two facilities. Expected and potential impacts (both positive and negative) are described in some 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, and 300 pounds per day from tank farms at St. James, Louisiana, Patoka, Illinois and Owensboro, Kentucky; sedimentation in downstream impoundments as a result of pipeline construction; and annoyance of nearby residents as a result of construction noise.

Oil spill damage potential is described in detail in Section 4.3.8. The expected annual average volume of oil release is extremely small (approximately 50 barrels over the entire transportation system from the Gulf of Mexico to Ironton, Ohio) and does not pose a threat to any unique or otherwise important component of the ecosystems, to human safety, or to normal use of land and water resources. Maximum credible spill incidents (60,000 barrels from tankers in the Gulf; 10,000 barrels from Capline or Ashland pipelines; 3000 barrels from the spur pipeline between Catlettsburg and Ironton 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.

Hydrocarbon emissions from transport, transfer and storage of crude oil between the Gulf of Mexico and Ironton 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 the 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. These emissions would occur for relatively brief periods during each fill operation. High ambient hydrocarbon concentrations would extend the area air quality standard exceedance slightly.

4.2 SITE PREPARATION AND CONSTRUCTION

Preparation of an oil storage facility at Ironton involves modification of existing mine facilities to receive oil and construction of a 13.1-mile pipeline to the Ashland refinery in Catlettsburg. No new construction is required to deliver oil from the Gulf of Mexico to the Ashland Terminal at Catlettsburg.

Major construction activity includes modification and extension of a pump shaft; sealing one existing shaft; surface grading; construction of an electrical power substation and a pump station, piping, and manifolds; regrading of the mine caverns to promote oil drainage; construction of a 13.1-mile pipeline; and construction of a terminal at Catlettsburg. 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, i.e., geology, hydrology, air quality, and so forth.

4.2.1 Geology

The Ironton 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 pipeline trench. Soil erosion rates are not expected to increase significantly. However, there will be some erosion of bare ground before new plant growth begins.

As presently planned, shaft No. 2 would be utilized for all of the pipeline casings and pumping equipment. Both existing shafts (Nos. 1 and 2) will be sealed with a double concrete bulkhead - one near ground level and the other a short distance above the mine roof. The lower bulkhead will be keyed into the limestone, and the upper bulkhead at shaft No. 2 will be part of the foundation for support of pumping equipment and casings.

Utilization of existing shaft No. 2 is the most expeditious development mode. Subsurface construction activities will be confined to sealing shafts 1 and 2, deepening shaft No. 2, and regrading the mine floor to promote effective oil drainage; the impact of this construction on the environment will be minimal. All surface facilities of the Alpha-Portland Cement Plant are in the process of demolition. The plant area is highly disturbed and would be very suitable for any minor amount of tailings disposal generated by conversion to crude oil storage. These tailings could be distributed over some of the surface acreage of the site, graded flat, and stabilized by revegetation.

Material excavated from the pipeline trench will be retained for backfilling after system pressure checks. Soil profiles will be inverted as a result of excavations and backfilling, but no significant adverse effects are expected.

Two small diameter ventilation shafts exist in the mine. Although it is possible that one or both of these shafts might be used for ventilation during the filling and drainage cycles of crude oil storage, this is not likely because the existing shafts are not located where the mine room height is greatest, and thus would not provide proper ventilation. Therefore, two new ventilation shafts are planned (Figure 2.1-3); the existing ventilation shafts will be plugged. The new ventilation shafts will be drilled from the surface by means of conventional drilling equipment. The area of disturbance will be confined to the immediate vicinity of the drill rig and limited earthwork that may be necessary to provide access.

Known economically recoverable mineral deposits in the vicinity of the mine are limited to coal, gravel, and limestone. Coal seams at the mine site are generally too thin to support underground mining and are marginal for economic contour stripping. Gravel deposits are quarried near the mine and will not be affected by oil storage. Limestone resources are limited to the Maxville Formation at the level of the mine. However, extraction of these resources is currently not economically feasible. Therefore, no significant mineral resources will be affected by conversion of the mine to crude oil storage.

4.2.2 Hydrology

4.2.2.1 Surface Water

The construction phase of the project will impact the surface waters of the study 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. Release of treated pumpout and seepage water.
4. A decrease in water quality.

The excavation and refilling of the 13-mile long pipeline trench will disturb the natural soil along the route. The total amount of disturbed soil along the route will be about 40 acre-feet. Of this amount, about 20 percent or 8 acre-feet of soil is estimated to be subject to the runoff-erosion process. This eroded material will gradually enter the streams of the watersheds crossed by the pipeline and will be carried as a bed and suspended load by these streams to the Ohio River. 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 also be less compact than the undisturbed material, causing a higher infiltration rate in part of the stream catchments along the pipeline trench. However, this impact is considered very insignificant on both the local and regional environment.

The most significant potential impact will be the increase of sediments in Ice Creek, which will enter the Ohio River. There are no impoundments or bodies of water which will receive an increase in sediment loading other than the Ohio River, which is directly downstream of Ice Creek. Greenup Lock and Dam is located about 16 miles downstream of the confluence of the creek and the river. The additional increase in sediments delivered to the Greenup Lock and Dam is estimated to be 0.37 acre-feet. Considering the size of the Ohio River and the impoundment behind the dam, accumulation of even the entire 8 acre-feet of potential sediment would be an insignificant impact.

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

The construction of the part of the pipeline crossing the Ohio River (1500 feet long) will cause some changes in the water quality. The disturbance of bottom sediments caused by dredging will create low oxygen conditions by exposing the BOD of sediments to dissolved oxygen in the water column; the pH will be lowered by exposure of sulfides to oxidation, creating sulfuric acid. In addition, heavy metal concentration may be increased by exposing complex metals to low pH conditions. River bed construction will also release trapped nutrients from the substrate, thereby stimulating local eutrophication and creating highly turbid conditions because of the mixing of water with the sediments.

The level of impact created by pipeline construction across the Ohio River is not quantifiable but will be adverse for a brief period of time during and after construction. These effects are judged to be significant and adverse to the immediate vicinity of the Ironton project but not to the region, because the impacts are localized. Generally, mixing of disturbed bottom sediments does not influence water quality downstream more than 2 to 3 miles. However, this is highly dependent on the nature of the sediment in any particular area.

The surface drainage pattern will not be altered significantly by surface facilities of the project. No surface stream water will be required by the construction activities.

Release of treated pumpout and seepage water will occur at the Ironton Mine. The Cavern Water Treatment System was designed to treat seepage and pumpout water before discharge into Ice Creek or the Ohio

River to remove oil, ammonia, BOD, barium, copper and mercury. Specific treatment is described in section 2.0. Table 4.2-7 presents concentrations of components found in a typical Ironton Mine water sample which might require treatment. The table also gives maximum allowable concentration in receiving waters based on Ohio water quality standards (Appendix B). Since the effluent will conform to state standards after treatment and will constitute a small fraction of the flow rate in receiving streams, it will not cause adverse impact to either Ice Creek or the Ohio River.

During pumpout of water from the mine prior to development for oil storage, an estimated 40 million gallons of water must be treated to remove potentially harmful concentrations of pollutants. A special, high volume capacity waste treatment system, similar in type to the permanent system described in section 2.3.3, will be required to process this effluent. Complete removal of the mine water in 30 days (assuming 24-hour per day operation) will require an average capacity of approximately 1150 gpm, discharging effluent to Ice Creek at the rate of 2.6 cfs. The average flow rate in Ice Creek is approximately 43 cfs (section 3.3, based on 30,476 acre-feet per year). Thus, only during below-average flow periods will the pumpout water constitute more than 6 percent of the flow in Ice Creek. Since water quality in Ice Creek is already significantly degraded by acid mine drainage, discharge of pumpout water from the mine, treated to comply with state standards, should have little adverse effect on Ice Creek and no adverse effect on the Ohio River.

4.2.2.2 Ground Water

Significant levels of ground water contamination or drawdown are not expected to result from construction activity at the Ironton Mine. The Pennsylvanian age bedrock at the mine site is not considered a usable aquifer because of its very low yield and poor chemical quality. Ground water in the vicinity of the mine site is available from the alluvial aquifer occupied by the flood plain of the Ohio River and Ice Creek. The alluvial aquifer is hydraulically connected not to the bedrock, but to the adjacent river or creek. Therefore, no interaction between development of the mine for crude oil storage and the alluvial aquifer is anticipated.

Construction of the pipeline and other surface facilities will be restricted to small areas and will involve relatively minor quantities of near-surface materials. Because the ground water levels will generally be below the pipeline, its emplacement will not affect the ground water hydraulics. Although the materials will be reworked, their physical characteristics will remain unchanged. Because of the original low permeabilities of most of the surface materials, reworking by the pipeline construction will not greatly affect their ability to absorb water. Exceptions would be the coarser loams and sands, but since the pipeline will cross little or none of these materials, there will be no noticeable effect on the recharge and ground water movement in the local aquifers.

During construction and modification of the site, an estimated maximum of less than 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 either from the municipal supply or from the existing well on the site in the vicinity of Ice Creek; these local supplies are more than adequate.

4.2.3 Air Quality

The State Implementation Plan has not developed detailed projected levels of air quality by region, but states that the primary standards will be met by 1976 in all areas, and that in many regions the secondary standards will be met. From 1974 data, the existing air quality in the vicinity of the site can be summarized as good, with the exception of the high ambient levels of hydrocarbons.

The two largest potential effects on air quality associated with construction of the proposed oil storage facility at Ironton are particulate matter (dust) and diesel exhaust (SO_2, NO_x, CO, hydrocarbons) emissions resulting from the construction equipment. Regrading at the site will be minimal; much of the construction activity at the mine site will be underground. Construction of the surface pipeline system 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 4.2-1 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.

Fugitive Dust

In addition to the particulate concentrations resulting from the operation of equipment, dust emissions will result from construction activities at the site and along the pipeline route. 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 Ironton 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 Ironton is estimated to be approximately 0.6 ton of dust per acre of construction per month of activity.

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 of concentrations were made using methods recommended by the Environmental Protection Agency (Turner, 1969) and averaged over appropriate time intervals.

Air pollutant concentrations resulting from Ironton project construction equipment are given in Table 4.2-2. The concentrations were calculated using construction area emission rates (Table 4.2-1) 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 4.2-2 will be lower with increasing distance. Therefore, the concentration at 0.5 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 4.2-2 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 Ironton construction site. Sound levels from construction activities (not including detonation) are summarized in Tables 4.2-3 and 4.2-4. Construction activities will take place over a 12-month period. Section 4.2.4.1 specifies 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 4.2.4.2 and 4.2.4.3).

4.2.4.1 Construction Sound Sources

During the period of conversion of the existing cavern to an oil storage facility, there will be many construction activities on the site. Each construction activity and the sound levels from the operation of the equipment are discussed separately in the following paragraphs. The sound levels are summarized in Table 4.2-5.

Conversion of Present Mine to a Storage Facility

Most of the construction activity such as installation of bulkheads and channelization along the mine floor to improve drainage will be conducted underground. The audible sound level above the existing ambient sound level due to underground construction activity is estimated to be negligible.

Aboveground construction will consist of sealing 1 of the 2 existing vertical shafts with concrete bulkheads, and drilling 2 ventilation shafts. These shafts will not be of sufficient diameter to require blasting. The surface equipment necessary for the mine conversion is presented in Table 4.2-3. The equivalent sound level contribution at 500 feet is estimated to be 69 dB (see Appendix D).

Construction of Pipeline System and Terminal

An estimated 2 trucks, 1 backhoe, 1 welding machine, 1 scraper, 3 wheel-mounted cranes, and 2 air compressors will be used to construct 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 detonation equipment will be required. It is estimated that 5 to 10 blasts per day for the first month of construction will be necessary to remove the substantial quantities of limestone that lie close to the surface along the route. Construction equipment and associated sound level data are presented in Table 4.2-4.

Pipeline construction activity is generally scheduled for 10 hours in the daytime. The equivalent sound level (L_{eq}) contribution at 500 feet from construction activity through pasture lands is estimated to be 68 dB. Pipeline construction activity noise (L_{eq}) 500 feet from construction through limestone rock 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.

4.2.4.2 Ambient Sound Levels

In order to estimate the ambient sound levels during construction, the sound level contributions (see Table 4.2-5) were extrapolated, using hemispherical sound radiation theory, and combined with the estimated background ambient sound levels. The assumption of hemispherical radiation does not include attenuation due to foliage, air, or ground absorption, and is therefore conservative. The construction at the mine site is assumed to occur concurrently with the construction of the pipeline. Ambient sound levels are estimated for the worst cases of construction where pipeline construction activity is closest to the area of concern. The results of this computation are presented in Table 4.2-6.

The results indicate that, except at the mine site and during blasting, the increase in ambient equivalent sound levels is small. At the city of Ironton, ambient L_d and L_n are estimated to increase by 1 dB and 5 dB, respectively. The nighttime sound level change is due to mine site construction. During the noisiest phase of pipeline construction, where rock removal equipment is used, ambient L_d at pasture lands 1 mile from the construction activity will be increased by about 6 dB. Impulse noise emitted from the use of explosives in the removal of rocks during pipeline construction will be high. However, overpressure created from detonation is of such a short duration as to not significantly contribute to the ambient equivalent sound level.

4.2.4.3 Impacts on Residents

The impacts 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.

The U.S. Environmental Protection Agency (EPA) 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 (see Appendix D). During the noisiest phase of construction, the ambient day/night equivalent sound level (L_{dn}) at the city of Ironton (1 mile from the site) is estimated to increase from 55 to 58 dB. This increase may cause some public annoyance to residents within a 1-mile radius of the site. However, the construction activity will be temporary; most construction will be underground.

Areas of Ironton further than 1-1/2 miles from the site will not experience any significant increase in ambient sound levels. At noise-sensitive areas along the pipeline route, the ambient L_{dn} is estimated to be about 53 dB during the construction period. This sound level is below the EPA-suggested criterion of 55 dB (L_{dn}). Impact noise levels from blasting at 1000 feet may be as high as 91 dB. The only impact data on blast type impulsive noise have been obtained from aircraft sonic boom studies. The EPA (1974) proposes that the peak daytime overpressure, as it relates to impulsive noises, be related to the frequency of impulses. According to the EPA, at 10 blasts per day and a peak overpressure below 113 dB, public health and welfare will not be degraded.

4.2.5 Ecology

No detailed wildlife inventories have been undertaken at the site to establish population indices or densities. Available inventory data does not quantify wildlife populations for the Ironton area (U.S. Army Corps of Engineers, 1975). The scarcity of this type of information makes quantification of ecological impacts with current methods impossible. Consequently, estimates of wildlife impacts are based on field observations and a general background knowledge of the site. Species discussed in this section are considered to be the most probable organisms to be impacted by construction of the storage facility and pipeline.

4.2.5.1 Terrestrial Ecology

An estimated 2 acres of land will be impacted by construction at the Ironton storage site; an additional 2 acres will be impacted at the pipeline terminal. Currently all of this land is an abandoned limestone mine site with buildings and structures in various stages of dismantlement. It is possible that some additional lands adjacent to the immediate site will be made temporarily unsuitable for certain species or activities by the noise and physical activities associated with construction. However, the entire 397 acres consist of disturbed land which has been in this condition for approximately 60 to 65 years, so there will be negligible loss of habitat resulting from storage facility construction. To the extent that the oil storage facility precludes other potential development of this site during the life of the project (for security reasons), existing habitat will be temporarily preserved.

There are no known 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 no observable difficulty in locating suitable habitats, especially to the north, east, and south of the site.

Locations of the pump station, and pipeline corridor were chosen to minimize the ecological effects of construction and operation. Two major ecosystems exist; the mixed mesophytic forest will be the only one potentially impacted during construction of the storage facility. It is unlikely that the construction activities will influence the upland hardwood forest on the site, for all construction will be conducted well below the elevation at which this vegetation is found.

Wildlife species inhabiting the mine site area are not likely to be significantly affected by construction of the storage facility. Very little habitat is expected to be lost as a result of construction. Species of wildlife that may be disturbed by construction activities and noise are those that have already adapted to man and his activities and often seek out his habitations for their own homes. Some of these species are the chimney swift, red-winged blackbird, starling, common grackle, cardinal, robin, house mouse, Norway rat, rat snake, American toad, and mountain chorus frog.

As indicated in section 4.2.7.1, forest, cropland and pasture activities are the most common activities within the pipeline corridor right-of-way. While construction activities will be completed within 6 months, it cannot be assumed that the land will be productive the year following construction. Within the forest lands, productive standing crop requires 50 to 75 years for economically valuable regrowth to occur. Cropland and pasture will require 2 or more years of revegetation to become economically usable grazing or production lands.

Impacts upon wildlife resulting from creating the pipeline trench and laying the pipeline are likely to be short term. Nearly 1/3 of the route near the Ironton Mine site follows an existing transmission line corridor. This portion of the corridor is predominantly ridgeland comprised of brushland and woodland edge. Some of the wildlife species that inhabit these areas and are likely to be directly or indirectly affected by the construction include the ruffed grouse, cottontail rabbit, white-tailed deer, white-footed mouse, ground skink, marbled salamanader, and northern ringneck snake.

The most pronounced effects will occur in woodland areas where the pipeline right-of-way leaves the existing transmission corridor. Creating the corridor will remove approximately 20 acres of woodland habitat that is frequented by a variety of wildlife species. Although the overall pipeline width and total acreage to be temporarily disrupted is small, the removal of den trees, cover, feeding, and nesting areas, and the increased human activities are likely to affect some deer, squirrels, white-footed mice, ruffed grouse, many forest-inhabiting songbirds, and several species of reptiles and amphibians (see section 3.6.2). The small extent of the project activities poses no threat to the survival of any of the terrestrial species which may use the area, however.

The overall effect on animals having to move to adjacent habitats is not known. Some losses may occur if competition with already present species is great or if animals are forced to move into marginal areas where they are more subject to predation. A simple move to new territory is significant for many animals. Familiarity with surroundings is a major factor affecting the survival of many species. The proposed action will result in the creation of new "edge" areas where forage species and brushy cover will provide food and protection for wildlife. Creation of this new habitat will occur through natural seeding or man's revegetation methods; either way will take time. Until this occurs, the approximate 40-foot right-of-way will have no positive value for wildlife. Instead, it is likely to serve as a barrier to some wildlife species, particularly the small rodent species.

Cropland and pasture along the pipeline corridor provide feeding areas for wildlife species. Placing the pipeline in these areas will have limited short-term effects upon wildlife. Some species that may be affected are the bobwhite quail, meadowlark, starling, common grackle, song sparrow, cottontail rabbit, striped skunk, meadow vole, deer mouse, eastern box turtle, and rat snake. The amount of habitat to be temporarily removed is fairly small, and it is unlikely that significant shifts in animal populations will occur.

Streams and creeks are important wildlife habitats in the project area. Many animal species inhabit the streambanks and feed along the watercourses. Few species, other than the muskrat, turtles, and frogs, actually spend much of their time in the streams. The amount of stream habitat to be affected by the proposed action is small, and the effects of construction likely to be limited and temporary. Most of the species inhabiting these areas are mobile enough to move either upstream or downstream from the impacted areas.

The remaining areas to be affected by the proposed action are either industrial or residential areas. Wildlife species inhabiting these areas have already exhibited an ability to adapt to their surroundings and are unlikely to be affected by the construction. The small acreage loss is unlikely to create a habitat shortage or to necessitate wildlife populations to shift to adjacent areas.

4.2.5.2 Aquatic Ecology

Direct impacts at the Ironton Mine site from any of the construction activities, including bulkhead construction, pump shaft excavation, plugging of existing vertical shafts, and mine dewatering, are expected to be minor. Sedimentation and erosion in Ice Creek and the Ohio River will occur; however, this adverse impact will be temporary, lasting for the construction period and 2 to 4 months afterwards.

As indicated in section 4.2.2.1, dewatering of the Ironton Mine will result in discharge of approximately 40 million gallons of water to Ice Creek over a period of approximately 1 month. Since this effluent will be treated for removal of harmful concentrations of oil, ammonia, BOD, and heavy metals, and the effluent will average only 6 percent of the normal Ice Creek stream flow, no significant adverse impacts on aquatic life in either Ice Creek or the Ohio River are expected.

The proposed pipeline route crosses 9 small streams of permanent flow and the Ohio River (see Figure 2.1-4). Construction activities at stream crossings, including trenching, pipelaying, and backfill operations, may have several potential adverse effects on the aquatic environment. However, extensive environmental damage will be avoided by use of standard ecological and soil conservation practices during construction of the project. Construction unavoidably will produce physical disruption of streambeds at stream crossings, with the consequent destruction and/or displacement of the associated biota. An area of about 300 square feet will be required for the pipeline right-of-way in the small stream beds. Stream bank erosion, downstream siltation, and increased water turbidity are other associated effects.

Physical disruption of streambeds will destroy some existing aquatic habitats (estimated at 2700 square feet) at the various small stream crossings. Mobile organisms, primarily fish, will move to other areas within the system, possibly exerting a slight pressure on adjacent habitats. However, local fish populations could be seriously affected if construction occurred during the spawning and egg maturation periods. Immobile benthic organisms and rooted vegetation in the dredged area and immediately downstream would be eliminated directly. The time required to reestablish these populations would be quite variable (generally from 6 to 24 months), and would be dependent upon the water quality, sedimentation, and biological characteristics at each crossing.

Organisms inhabiting the stream banks will also be affected by construction. Noise, dust, and fumes will cause wildlife to retreat from the construction areas. Waterfowl, reptiles, amphibians, and other fauna of riparian association will be dislocated.

Some erosion of the disturbed stream banks and displacement of dredged materials downstream will occur even when proper construction methods are implemented. The extent of erosion will depend upon the time of year that construction takes place and the precipitation and runoff patterns that follow it, but is generally estimated to occur as much as 1-1/2 to 2-1/4 miles downstream. With proper bank stabilization and disposal or containment of dredged material, turbidity of river waters and sedimentation downstream will be short-term.

Increased dissolved and suspended solids in a river system will alter water quality for a distance of 2 to 9 miles downstream and may affect the aquatic biota by increases in nutrient levels and biochemical oxygen demand, and by releasing toxic materials to the system for a period of 6 to 18 months. An increase in nutrient level may be desirable in systems with low biological productivity, but would be detrimental to a system with high primary productivity, such as the streams within the study area. These streams 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 quiescent rates (Seattle University, 1970).

Increased turbidity also decreases light penetration, and therefore can decrease photosynthetic production of phytoplankton, attached algae, and submerged vegetation. Persistent high turbidity may ultimately affect high trophic level organisms, including fish. 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. Increased turbidity can impair fish vision and respiration; high levels of suspended solids clog gills.

Heavy siltation can impair growth and respiration of attached algae, rooted vegetation and grasses, and can alter species composition and numbers of the bottom fauna. Tarzwell (1957), as cited by the FWPCA (1968), found that bottom organisms from a silted area averaged only 36 organisms per square foot, compared to 249 per square foot in a nonsilted area. Siltation has been found to be especially damaging to gravel and rubble-type spawning grounds and habitats of aquatic insects, crayfish, mollusks, and fishes.

4.2.6 Historical and Archaeological Resources

The conversion of the abandoned Ironton Mine to an oil storage facility will not interfere with any known historical or archaeological sites on the mine property.

Before the proposed oil pipeline route can be finalized, 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).

As a result of the planned archaeological investigation at the mine site and along the pipeline route, no adverse impacts to archaeological resources in the area are anticipated.

4.2.7 Socioeconomics

4.2.7.1 Land Use

Approximately 2 acres of the 397-acre project site will be required for the cavern withdrawal and pump station, on-site piping equipment, and access. The site is already zoned for industrial use. No additional acreage will be used for construction at the site since parking and staging areas from previous mining activities already exist. The pipeline terminal will use approximately 2 acres of land.

The pipeline route is approximately 13 miles in length and follows a southeasterly alignment through unpopulated areas along mostly hilly countryside. It is not subject to local zoning regulations. The following tabulation gives the approximate acreages and mileage through which the pipeline corridor will pass. About 4.2 miles will run parallel to existing transmission routes (see Figure 2.1-4).

The area in the immediate vicinity of the Ironton Mine and Catlettsburg Terminal will be precluded from other possible uses for the life of the project.

Land Use	Miles	Acres
Wooded	8.0	38.50
Cropland or Pasture	2.0	9.63
Residential	1.3	6.25
Mixed Industrial	1.2	6.25
Streams and Canals	0.4	1.94
Industrial and Commercial	0.1	0.48
Utilities	0.1	0.48
TOTAL	13.1	63.52

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*Average width for calculation = 40 feet. Actual width ranges from 20 to 60 feet.

4.2.7.2 Transportation

No significant transportation impacts due to pipeline construction or mine conversion are likely. Traffic on U.S. Highway 52 from about 65 new workers each day will be a negligible addition to existing traffic and will not noticeably change the percent of road capacity that the traffic represents.

No roads will be taken out of use by construction. Circulation patterns will be modified temporarily along the pipeline route and some new access roads may be required. These new roads could result in changes in land-use patterns for adjacent areas.

Transport of the facility's oil by pipeline will avoid interference with any other commercial transportation systems. The new 13-mile pipeline will not add transport capacity to the region, though, because it will be dedicated solely to SPR Program use.

4.2.7.3 Population and Employment

As stated in section 2.0, all construction workers for the project are expected to come from within the Huntington-Ashland SMSA. This means that no new families will be moving into the region to work on mine construction. In addition, no moves of families within the region will be necessary since all areas are within commuting distance to the site. And since workers will be commuting from their present homes, there will be no impact on the region's housing.

The construction workers for the project will come from the "craftsmen, foremen, and kindred workers" category of the region's labor force, which had over 14,000 workers in 1970 (see Table 3.9-2). The 65 jobs supplied by the project represent 8 percent of the Ironton workforce in this category and 2 percent of the same group in Lawrence County. The jobs will therefore make a small, temporary contribution to lowering the high unemployment rate in the area.

4.2.7.4 Economics

The project is estimated to have a total gross payroll of approximately $1.5 million (see Table 2.3-1). A gross estimation of taxes amounts to 30 percent, leaving around $1 million in disposable income for a period of just over a year. The Huntington-Ashland SMSA had a disposable income totalling over $1 billion in 1974, and Lawrence County had over $210 million the same year (Sales Management Magazine, 1975), so the additional amount coming into the regional economy from the project is negligible. Retail outlets and service centers in Ironton may experience some additional business during the construction period, but the amount of that business will depend on the number of workers from the immediate area; it is anticipated that the business increase due to the project will be slight.

4.2.7.5 Government

Because no new people are expected to move into the region for project construction, no public services should be affected. If the FEA purchases the property, no taxes will be collected by local governments. If the property is owned and operated by a private entity, it is unlikely that it will be assessed in time for taxes to be collected during the construction period.

4.2.7.6 Aesthetics

Some dust and open storage of equipment, such as stockpiles of pipe, will be evident at the site during construction. However, this should not be much different from the cement plant remains and demolition activities now occurring on the site. Also, the terminal facilities at Catlettsburg will be adjacent to an existing terminal and thus, should have little adverse aesthetic impact.

Construction of the proposed pipeline corridor will have a more obvious effect on the hilly countryside along the Ohio River. Digging of the pipeline trench and stacking of pipes will be in contrast to the natural surroundings. The route will avoid populated areas and those of potential development, and will also follow existing power rights-of-way as much as possible so that the aesthetic impacts of construction will affect as few people as possible.

TABLE 4.2-1 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 4.2-2 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 downwind concentration ($\mu gm/m^3$)
Particulate	Annual mean	75	1.6
	24 hr max	260	48
CO	8 hr max	10,000	637
	1 hr max	40,000	907
HC	3 hr max	160	99
NO_2	Annual mean	100	3
SO_2	Annual mean	80	2.2
	24 hr max	305	66

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

TABLE 4.2-3 Shaft excavation and sealing 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

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

[b] Dames & Moore files.

[c] Estimated.

(1) "Background Document for Proposed Portable Air Compressor Noise Emission Regulations," U.S. Environmental Protection Agency EPA-550/90/9-74-016 (October 1975).

TABLE 4.2-4 Pipeline construction equipment

Equipment	Number	A-Weighted(1) Sound Level at 50 feet (each 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

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

[b] Estimated.

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

TABLE 4.2-5 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 (conversion of existing mine)*	69	69	69
Pipeline Construction (through pasture lands)	68	66	-
Pipeline Construction (through limestone rock areas)	72	70	-

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*Estimated for 24-hour per day construction activity.

TABLE 4.2-6 Ambient sound levels during construction (dB)

	Estimated 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	55	45	55	71	69	76	73	69	76
City of Ironton*	55	45	55	56	50	58	57	50	58
Pasture Lands**	45	35	45	49	35	48	51	35	50
Noise Sensitive Land Uses along Pipeline Route***	50	42	51	52	42	52	54	42	53

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[a] Construction of Pipeline with conventional methods

[b] Construction of Pipeline through limestone rock areas

*Estimated at one mile from site

**Estimated one mile from pipeline route, a long distance from mine site

***Estimated at Catlettsburg

TABLE 4.2-7 Sample concentrations in Ironton Mine seepage water

Component	Sample Concentration (ppm)	Maximum River Concentration (ppm)
Oil	0.5	5.0
Ammonia	9.07	1.5
BOD_5	N.A.	N.A.
Barium	4.10	0.80
Copper	0.0018	0.0010
Mercury	0.0024	0.0005

4.3 OPERATION AND OIL STORAGE

4.3.1 Geology

At present, the Ironton Mine site is owned and operated by Alpha-Portland Cement Co. The mine has been abandoned since 1970. The storage of oil in existing caverns is a well-established technology, as evidenced by the historical safe operation of cavern storage of gaseous and liquid petroleum in Europe, Scandinavia, and the United States.

Ironton Mine does not have any known faults in the cavern and, due to the impermeable nature of the limestone and the pressures of ground water surrounding the mine cavern, seepage out of the storage cavern is unlikely. Some oil will absorb into the limestone walls, roof and floor of the caverns. In a mixed state, neither the oil nor the limestone will be useful for the present market. However, if and when the market values of the limestone and/or oil reach levels making recovery economically feasible, techniques such as distillation processing could be used to separate the oil from the limestone and make both available for use.

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 known 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, is 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.

The cavern appears to be stable and does not show any indication of significant pillar distress. Minor spalling has occurred in some pillars where external slaking of a calcareous shale band has removed support from the stable limestone above and below the band. Slab failure of pillars is rare, but has occurred where some sloping joints intersect pillars. Both the spalling and slab failure have caused local rockfalls but do not jeopardize the overall stability of the mine.

The lithostatic pressure ranges from about 450 to 600 psi. The limestone pillars carry a load of approximately 750 to 1000 psi, based on a typical recovery factor of 40 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 on 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 500 feet of overburden and carries an approximate overburden pressure of at least 500 psi. An explosion-related overpressure would not exceed the lithostatic pressure in any portion of the mine and therefore, would not be of sufficient strength or duration to overcome the weight and intertia of the mine roof. No significant impacts, either positive or negative, are attributed to cavern integrity or stability.

4.3.2 Hydrology

4.3.2.1 Surface Water

The water requirements of the existing mine facilities are minimal, limited primarily to waste disposal, drinking, and fire prevention. Water is presently supplied from the Ironton municipal water system. Water requirements for the oil storage facility will also be supplied by Ironton or perhaps from an existing well in the vicinity of Ice Creek. No impact on surface waters is expected.

Some seepage of water into the mine is possible, but should be limited to less than 10 gpm. This seepage will be periodically pumped from the mine through the sump pump, treated at the surface in an on-site water treatment facility, and then releeased to Ice Creek (see section 2.3.3). As the effluent quality will comply with state standards, and the quantity to be released will be less than 1 percent of the average flow in Ice Creek, no measurable effect on water quality is expected.

There will be no discharge of wastes from surface facilities at the mine site to surface waters. The major potential impact is from oil spills at the surface. However, the risk of a large spill is extremely small. A small oil spill would affect surface water quality, but would be of primary significance to biological resources in the spill zone. This aspect is discussed in detail in Section 4.3.8. Small spills, if occurring with greater than expected frequency, could have a cumulative effect on the water quality in the area of the spills.

As indicated in Section 3.3, the 100-year return flood level at the mouth of Ice Creek is approximately 547 feet above MSL. Since the major surface facilities and pump shaft are located at 580 feet above MSL, they 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

Cavern Storage

The only potentially serious impact from cavern storage involving ground water is the possibility of contamination by the crude oil The fact that virtually no ground water is seeping into the mine under a minimum hydrostatic pressure of 180 psi is a good indication that the caverns are 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. Dewatering of shallow aquifers above the mine is not expected to occur as a result of mine conversion. Any contamination would be limited to 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.

Pressurization that could cause explosive expulsion could result from temporary overpressures such as those from barometric fluctuations, tidal gravimetric changes, or earthquake-generated seismic pulses. These volume changes will be accounted for in establishing the size of the unfilled space in the workings.

Failure of the mine, either by collapse or closure, is also highly improbable. The cavern appears to be stable and does not show any indication of pillar distress. As indicated in section 4.3.1, the limestone pillars have much more strength than is needed to support the cavern roof. Even if a collapse occurred, it would arch only a short distance above the roof of the mine (about 20 to 30 feet) due to the room-and-pillar geometry of the caverns. This distance is insignificant compared to the 500 feet or so of impermeable rock above the mine which would prevent oil from seeping into the surrounding material.

The sole remaining potential for contamination, then, involves upward displacement of oil by water infiltration through the shafts, vent lines, or intake and discharge lines. However, the competency of the bedrock provides a solid basis for support of the various plugs and seals. Despite a hydrostatic head of several hundred feet, the mine workings are virtually dry, illustrating the relative impermeability of the limestone. Therefore, any future effects of oil storage on ground water will require an alteration of existing conditions. The following paragraphs evaluate the various plausible changes.

As described in section 4.2, none of the modifications to the mine interrelate with the ground water system. Therefore, any potential impact would involve a loss of the integrity of the mine and/or its appurtenant structures, resulting in an accidental outward migration of oil. Such migration requires both a driving force and a passageway. Potential driving forces consist of either buoyant uplift by insurgent ground water or pressures induced from decreased available volume. Decreased volume could possibly result from temporary overpressures from barometric fluctuations, earthquake-generated seismic pulses, long-term plastic mine closure, or intrusion by water or gas. The small volume changes due to barometric and seismic causes, as well as those associated with plastic mine closure, will be accounted for in establishing the size of the unfilled space in the workings. Also, there is no evidence of significant amounts of gas in the rock above the caverns in the vicinity of the shafts which might force water into the caverns. The remaining possible driving force is water.

Significant rates of water seepate do not occur within the caverns. Since the termination of mining in 1970, portions of the cavern have collected seepage to a height of 15 feet, but most of this water is from surface drainage down the shafts. Therefore, the only passageways that appear pertinent to high volumes of water influx are those that extend beyond the boundaries of the limestone bed. Potential man-made avenues include shafts, other intake and discharge pipes, and oil and gas wells. Other potential passageways that have been considered are fractures created by accidental explosion, faults reactivated by earthquakes, and a possible upward growth of a rubble chimney that could result from mine collapse.

As previously indicated, the region around Ironton Mine is seismically inactive. There is no indication that earthquakes of a magnitude sufficient to affect the cavern structure have occurred. The room-and-pillar geometry of the caverns prevents a massive roof collapse which could cause a rubble chimney passageway for oil to escape. There is also no likelihood of significant explosion-induced fracturing. As mentioned in section 4.3.8, the possibility of an underground explosion is very remote. If an explosion occurred, its maximum overpressure would be approximately 150 psi, or less than 35 percent of the lithostatic pressure on the storage space. Because of the very low flame velocities associated with oil explosions, the high relative confining pressures of the rock column are sufficient to preclude cavern expansion and associated fracturing.

Therefore, the only passageways recognized to have potential for water inflow are intake, discharge and vent lines in the shafts, and the shafts themselves. Potential sources of water inflows through the shaft are twofold: either from the surface, in the form of flood water, or from prolific ground water, which could result from shaft failure. The first possibility is prevented by the presence of the collar seal and shaft plug, shown on Figure 2.3-2, and by the elevation of the shaft opening and lack of surface flooding potential. The sole remaining potential impact, then, involves shaft collapse or leakage in the soft saturated strata above the limestone, where the amounts of water inflow could be quite voluminous. If, in turn, the pipes through the shaft plug are broken at or above the plug, then water in the shaft would be free to mingle with any oil in the ruptured pipes and would sink into the mine, allowing upward migration of oil 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 could escape from storage. Therefore, the total amount of oil escaping the caverns would be that displaced by the few tens of barrels of water required to partly fill the sump.

Once in the shaft, the oil lacks a driving force to migrate any further. 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 40 feet below the shaft collar, and thus could not impose a surface oil spill hazard. The worst result would be minor local oil intrusion into aquifers that were bared by shaft lining failures. Once the shaft water reached the water table, the hydrostatic heads of both the aquifer and the shaft would be equal and the water flow from the aquifer would cease to drive the oil/water mix upward in the shaft. For the same reason, the oil will not significantly penetrate the aquifer.

Pipeline

One minor impact on ground water resources that could be anticipated would result from a break in the oil transmission pipeline. The bedrock aquifers are relatively poor and the topography is usually steep, such that any oil spill originating from a pipeline break would have its principal effect on the surface water environment. Therefore, the impact on the ground water environment would be very small.

The impact of oil contamination in the shallow aquifer is a consideration, although the risk of occurrence is probably not great (see section 4.3.8). Furthermore, oil contamination in the aquifer would have little impact on ground water availability 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.

Water Waste Discharge

There will be no significant discharge of wastewater to the ground water. Oily wastes and sanitary wastes generated during actual operation of the Ironton facility will be routed directly to an on-site water treatment facility that will separate the oil-water waste and treat the sanitary waste materials before discharge to Ice Creek (see section 2.3).

4.3.3 Air Quality

Because of the generally low concentration level of air pollutants in relation to ambient standards and existing levels, atmospheric pollutants from the project should not pose a significant problem to local air quality, with the possible exception of hydrocarbons. It should be emphasized that the concentration estimates presented below represent the worse case under the most conservative meteorological conditions.

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

Some small vapor leakage may occur from the system of pipes, manifolds, and valves during oil filling and withdrawal periods. 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. 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 C).

Preliminary estimates of leakage and flaring from the mine have been determined and are presented in Appendix C. 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 of resulting downwind vapors were made 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 (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 3-hour concentration (365 $\mu g/m^3$) and the annual standards (60 $\mu g/m^3$). 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 126 $\mu g/m^3$ (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. There is no ambient air quality standard for H_2S in the vicinity of Ironton.

4.3.3.2 Hydrocarbon Vapor Emitted During Oil Transport

Another potential 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. Transport of oil by pipeline between the Catlettsburg Terminal and Ironton involves negligible hydrocarbon losses. Furthermore, the 18-inch pipeline is designed to pass the maximum rate of oil flow to be delivered from Ashland's pipeline system, thus requiring no storage tanks at the terminal.

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 and Owensboro, Kentucky. Estimates of total emissions, emissions rates, and atmospheric concentrations of hydrocarbons are provided in this section; further details on calculation methods are provided in Appendix C.

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), floating roof storage tanks at St. James, Patoka, and Owensboro would emit a total daily loss of approximately 300 pounds of hydrocarbons to the atmosphere during temporary storage of oil for Ironton Mine. Atmospheric concentrations in the vicinity of the tank farms would exceed 160 $\mu g/m^3$ (0.24 ppm) no futher than 0.5 miles downwind (Table 4.3-1 and Figure 4.3-4). Emissions would be attributable to the Ironton Mine project only for brief periods during each fill at St. James Patoka and Owensboro. Total hydrocarbon emissions during the project lifetime (5 fill/withdrawal cycles) are estimated to be 5403 tons (35,930 barrels of oil equivalent) during fill and negligible amounts 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 Ironton Mine 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 nore 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 period 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 (5) 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 reanged 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 (Kem-Tech, 1975). Thus, the NAAQS for ozone may be occasionally exceeded in southern Louisiana.

Along the oil transportation route between the Gulf of Mexico and Catlettsburg, Kentucky, 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 67 tanker round trips between the Gulf of Mexico and St. James, Louisiana will be required within a period of about 38 days to provide oil to fill Ironton 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.

4.3.5.1 Terrestrial Ecology

Wildlife will return to the outer fringes of the surface facilities after construction is completed, and daily activities of storage operating personnel will be minimal. 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 during the summer months.

Other impacts on wildlife might occur if seeding and revegetation of the construction site and pipeline corridor and subsequent wildlife management practices are unsatisfactory. The projected noise levels from operation (see section 4.3.4) should have no effect on the wildlife.

4.3.5.2 Aquatic Ecology

Operational impact of the storage facility 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 (see section 4.2.5).

4.3.6 Historical/Archaeological Resources

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

4.3.7 Socioeconomics

After the construction period, when the storage cavern has been filled and the pipeline completed, there will be very little activity at the project site or along the pipeline route. A small maintenance staff of 2 to 3 people will be employed at the site. Eight to 10 personnel may be required during withdrawal and refilling activities. Therefore, socioeconomic impacts from project operation will be even less than those from construction.

4.3.7.1 Land Use

The project will determine the land use of the mine site, pipeline terminal facilities and pipeline corridor for the life of the project. without the project, the land would presumably be put to some other industrial use.

4.3.7.2 Transportation Requirements

Transportation for the few project employees will be insignificant. Oil withdrawal and refilling will be accomplished through its own pipeline and the Ashland pipeline.

Movement of crude oil between the Gulf of Mexico and Catlettsburg Terminal will utilize existing capacity in the nation's oil transportation systems. There are also plans on 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 problem (see Section 8.3.4.4).

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 and Economics

Full-time employees will be limited to two or three, and no significant purchases will be made for the project once the construction is finished. Therefore, no effects on population, housing, employment, or the area's economic structure are anticipated. Likewise, no significant demands on public services are expected.

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 sects of the economy. Most of the benefits would accrue to owners of oil tankers and pipeline systems and to shipyard workers and suppliers.

4.3.7.4 Taxes

If the storage facility is owned and operated by FEA, Lawrence County will loose $2500 in annual property taxes now being collected from the Alpha-Portland Cement Company. The county had revenues of over $18 million in 1974, so this loss will not be significant. The state will lose $50 annually, which represents an even smaller percentage of their revenues. If the project is owned and operated by private entity, county and valorem taxes could amount to $96,000. If the pipeline route is also owned privately, Boyd County, Kentucky will receive a small amount in ad valorem taxes on the portion of the pipeline route that runs through that county. In any case, the amounts involved are not considered high enough to significantly affect county finances.

4.3.7.5 Aesthetics

Figures 2.1-3 and 2.3-3 give an idea of the storage facility components, which will cover approximately 2 acres. Since the land is zoned industrial and is located right across U.S. Highway 52 from Ironton, the facilities are not expected to be aesthetically offensive to anyone. Much of them may be screened by vegetation. The pump station, treatment plant, and above-ground piping will be relatively low-profile, although the site will probably be surrounded by a high fence for security reasons. Flaring may be visible in the immediate area, including nearby residences, especially at night.

The pipeline will be buried and therfore not visible. The route goes through primarily forest land and varies from 40 to 60 feet wide. It will probably be visible until revegetation occurs, although it is mostly in remote areas. It crosses the Ohio River at an industrial location, so it should not be noticeable there.

4.3.8 Oil Spills and Related Risks

The major risks from oil spills that may be attributed to the storage of oil in Ironton 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 carried through the 40-inch diameter Capline pipeline 575 miles north to Patoka, Illinois and then 380 miles east through the Ashland pipeline system to Catlettsburg (Figure 3.2-9). From Catlettsburg, a 13.1 mile long pipeline is proposed to connect the Ironton 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 Catlettsburg only during fill operations. Transport operation between Catlettsburg and Ironton Mine is considered for both fill and withdrawal. Allocation of oil from Catlettsburg during an oil 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 G. An oil spill containment and recovery plan is presented in Appendix I.

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 x 10^{-5} spills per mile per year, or 0.5 events per year per 1000 miles (see Appendix G). The 13.1-mile pipeline route between Ironton Mine and Catlettsburg Terminal was chosen to avoid as much urban area as possible, rather than to minimize length (see Figure 3.3.1).

During standby operation of the oil storage facility, the pipeline could be operated in either of two modes: 1) it could be left completely full of oil; or 2) it could be purged with an innocuous fluid. If the pipeline were kept full of oil during the standby or storage period, the line would always have a potential for accidental oil release. The line frequency of a spill in the continuous exposure mode is projected to be 0.14 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 Ironton in this mode would be 156 barrels over the life of the project. The expected frequency of a spill would be:

None in 22 years - 86.5 percent
One in 22 years - 12.6 percent
Two or more - 0.9 percent

Alternatively, the pipeline could be flushed and filled with an innocuous fluid during standby periods. In this mode the pipeline would be full of oil only during operation. Assuming a 28,000-BPD fill rate for the cavern, a withdrawal period of 150 days, and 5 full cycles of use (12.3 years total pipeline use), the number of spills in the life of the project would be 0.08 (1 chance in 12), and the total spill volume expectation would be 87 barrels. The spill probabilities for this mode would be:

None in 22 years - 92.2 percent
One in 22 years - 6.9 percent
Two or more - 0.9 percent

If a 50,000- or 60,000-BPD fill rate were used, spill risk exposure would be approximately 6.7 years; the expected number of spills would be 0.04, and the total spillage during the life of the project would be expected to be 48 barrels.

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 25,000 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 pipeline will be designed to remain full of oil throughout the life of the storage facility.

The maximum credible spill for a closely supervised spur pipeline connecting Ironton Mine with the Ashland Terminal at Catlettsburg is estimated to be about 3000 barrels, based on various combined static and pumping losses (see Appendix G).

The Capline and Ashland pipelines will be subject to additional spill risk exposure as a result of pumping crude oil to Ironton Mine. The approximate distance between St. James, Louisiana and Patoka, Illinois, through the Capline pipeline, is 575 miles; from Patoka to Ashland Terminal, through the Ashland pipeline, is approximately 380 miles. Pumping 21 million barrels of oil to Ironton represents approximately 21 days of capacity for Capline and 75 days for Ashland. At 50 X 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, 18 barrels with an expectation of 0.0165 spills; for Ashland, 42 barrels with an expectation of 0.039 spills. Total expected spillage for 5 fill operations is 300 barrels (Table 4.3-2), with a frequency of 0.28 events (1 chance in 3.6 of a spill occurring). Even if potential risks due to earthquakes and karst topography should increase risks by an order of magnitude, only 3000 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 0.029 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 Ironton Mine is not known with certainty at this time. The transportation mode assumed for this analysis consists of offloading from VLCCs (very large crude carriers) to small 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 deep water port terminal facilities at various locations in the Caribbean and then transported to St. James via small tankers. Each of these methods would require 67 trips up the Mississippi to St. James to achieve one fill cycle if 45,000 DWT tankers were used.

VLCC Transfer in Gulf

Each fill cycle would require 67 transfer operations. Spills occur approximately once in each 18 transfers; spill volume rate is estimated at 3.0 x 10^{-6}. Thus, 3.7 spills, totaling 63 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 4 percent chance of occurring from this mode during the life of the project (18.5 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 0.07 (1 chance in 14), and total expected spillage is 30 barrels. During the life of the project, therefore, the total number of tanker spills in the Mississippi River is 0.35 (1 chance in 3), and total expected spillage is 150 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 0.7 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^{-6} units per unit transferred, or 21 barrels per fill (105 barrels over the life of the project). Spill frequency is estimated at once in 90 offloadings. This yields an estimated 3.9 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 2 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 (315 barrels total; 18.5 spills). The total oil spillage expected during five complete fill operations is 570 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 0.63 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 Ironton 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 Ironton and Catlettsburg Terminals (see Appendix G). Five emptying and filling cycles during the life of the program (210 million barrels total movement) indicate an expectation of 0.105 events, or 1 chance in 9.5 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 30 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.

Although the maximum credible spill size at the terminals is estimated to be about 1000 barrels, the maximum credible spill has been taken to be 3000 barrels, consistent with the presence of the 18-inch pipeline.

The proposed design of the Ashland Terminal will not require the use of surge tanks during transfer of oil to and from the Ironton pipeline. Therefore, the spill risk attributable to the project at the terminal is the same as for the Ironton storage site. If tankage were required to increase the input/output flow rate for storage, the average and expected total spill volume would be increased, similar to typical U.S. terminals. However, the hazard to the environment associated with tank spills would be no greater because the tanks would probably be enclosed with a protective diking system.

The tank farms at St. James, Patoka and Owensboro are existing facilities. Spills from storage tanks due to incremental throughput of oil for Ironton 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 516 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 4.3-2. This table indicates that very large spills are statistically improbable from the proposed Ironton system. Combining the spill rate statistics in Tables 4.3-1 and 4.3-2, the chance of a spill greater than 2000 barrels during the lifetime of the project is 1.3 percent (1 chance in 77 or a recurrence interval of 1700 years). During the life of the project, a spill of 2000 to 3000 barrels has a probability of 0.0005 (1 chance in 2000) at each terminal. The chance of having a spill between 2000 and 3000 barrels during the project is 0.014, or 1 chance in 71.

Fume and Vent Control

There would be a slight risk of toxic gas (H_2S) escaping during cavern filling if flaring were not employed. The amount of hydrogen sulfide gas remaining after shipment of a sour crude should, however, be negligible. Combustion of the gas vented out of the cavern through a 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. The water treatment system to be installed at Ironton in order to handle cavern seepage will also be available for treatment of any water released from a berm containment area.

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

Fire Losses

The risk of a major fire due to oil storage in the Ironton system lies almost entirely at the pipeline terminal at Catlettsburg 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. Also, the terminal and site pumping systems will be in use only half the time.

Storage of crude oil in the Ironton 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 annualar 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 Ironton Mine Affecting Oil Spill Risk

The Ironton Mine has been excavated by the room-and-pillar method from massive limestone formations between elevations of 74 and 120 feet MSL. Ground level of the rock overburden is between 580 and 850 feet MSL. The mean level of the Ohio River (normal pool) is about 515 feet. The lowest elevation of a proposed shaft collar is well above flood waters.

The limestone rock in the caverns is stable, relatively impermeable, and has very little rockfall. The mine experiences a small inflow of ground water which will have to be pumped from the cavern, treated, and then released to Ice Creek.

The exposure of the mine shafts to surface water inflow is limited to runoff from a very localized area by the rolling topography of the site. Surrounding areas are mainly woodland, but the site is accessible to heavy equipment.

Risk of Catastrophic Spills from Storage Cavern

The intended level of oil storage is below both surface and ground water. To escape the reservoir, oil must be displaced to the surface or to ground water levels, and then along a pressure gradient to produce lateral migration. If oil reaches the surface, it can migrate downhill to a creek system and subsequently to the Ohio River.

The normal pool level of the Ohio River (515 feet above MSL) regulates the level of the most abundant ground water supplies in the area. Even in flood, the backwater level would not be sufficient to drive oil from the storage cavern to the lowest surface elevation of the existing mine shafts (580 feet above MSL). Although local ground water pressures above the mine might be sufficient to raise the oil to the ground surface elevation, quantities of water inflow from the sources would not displace oil at a significant rate.

If the oil 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 shafts will be sealed and inspected to prevent ground water entry, but even a hypothetical inflow of ground water would not be sufficient to induce a catastrophic release of oil from the storage cavern.

Surface Water - With shaft seals, there is very little surface water exposure for the cavern. Local drainage areas that might funnel water into a mine shaft are small and involve virtually no impoundments greater than puddle size (see section 3.3). No other surface water sources, such as sewers or water mains, are present to induce flooding of a shaft opening.

Ground Water Inflow - Small amounts of water flow into the mine cavity through the existing shafts (surface drainage) and by seepage (groundwater). Most of the water appears to enter through the shafts from the surface. The ground water inflow helps seal the surrounding rocks against oil migration. The inflow of a large amount of water would require a nearby artesian source; the history of the mine indicates that no such sources exist. It is unlikely that a sufficient head of pressure could be developed to force water and oil out of the mine in a dynamic (sudden) action.

The static pressure induced by water seepage represents a potential hazard to the cavern shaft seals. If the cavern filled up with the shafts completely sealed, then ground water pressure could be imposed on the seals. The maximum potential ground water pressure is not known; it might be insufficient to raise the oil through a pressure vent pipe. In any case, the facility design avoids the problem by utilizing a gas space in the cavern over the oil surface. The possibility of prolonged power failure at the site during a flood (preventing seepage water from being pumped out) requires that sufficient space be provided for water seepage during the power outage. Because the inflow rates are so low, seepage does not induce a potential for catastrophic release of oil even if static pressures provide a greater head than the shaft elevations.

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 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 ruptures 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 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 can be impressed on the cavern and the seals made to support the pressure. Standard designs avoid this problem by utilizing a gas space in the cavern over the oil surface.

Shaft Failure - The chance of shaft failure, along with possible rupture of pipes above the shaft seal, has to be considered a potential risk for oil storage at Ironton. However, there is little chance of any oil migration from the site following such a failure, as long as the shaft seal over the cavern remains intact. Water can enter the cavern through a broken pipe above the shaft seal. The water will flow down the pipe into the sump, displacing an equal volume of oil up the pipe. When the sump has filled with water to the bottom of the pipe, no more oil can enter it -- a water seal is created. The total amount of oil that could be displaced from the cavern is around 50 to 100 barrels, and this would be contained in the shaft. The water seal is an important passive safety factor.

If the shaft plug should fail along with a shaft collapse, the overburden of limestone rock, sandstone, clay and shale does not pose a significant potential for displacement of oil from the cavern. No massive quantities of water or mud would be available to flow into the cavern. However, this possibility appears very remote. As shown by Figure 2.3-2, the plug will be situated in the massive competent limestone rock deep underground. Given the shaft plug emplacement environment, coupled with its vital importance, final design of the plug will incorporate necessary assurances against failure. The level of dependability that is achievable by standard engineering practice is best illustrated by the numerous successes of such plugs to certain shaft- and tunnel-emplaced nuclear detonations.

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. The mode of lateral cavern failure supposes that unknown void spaces beyond the perimeter of the mine may exist, providing a migration path for oil. Such a possibility can be excluded, since such spaces would have to be filled with ground water, and the oil would not be able to enter.

The mine is penetrated by two older gas wells. These two wells have shown no evidence of gas leakage in the past. They are plugged, and substantial pillars have been left around them. A hypothetical escape of oil into one of these depleted wells does not provide any path for oil to enter the surrounding environment. Oil would flow down the well, filling it and any accessible void pockets, and although valuable oil would be lost, none would be forced up the well to the surface.

Explosions - The explosive range of the air vapor mixture over crude oil is narrow, but it must be considered reasonable that an explosive mixture could exist in the cavern at some point during a filling and/or emptying cycle. There are no 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, as so forth. None of these sources seems likely for the Ironton Mine, although they cannot be ruled out entirely. The alternatives for absolute safe storage conditions are either to create an inert 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 Ironton Mine range from 450 to 600 psi. Rock structures in the cavern would be virtually unaffected by a pressure surge of 10 atmospheres because of the slow rise of the pulse (i.e., fractions of a second, as opposed to microseconds in a dynamite type of explosion).

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. In addition, there may be very small amounts of water seepage into the cavern during storage.

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, and passed through the water treatment plant. Recoverable oil will be returned to storage. 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 expected 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 Ironton 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 18 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 the 300 barrels plus about 10 minutes of full flow from the piping system, or a total of about 1000 barrels. Routine inspection carried out as standard operating procedure would prevent oil spills from otherwise unnoticed small chronic leaks. Since the main 18-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 3000 barrels.

If a 3000-barrel spill breached the containment berms, the spilled oil could flow rapidly through Ice Creek and then to the Ohio River. It may be possible to prevent such outflows from reaching the Ohio River during periods when the mean flow of Ice Creek, just before entering the river, is less than 1 foot per second. Damage would then be confined to a small portion of Ice Creek downstream of the mine.

Pipeline Spills

The ultimate receiving waters for spills along the pipeline route between Ironton Mine and Catlettsburg would be the Ohio River. In evaluating spills for the river, a maximum credible pipeline spill of 3000 barrels has been used. The 3000-barrel spill has the potential of spreading and polluting up to 30 miles of bankline, assuming a nominal channel width of 800 feet. The maximum spread of the oil would be about 3 miles of river, but this band of polluted water would be carried downstream until it was either dispersed or cleaned up. The most damaging impacts (oil densities of over 8 barrels per acre) would be confined to the first 3 miles downstream of the entry point. Removal of the oil at cleanup strike points along the stream would reduce this damage potential (see Appendix I).

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 high seismic risk areas and karst topography crossed by the Capline and Ashland pipelines 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 due to earthquakes or foundation instability. 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 frainage 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 spill 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.

4.3.8.7 Oil Spill Impact on Surface Waters

During the project operation, the most significant impact on the surface waters of the Ironton 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 Catlettsburg Terminal (Table 4.3-1). An average size spill is estimated to be 1000 barrels; the maximum spill size could be as high as 3000 barrels.

If a large spill should occur at the mine site or along the pipeline sections crossing Ice, Possum Hollow, Lick, Salida, or Catletts Creeks, the oil would eventually flow into the Ohio River. (A spill could also occur from the pipeline where it crosses the Ohio River.) Average flow velocities in these creeks are about 1.5 to 2.5 feet per second.

A spill that occurs at Catlettsburg Terminal or in the pipeline sections that cross Chadwick, Paddle or Ice Dam Creek will flow into Big Sandy River and then into the Ohio River. Average flow velocities are 1.0 to 2.3 feet per second.

The distance to the Ohio River from the pipeline crossings in the watersheds varies from 1.0 to 4.0 stream miles. Therefore, during periods of normal stream flow, it would take an oil spill about 0.5 to 6 hours to reach the river. During high flood flows, when stream velocities reach 6 to 8 feet per second, a spill could cover this distance in a much shorter time. Thus, the worst case condition would be a maximum spill (3000 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 downstream, including the Ohio 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 down the Ohio River approximately 2 miles downstream from the confluence of the affected creek during normal flow periods and more than 45 miles during high flows. Downstream from the city of Ironton, Greenup Locks and Dam in the river channel could help prevent the spill from moving further downstream.

The Greenup Locks and Dam is located on the Ohio River at river mile 341 about 17 miles downstream from the mouth of Ice Creek (river mile 324) and 24 miles downstream from the Big Sandy River (river mile 317), near the Catlettsburg Terminal. If the river levels remain below the normal pool level and the dam gates and the navigation lock structures remain closed, the cleanup strike force could use this area of the Ohio River to deploy their oil containment booms to restrict the spreading of the spill into the lower reaches of the river. However, if the flow of the river has exceeded the natural capacity of the channel at normal pool levels, the dam part of the structure at this location would not offer much of an assistance to the strike force, since the dam gates begin to gradually open as soon as river flows begin to increase above normal. On the other hand, the navigation structure which runs parallel to the flow of the river could be utilized for attachment of the oil booms and thus direct the surface oil away from the main stream of the river.

Use of the Greenup Locks and Dam as a deployment area for the strike force would preclude the use of the locks for normal navigation of the river. This restriction could have an impact on industries which depend on the waterway for transportion of their raw materials or products, but because the major cleanup effort to restrict the flow of oil in the main stream of the river should be only two to seven days of effort, this restriction should not present a major impact on the industries of the area. For example, assuming that a pipeline break could be shut down relatively quickly, that is in less than two hours, the bulk of the oil in the spill would pass from the farthest point up-river (river mile 317) to the locks (river mile 341), a distance of 24 miles river flow, in about 12 hours, assuming a normal rate of travel of less than three feet per second in Lawrence County. At low flow rates of about

3 days to pass the lock and dam at Greenup. In these cases, the impact of an oil spill on navigation in this reach of the river should be minor and of a temporary nature.

In addition to ecological impacts (see section 4.3.8.7), an oil spill in the Ohio River would also affect the downstream water uses. A major impact could occur to the domestic and municipal water systems located along the river between Huntington and Portsmouth. Municipal water systems would have to provide additional charcoal polishing of the water to eliminate any residual oil taste.

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 2.3-9). 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, dissoultion, 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 weathering which disturb bottom sediments. Sedimentation can also 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 Ironton storage facility will affect the terrestrial and aquatic resources of the area by direct oiling of the soil, water, vegetation, and individual animal 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 Ironton storage facility, 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 oil spills.

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. Certain oil fractions can enter the plant at the point of contact. Others can penetrate through stomata, which are pores utilized during gaseous exchange. Once within the plant, oil travels within intercellular spaces and reduces transpiration and translocation by blocking the spaces as well as the stomata. Heavy oiling can effectively block gaseous exchange through stomata from the outside and thereby disrupt the plant's metabolic mechanism by interfering with respiration.

In general, plants are more vulnerable to damage from oil when they are in the active growing stage. This is understandable since, during periods of new growth and reproduction, the plants have accelerated metabolisms that demand increased amounts of nutrients, sunlight, and other necessary elements; when metabolism is disrupted or the plant deprived of essential elements, the plant is affected almost immediately. The growing season for the Ironton area is relatively long, averaging 180 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.

Because of their size, abundance, and proximity to the oil storage area and pipeline, vegetative communities that are likely to be impacted by an oil spill include a large variety of mixed woodland species, grasses, herbs, and shrubs. 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.

More than 71 percent of the land area in Lawrence County is now in timber that is capable of providing wood products. Most of the woodlands are second- and third-growth stands; virtually none of the original trees remain. The local woodlands contain over 50 species of mixed-hardwoods, oak-hickory, and other deciduous-coniferous forest types. Mixed mesophytic hardwoods are scattered along the pipeline, but reach their best development along the small stream valleys. Mixed-hardwoods contain species such as sycamore, beech, elm, hickories, and soft maples. Oak-hickory is found predominantly in the higher elevations of the pipeline and is represented by the red, white, and chinquapin oaks and hickories. The major crops and grasses of the area include corn, wheat, clover, timothy, alfalfa, lespedeza, and miscellaneous truck crops.

A maximum credible oil spill occurring in these areas could destroy 5 to 7 acres of forage and grassland. The forested areas, because of tree height and deeper roots, would be affected to a much lesser extent. Here, more damage might be attributable to the cleanup procedures than to the direct impact of the spilled oil.

Terrestrial Wildlife - In the event of a large oil spill, the terrestrial animals can either be directly or indirectly affected by the spill. The direct effects of oil spills upon land mammals are generally minimal, since most 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, or may suffer 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 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 population may cause adverse effects on both the migrant mammals moving into the area and on those already inhabiting the site. Deaths from overcrowding, starvation, predation, and disease may possibly occur.

The mammals most likely to be affected by an oil spill in the woodland areas of Ironton are the opossum, short-tailed shrew, gray fox, raccoon, gray squirrel, cottontail rabbit, and white-footed mouse. Where the pipeline crosses streams and creeks, the muskrat, mink, and long-tailed weasel could be affected. 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 by some species of salamanders, frogs, and toads that breathe through their skins may limit their respiration and result in death. Species inhabiting the woods and woodland edges at the mine site and the streams, creeks, and streambanks along the pipeline corridor are likely to be affected most by a spill. Species that are likely inhabitants in these areas include the slimy, northern dusky, ravine, and red-backed salamanders; ground skink and five-lined skink; common water snake and garter snake; and American toad, mountain chorus frog, and pickerel frog.

The direct effect of oil spills and leakages on birds inhabiting 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 Ironton Mine; however, the fresh and brackish marshes of the lower Mississippi River delta are habitat for large numbers of waterfowl in winter months. Oil-fouled birds preen excessively in their attempt to remove the contaminant. Autopsies have shown this preoccupation to be so great as to supersede the need for food; most gastrointestinal tracts of autopsied birds contained little, if any, food. Physiological weakening of the body, coupled with reduced food intake, will eventually result in the death of the bird.

Reduction in the insulating capacity of the feathers causes an increase in metabolic rate to maintain the body temperature. Heat loss in an oil-fouled bird has been shown to be approximately twice that of a normal bird (Hartung, 1967). To maintain body temperature, the dietary intake must be doubled. This is difficult because energy is expended for increased foraging activities and because the ingestion of oil has caused inefficiency in the body's system. The increased metabolic rate requires an increase in energy intake; however, in reality, the bird may give up foraging to rest on the shore. Foraging decreases and may actually cease, resulting in starvation. The metabolic rate has been shown to increase linearly with decreased ambient temperature. Therefore, the rate of starvation is further accelerated by cold weather (Hartung, 1967).

Ground-nesting and ground-inhabiting species of birds could be seriously affected by an oil spill, particularly during the nesting season. Large spills on land would also indirectly affect all birds that utilized the spill area for foraging purposes. Bird species that may be affected by an oil spill at the Ironton Mine site include the rufous-sided towhee, cardinal, red-winged blackbird, mourning dove, wood thrush, and starling.

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 determining 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 more mobile fish would have little chance 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.

Impacts of an oil spill in the small streams would be felt by all aquatic forms from plankton to fish. However, in the Big Sandy and Ohio Rivers, impacts of an oil spill would be limited primarily to the plankton; recovery of this group would be rapid. Because the fisheries' resource is more strongly linked to the major water courses, impact to the study area of an oil spill would be minor.

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 too great for complete recovery; or 2) that resulting from a continuous discharge of low levels of oil and effluents, such as those from refinery outfalls.

Many studies concerning crude oil effects on vegetation have been limited to observations of areas after a spill has occurred (Stebbings, 1968; Baker, 1969; Cowell, 1970; Cowell and Baker, 1969). Bioassay procedures are usually employed to assess the impact of the pollutant upon the environment. Effects of oil on vegetation depend upon several factors: species and age of plant; time of year and whether plants are actively growing or dormant; amount and type of oil involved; and degree of weathering of the oil (Baker, 1970). Physical weathering, total chemical decay, and biological breakdown are involved in degradation, but the relative importance of each has not been ascertained.

Baker (1971a) described the effects of oil spills in Milford Haven during 1968 and 1969, and 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 (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 a film, which is difficult to wash off, that forms on the plant and causes 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).

Stebbings (1968) and Cowell (1969) indicated that the major effect of an oil spill resulted from the lack of gaseous exchange created by the oil. Oil blocks oxygen passage within the substrate, setting up anaerobic conditions that eventually become detrimental or lethal to plant growth. Oil toxicity to a plant is dependent upon the oil's molecular configuration, whether fractions are aliphatic or aromatic, the degree of saturation, molecular size, and possibly whether it is a paraffin or asphalt-based crude (Texas A & M University, 1972). Compounds with small molecules are usually highly volatile and evaporate before they damage plants. The influence of these volatile compounds on terrestrial vegetation is not known. Crude products with large molecular structures do not penetrate plant tissue but cause damage by adhering to the leaves (Baker, 1969).

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, final toxicity is a function of the quantity and characteristics of the oil, the quality of the stream water, and the sensitivity of the target organism.

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 mucous film to wash away irritants. If the concentration 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, for current and other turbulence would maintain adequate reaeration.
7. Water-soluble fractions acting directly and toxically with fish or fishfood organisms.

The toxicity of crude oil is highly dependent upon the individual fractions present in the oil. Many of the low-boiling aromatic hydrocarbons are toxic to aquatic organisms, and some of the high-boiling paraffin hydrocarbons are nontoxic (Murphy, 1971). Crude oil (bunker oil) is apparently less toxic than many of the pure hydrocarbon fractions; however, this is not always the case, as Chipman and Galtsoff (1949) reported crude oil concentrations of about 0.3 mg/l as being extremely toxic to freshwater fishes.

To completely evaluate the toxic effects of an oil spill, synergistic characteristics of the oil should be considered. Gutsell (1921) showed that certain petroleum products that appear to have no soluble poisonous substances become very toxic to fish when emulsified by agitation with water, a condition likely to occur in rapidly flowing streams. Sedimented oils may also act as concentrators for chlorinated hydrocarbon pesticides (Hartung and Klinger, 1970), and petroleum oils that are used as solvents for pesticides often increase pesticide toxicity.

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 vegetations types (mesophytic and upland hardwoods) associated with the proposed facility.

Aquatic Biota - 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. Fish communities are somewhat slower to recover, depending on the extent of damage and the availability of nearby populations that could colonize the area. Ryck and Duchrow (1974) reported that, 4 months after an oil spill in the South Fork of the Salt River (Missouri), fish populations seemed nearly recovered; but Schultz and Tebo (1974) reported only partial recovery of fish populations after 6 months from an oil spill in Boone Creek (South Carolina). 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 impaired by sediment contamination. Many authors, including Ludzack and others (1957) and Hunt (1957) have shown that oil is found in the sediments of rivers in many areas where oil spills or contamination have occurred. Hunt (1962) reported that the benthic fauna is usually impoverished in areas that contain oily sediments; however, the extent to which the oil contributes to this is unclear. An indication of the actual time required for the benthic community to recover from an oil spill is given from the following examples. Shultz and Tebo (1974) reported that hydrocarbons were still present in the sediments of Boone Creek (South Carolina) 13 months after a spill. Benthic organisms in the area of a spill at West Falmouth, Massachusetts, contained traces of the source oil 18 months after the spill (National Academy of Sciences and National Academy of Engineering, 1972). Based on these studies, 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 Ironton Mine and Catlettsburg) or terminal failure is expected to be 3000 barrels (see Appendix B). For estimation of impacts, it is assumed that 10 percent, or 300 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 2700 barrels (3000 minus evaporation) could effectively destroy vegetation on 108 acres of land. It is unlikely, however, that the oil would spread across 108 acres, unless soils were saturated and slopes were high. A more typical coverage would be 80 to 160 barrels per acre, or coverage of 17 to 34 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 vegetative 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 bef 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.

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 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 woodthrush, whippoorwill, short-tailed shrew, white-footed mouse, and cottontail rabbit. Bird species which utilize the wooded habitat for food and roosts include the ruffed grouse, red-tailed hawk, cardinal, crow, and blackbird. Mammal species affected would include squirrels, opossum, raccoon, and gray foxes.

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 100 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.

A large oil spill could reach the Ohio River within one or two hours from several of the streams crossed by the pipeline. Also a large oil spill could occur from the section of pipe which crosses the Ohio River. The pipeline will be buried typically to a depth of about 5 feet below channel bottom to prevent exposure to scouring or ships anchors. Since there is no data to specify spill risk exposure at such a crossing, oil spill risks are assumed to be identical to those for the rest of the pipeline.

A 3000 barrel maximum credible spill would be carried downstream immediately, spreading across much of the river and covering perhaps 3 miles of river length at a time. Depending on the conditions at the time, cleanup strike points may not be able to contain the oil for several miles, possibly not until it reaches the Greenup Lock and Dam located 22 miles downstream. Possible effects on municipal water supplies have been described previously. Ecological effects should be relatively minor because of the dilution provided by the river. Fish kills and substrate contamination would be limited to shallow, poorly flushed sections of the river along the shore where oil might accumulate. Some coating of stream bank vegetation would occur but, except for the aesthetic and nuisance effects, overall impact on the river of a single large spill would not be significantly adverse.

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 require 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, or 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 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 Ironton Mine during each cavern fill operation

Location (see Figure 2.3-9)	Estimated Emission Rate (tons/day)	Duration of Emissions (days)(a)	Concentration Exceeding Standard(160 ug/m^3) Distance Downwind (miles)	Total Emissions (tons)(b)
Gulf of Mexico	16	38	9.6	600
Mississippi River	0.8	38	(c)	30
St. James, Louisiana	11.2	38	7.5	420
Tank Farm Terminals:				
St. James	0.15	22	0.45	3.3
Patoka, Illinois	0.15	90	0.45	13.5
Owensboro, Kentucky	0.15	90	0.45	13.5

(a) Duration of emissions depends on scheduling of tankers and batch operating modes of pipeline systems. Emission rates from tanker transfer and transport operations are throughput-dependent, i.e., total emissions would be little changed by different scheduling. Emissions rates from tank farms are time-dependent.

(b) Expressed in terms of equivalent weight of oil. One ton equals 6.65 barrels.

(c) Non-point source. Transient concentrations exceeding 160 ug/m^3 approximately 1.2 miles downwind of tanker location.

TABLE 4.3-2 Summary of oil spill accident potential, Ironton 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 Ironton and Catlettsburg	Pipeline	0.013	0.144	1083	156	3000
	Terminal at Ironton	0.0105	0.105	300	30	3000
	Terminal at Catlettsburg	0.0105	0.105	300	30	3000
	Subtotal	0.034	0.354	610	216	-
Transportation Between Gulf of Mexico and Catlettsburg	Pipeline	0.056	0.28	1083	300	10,000
	Tanker Transport	.070	0.35	428	150	60,000
	Tanker Transfer:					
	Gulf	3.7	18.5	16.2	315	1,000
	St. James	0.78	3.9	27	105	500
	Subtotal	4.6	23.0	37.8	870	-
	Total	4.634	23.35	46.5	1086	-

TABLE 4.3-3 Probable spill size distribution for pipeline, tanker, and terminal accidents, assuming the occurrence of an oil release

Pipeline Transport
Ironton to Catlettsburg
(Average Size 1083 bbl)

Size Range (bbl)	%Probability
0 - 200	2
200 - 500	14
500 - 1000	44
1000 - 2000	31
2000 - 3000	9

Pipeline Transport
St. James to Catlettsburg
(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	47.3
200 - 500	40.6
500 - 1000	9.2
1000 - 2000	2.4
2000 - 2500	0.5

VLCC/45 MDWT Tanker Transfer in Gulf
(Average Size 16.2 bbl)

Size Range (bbl)	%Probability
0 - 20	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 Probable spill size distribution for pipeline and terminal accidents, assuming the occurrence of an oil release

Pipeline Transport

(Average Size 1083 bbl)

Size Range (bbl)	% Probability
0- 200	2
200- 500	14
500-1000	44
1000-2000	31
2000-3000	9

Terminal Facilities

(Average Size 300 bbl)

Size Range (bbl)	% Probability
0- 200	47.3
200- 500	40.6
500-1000	9.2
1000-2000	2.4
2000-3000	0.5

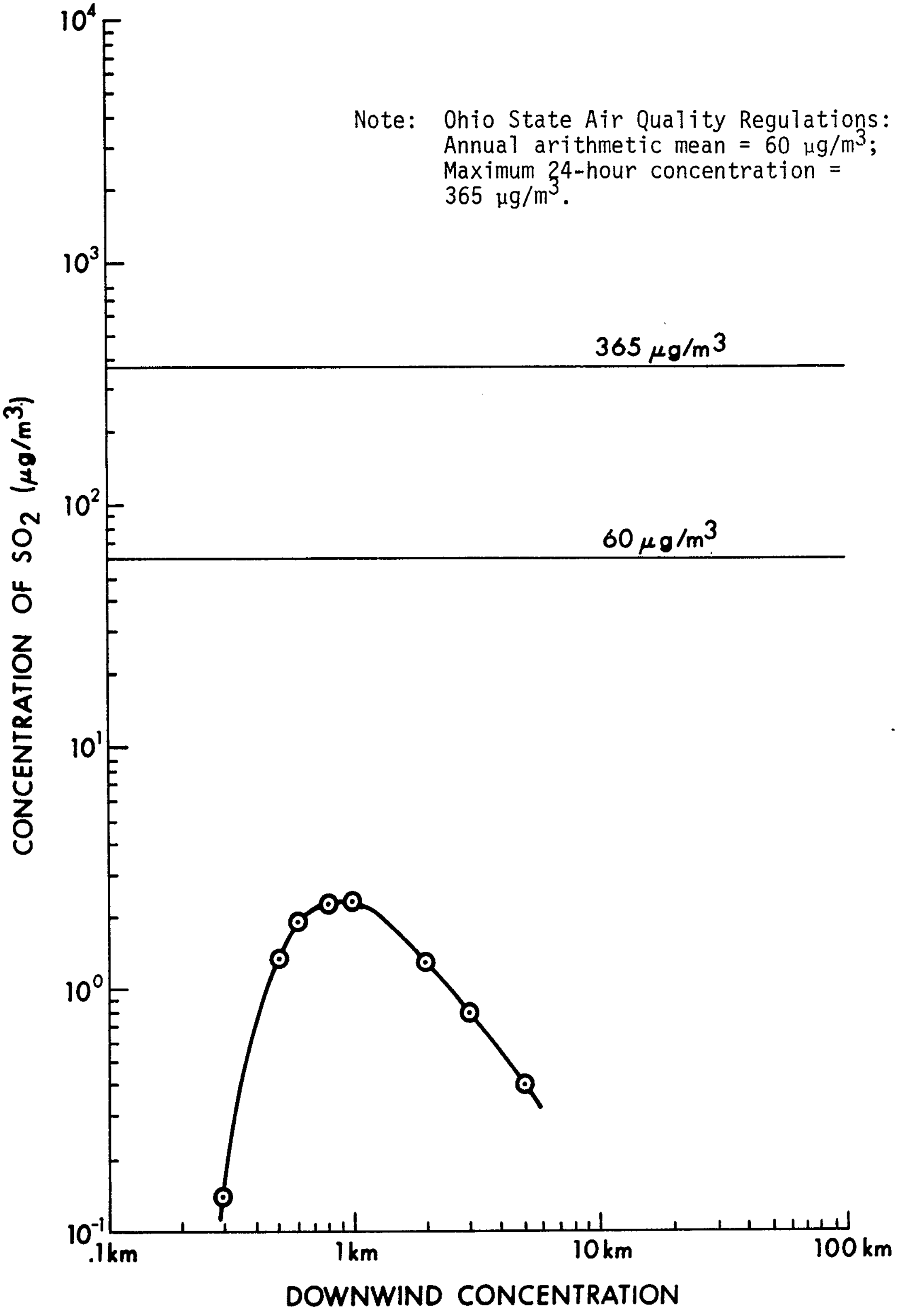


FIGURE 4.3-1 Downwind concentration of SO_2 ($\mu g/m^3$) resulting from flaring (assuming 0.15 gm/sec release SO_2 and 28,000 bbl/day pumping)

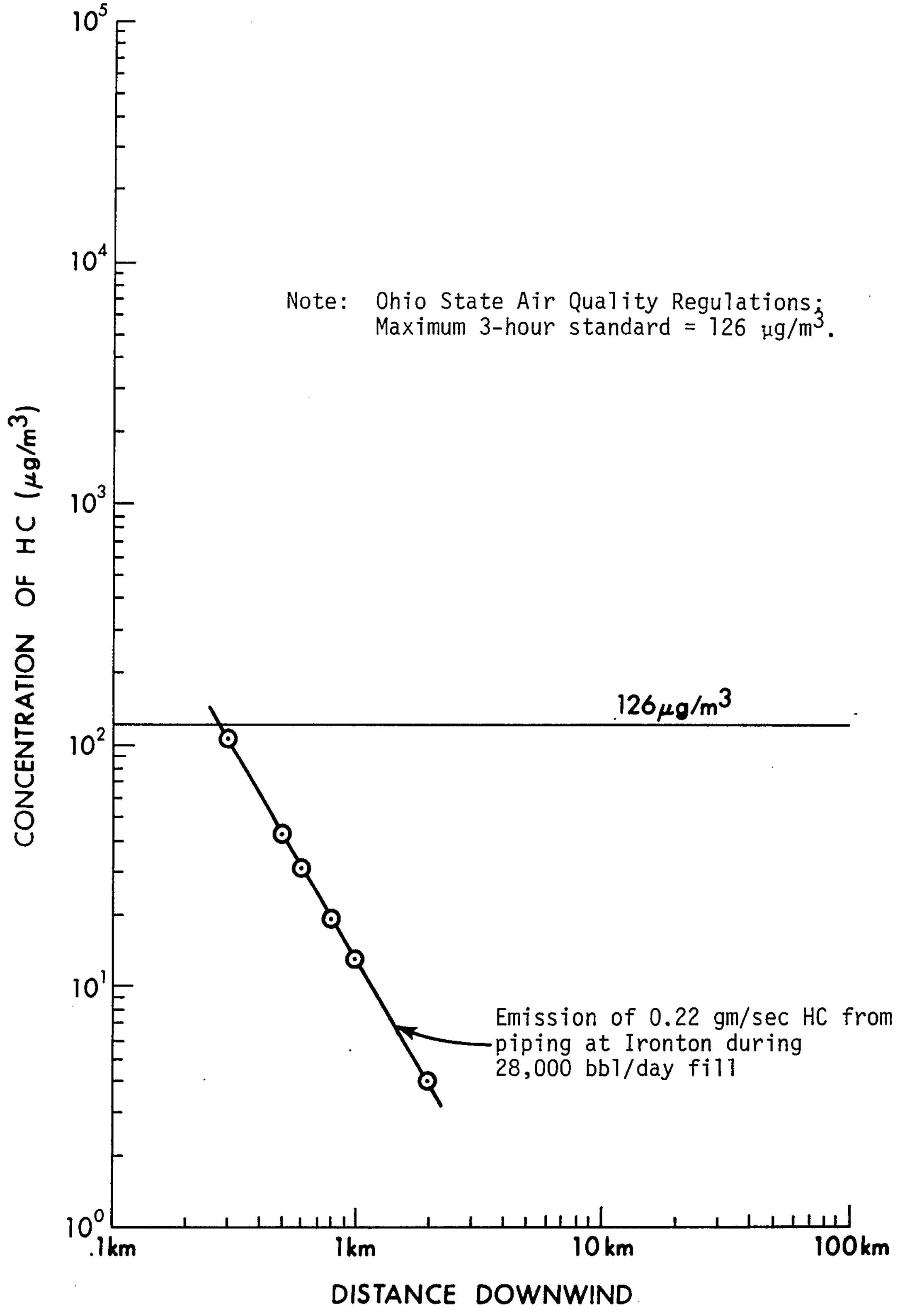
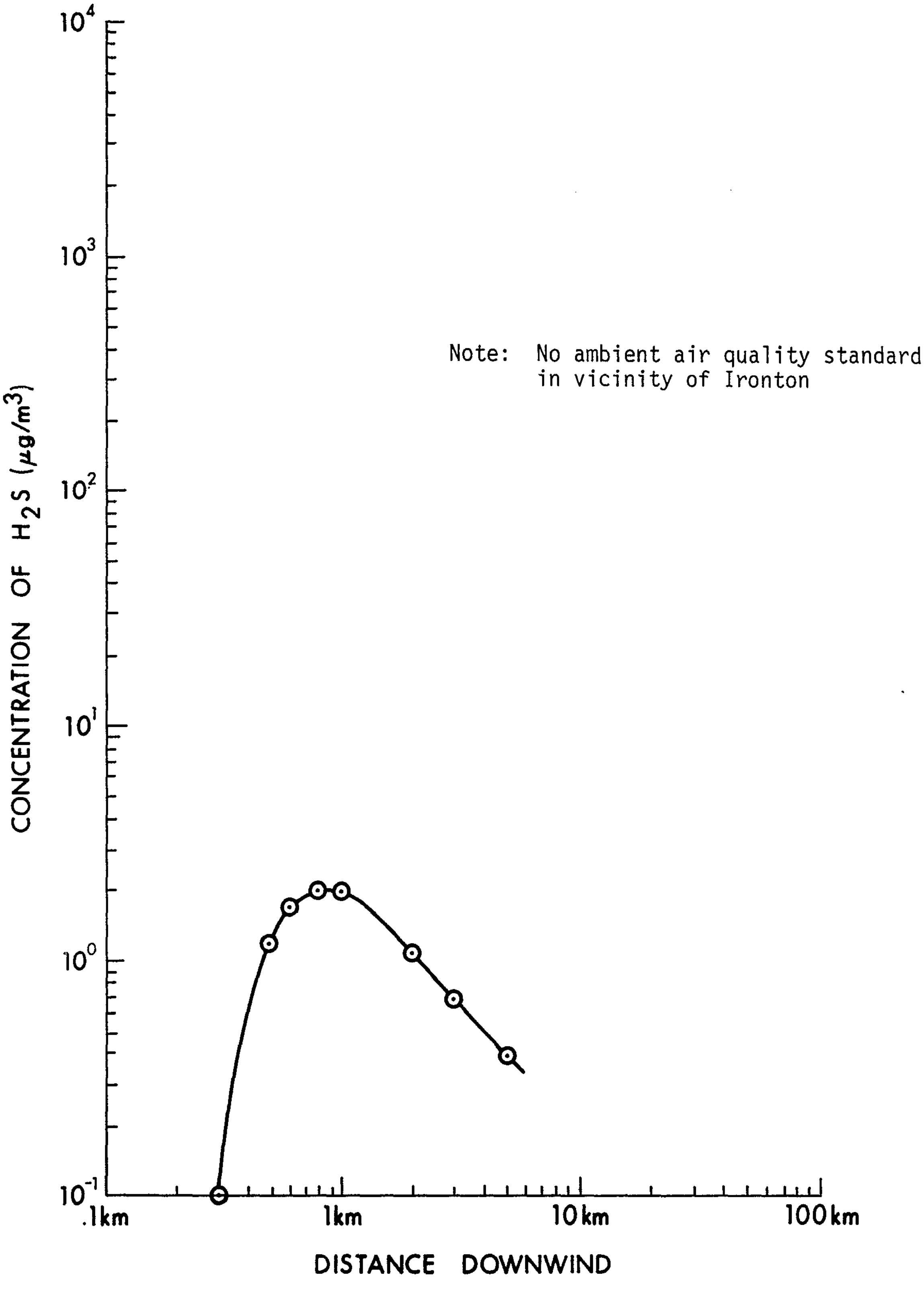
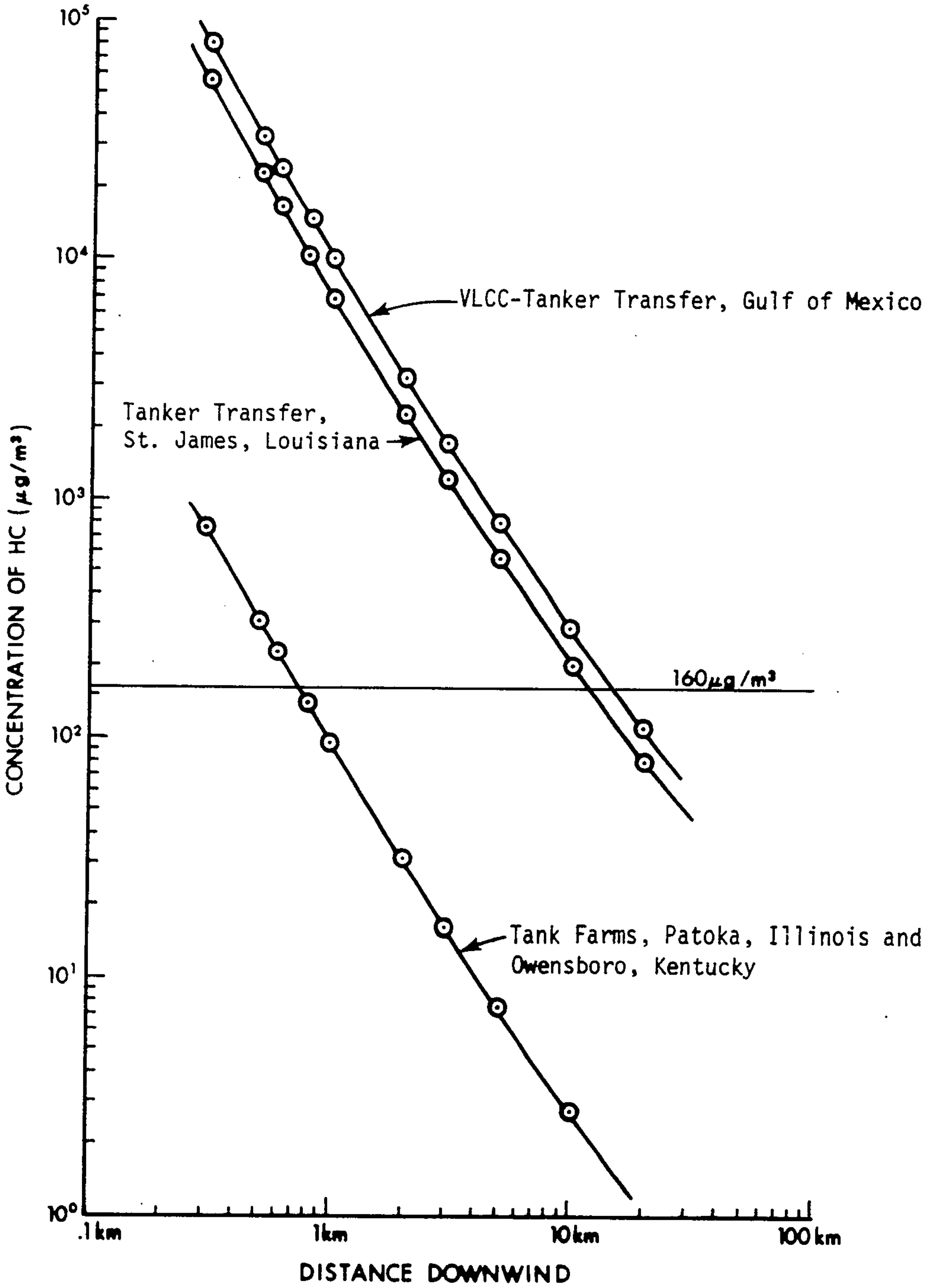


FIGURE 4.3-2 Downwind concentration of HC from leakage



Note: No ambient air quality standard in vicinity of Ironton

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



Note: Calculated for unstable atmospheric conditions and 2 m/sec wind speed. Emission rates of 16 tons/day in Gulf, 11.2 tons/day at St. James and 300 lbs/day at tank farms

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 Ironton 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 abandoning the mine include putting it to some beneficial use, such as disposal of dredge spoil, slurried fly ash, or other polluted or toxic materials. 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.

Continued use of the facility would assure surveillance of the cavern. The inherent integrity of the cavern would prevent any leakage of material into the environment. Activities associated with the specific use, such as waste transport, would impose some potential for environmental damage resulting from traffic, spillage, and noise.

If the facility is not put to beneficial use, the shafts could be sealed and the caverns left empty, as is the current practice with most abandoned underground mines. No adverse environmental effects are likely to result from such action.

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

There are presently no official plans, policies, or controls established by Federal, state, and local agencies in Lawrence County affecting the Ironton Mine site. Furthermore, lands under consideration for use in developing the Strategic Petroleum Reserve facility at Ironton are presently abandoned. This includes the 1.5 acres at the Ironton site that will be required for the pumping facilities. Approximately 65 acres of land in the pipeline right-of-way will be used for oil transport. The project will have a short-term impact on these lands during construction and no effect during project operation.

A preliminary plan has been submitted to the Lawrence County Historic Commission for development of the Alpha-Portland Quarry property to the north of the site for recreational purposes due to the hardwoods found on the property. Because of the existing industrial buffer zone located west of the Ironton site, no conflict between the proposed oil storage facilities and the characteristics of the area are envisioned. The oil storage project would not affect use of forest lands to the north for recreational purposes.

4.6 SUMMARY OF ADVERSE AND BENEFICIAL PROJECT IMPACTS

4.6.1 Summary Tabulation of Adverse and Beneficial Impacts

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 Ironton 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 producing a substantial crude oil reserve for the country, in case of a national emergency (see section 4.7). The 21 million barrels to be stored at Ironton represent about 4 percent of the total planned Strategic Petroleum Reserve and 13.5 percent of the Early Storage Reserve.

4.6.2 Overall Project Appraisal

Conversion of the abandoned Ironton limestone mine to an oil storage facility is not likely to generate significant environmental impacts except for the remote possibility of a major oil spill, the release of relatively small amounts of hydrocarbon vapors from 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, Ashland Terminal and the entire transportation route from the Gulf to Catlettsburg have long been used for industrial purposes and that the project locations are not a unique resource or habitat for significant flora or fauna minimizes the scope of impacts resulting from construction and operation activities. Also, the area affected by construction will be relatively small (affecting only 65 acres) when compared to the large extent of adjacent, similar lands. Since the pipeline will be buried beneath the ground, the impact on vegetation, soils and land use will be of short duration. Socioeconomic impacts of construction will be insignificant since the entire work force is expected to come from within the Huntington, Ashland, Ironton SMSA. Local use of personnel should not lead to scarcity in local manpower. Neither housing availability and costs, nor public services will be measurably affected.

Operation of the Ironton facility will have virtually no socioeconomic impacts since employment requirements are for only 2 to 3 workers. Environmental impacts of operation relate primarily to transportation of the oil by pipeline and to possible accidents involving oil spills.

Transportation of oil by pipeline and tanker may result in oil spills along the route between the Gulf of Mexico and Ironton Mine. If a maximum credible oil spill occurred the costs could be very 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.

Hydrocarbon vapor release from tank farms at Patoka, Owensboro and St. James will total an estimated 300 pounds per day for brief periods during fill operations. 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 38 days during each cavern fill operation. Calculation of hydrocarbon concentrations downwind indicate that ground level concentration may exceed 160 $\mu g/m^3$ 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	No impact	None
4. Cavern Integrity	No impact	None
5. Disposal of mine water	Pump out and treatment of an estimated 40 million gallons before construction. Dewatering rate of less than 15 gpm during storage.	None
6. Loss of mineral resources	Negligible oil absorption, slight loss of recoverable limestone; however, mine is abandoned.	
Hydrology		
1. Surface water pollution	From mine: No significant adverse effect. From oil spill: small risk of large spill; temporary adverse impact. From pipeline: slight increase in erosion during construction periods.	None
2. Ground water pollution	Highly unlikely from mine due to impermeability of limestone and absence of faulting. Possibility of local contamination of shallow aquifers resulting from oil spill.	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 oil spill reaching the Ohio River.	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 volatile oil fractions vented during filling of cavern; negligible odor generation during filling and withdrawing operations ; minor amounts of HC vapors released at tank farms at Patoka, Illinois, Owensboro, Kentucky, and St. James, Louisiana; locally significant amounts of HC vapors released during transport of oil from VLCCs in the Gulf of Mexico to the tank farm at St. James.	None
Noise		
1. Construction equipment	Increase in nighttime ambient sound levels at nearby undeveloped areas will be less than 6 dB; increase within city of Ironton will be 4 dB. Some potential for annoyance to residents within one-half mile during blasting.	None
2. Pumping operations during filling and withdrawal	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	 Beneficial
errestrial Ecology		
1. Wildlife habitat	Removal of approximately 65 acres for site preparation and pipeline structures	Creation of new "edge" at perimeter of site and along pipeline route might lead to increased diversity of wildlife.
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, avifauna 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 would temporarily displace local aquatic life.	None
Historical and Archaeological Assets		
1. Historic places	None of record	Survey will add to archaeological knowledge of area.

TABLE 4.6-1 Continued

Subject Areas and Environmental Impact	Summary Characterization of Impact	
	Adverse	Beneficial
5. Government		
a) Construction phase	None	None
b) Operation phase	Costs of restoring public facilities in case of oil spill possibly significant, but not highly probable.	Small increase in annual county tax revenues ($96,000) if owned by private company.
6. Aesthetics	No significant adverse effects. Mine land is zoned industrial. Pipeline will be buried. Pipeline corridor in remote areas. A large oil spill could significantly degrade aesthetic qualities relating to recreational uses of water, and costs of restoration could be significant, but the probability of such a spill is very low.	None

TABLE 4.6-1 Continued

Subject Areas and Environmental Impact	Summary Characterization of Impact	
	Adverse	Beneficial
Socioeconomics		
1. Land use		
a) Construction phase	Removal of approximately 65 acres of forest land and pasture resulting from oil pipeline and handling equipment usage	Increased economic utilization of natural resource (land) and slight expansion of local property tax base if privately developed
b) Operation phase	No impact on existing land uses in area, except in case (remote) of oil spill; probability of large oil spill occurring and reaching developed water recreation areas judged very small	None
2. Transportation		
a) Construction phase	Negligible impact. Slight increase in traffic and some new roads for pipeline construction.	None
b) Operation phase	Minor increase in tanker traffic on Mississippi River.	Fuller utilization of existing pipeline capacity.
3. Population and housing	None	None
4. Economics		
a) Construction phase	None	Possible slight increase in business for Ironton commercial establishments. Small decrease in unemployment.
b) Operation phase	None	Slight long term increase in income and employment in Ironton area. Slight temporary increase in tanker and pipeline employment and in shipyard construction employment.

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 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 dependence on foreign oil supplies, recognizing our present national short-term oil dependence.

Ironton Mine was selected 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 Ironton Mine for oil storage (Sections 4.1 through 4.6). The importance of the site in providing a potential 13.5 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 ENVIRONMENTAL IMPACTS

5.1.1 Geology

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 burial of the pipeline. These impacts on the environment will affect only the immediate construction zone of the project.

Virtually no effect on the local or regional geology will occur as a result of project operation.

5.1.2 Soils

The principal adverse impact on the physical environment as a result of construction is erosion and subsequent sedimentation occurring as the result of runoff over disturbed land surfaces or along excavated trenches. Soil in most of the construction area is of the clay residual type; topography of the region is rugged to steeply rolling. These factors greatly increase erosion potential.

The type of erosion possible consists of surficial landslides in which local failures due to surface sloughing are likely to occur, being generally common in the region. Interceptor barriers in the trench, shallow drainage ditches, and temporary settling basins will serve to minimize erosion during the actual construction period. By proper backfilling of the trench, especially in areas susceptible to erosion, and careful revegetation procedures, erosion can be minimized. There will be a period of time before plant growth when the uncovered ground will be susceptible to erosion. Exposed soils will at that time 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.

Direct impacts to disrupted lands will be adverse but temporary, except for the inversion of some soil as the result of excavation and backfilling the trench.

5.1.3 Hydrology

5.1.3.1 Surface Water

River and stream crossing will require the excavation or dredging of trenches where the pipeline will be located. Small streams may be either temporarily diverted, dammed, or passed across the pipeline trench by means of a flume or conduit. High flow stream crossings require that trenching, pipe laying, and backfilling operations be conducted while the water flow continues. In most cases, some amounts of disturbed soil and bottom sediments will be carried downstream. Sand, gravel, or rock-bottom streams will be backfilled with excavated material. If additional backfill material is required, it will consist of bankrun sand, gravel, or crushed stone.

Temporary causeways required in soft-bottom streams for movement of construction equipment will cause some siltation and increased turbidity in the stream. Causeways will be constructed of nonpolluting material with properly sized pipe flumes installed to minimize erosion. The causeways will be removed after construction is completed.

During construction, some siltation of the small streams will occur despite efforts to prevent erosion. A reduction in water quality will temporarily occur due to increased turbidity and suspended solids during site excavation and grading. Construction of the pipeline crossing at the Ohio River will create local and temporary low oxygen conditions, low pH, increased eutrophication and turbidity, and possible increased heavy metal concentration.

No freshwater lakes will be directly affected by construction or operation of the facilities.

Consumptive use of water by the oil storage facility during operation will be small. Mine modification should require less than 35 gallons per minute. This water will be required for mixing cement, sanitary, and miscellaneous uses. During operation, little or no water use will be required.

An estimated 10 gpm, or less, of seepage must be pumped from the mine during storage. Approximately 40 million gallons must be pumped out prior to construction. All effluent will be treated to conform with state water quality standards prior to discharge. Effect on local streams should be minor.

5.1.3.2 Ground Water

No rock cuts or excavations for the pipeline will be carried below the ground water table. Therefore, the adverse impact of construction of the storage facility and pipeline route on the natural ground water regime will be minimal.

Filling the cavern with oil will not have an impact on aquifer hydraulics or on ground water quality. The mine cavern is believed to be hydraulically isolated from known aquifers in the area. The shallow aquifers created by the upper zone in the bedrock are usually perched and are not extremely sensitive to contamination from surface sources. Therefore, no impact on the ground water regime is expected to result from operation of the storage facility.

5.1.4 Air Quality

Dust typical of mining activities will be created, particularly during the site preparation activities, blasting, and shaft sinking operations. Small amounts of emissions will be produced from open burning and engine exhaust. FEA is committed to minimize such effects and to comply with local and state regulations and standards (see Appendices A and B).

During storage operation, there will be no atmospheric emissions at the site except for flaring of small volumes of vented gases from the oil cavern and approximately 42 lb/day of hydrocarbons from the site piping system during filling. Flaring will prevent the accumulation of an explosive atmosphere in the vicinity of the mine and also reduce odor and hydrocarbon emissions to nominal amounts. No increases in gaseous concentrations should be detectable beyond the immediate construction area.

Oil leakage during filling operations will release a total of approximately 300 lb/day into the local atmosphere 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.

5.1.5 Noise

Construction noise may cause some annoyance to residents within 1 mile of the mine site and within 1/2 mile of the pipeline route. There are very few residences this close to the project, however.

5.1.6 Ecology

5.1.6.1 Terrestrial

Implementation of the proposed action is likely to result in the following unavoidable adverse impacts:

1. Loss of 1.5 acres of previously cleared habitat at the mine site.
2. The temporary loss of approximately 65 acres of mixed hardwood habitat during construction of the pipeline corridor.
3. The disruption and possible loss of those wildlife species that inhabit mixed hardwood habitat and cannot relocate in adjacent habitats.
4. A disruption in the area food chain resulting from loss of food source from primary consumer species (herbivores) with an escalating effect on higher level consumers.
5. A temporary reduction in carrying capacity for habitat affected by construction of the pipeline corridor.
6. Potential disruption of wildlife species as a result of noise at the pump station and terminal during the filling and withdrawal period.
7. Potential adverse impacts on the biological environment from an oil spill.

Disruption of the terrestrial food chain is an unavoidable adverse consequence of construction. There is a potential problem from a spill or leak from the crude oil pipeline. If the maximum credible spill occurred, it would significantly affect habitat for terrestrial wildlife.

5.1.6.2 Aquatic

Localized increases in turbidity and siltation, with resulting destruction or displacement of biota, are an unavoidable consequence of construction of pipeline crossings over flowing streams. If proper mitigative measures are taken, adverse effects can be minimized. Approximately 2700 square feet of existing stream habitat will be directly affected. Indirect effects could be felt up to 9 miles downstream. It would probably take 6 to 24 months for aquatic populations to re-establish themselves.

5.1.7 Historical and Archaeological Resources

Construction of the pipeline will not have an unavoidable adverse impact upon historical and archaeological resources because the route will be surveyed by an archaeological consultant prior to and during construction.

Construction of the pump facilities and operation of the oil storage facility should not have unavoidable adverse impacts upon the historical or archaeological environment since facilities are to be constructed in already disturbed areas.

5.1.8 Socioeconomics

Construction of the pipeline will have a short-term effect upon approximately 65 acres of land. Once construction is completed, the land can be returned to its normal use. The terminal will utilize approximately 2 acres of land and the pump facilities approximately 1.5 acres. The area in the immediate vicinity of the Ironton Mine site and Catlettsburg Terminal will be withdrawn from other possible uses for the life of the Strategic Reserve Plan.

Trucking and other vehicular traffic will increase during construction of the project, but will not significantly impact current traffic patterns. No roads will be taken out of use as a result of the oil storage facility and no major changes in circulation will result from operating the facility. 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.

There will be a temporary (38 days) increase in tanker traffic in the Mississippi River during each fill operation. The increase is equivalent to approximately two round trips per day.

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.

If the FEA owns and controls the project, it will take the mine property off the tax roles. The current taxes from the property are less than $3,000, but an alternate industrial use of the site and resulting increased revenues will be precluded if the project is run by the FEA.

Aesthetics along the pipeline route will be changed temporarily. The facilities at the mine site will be low profile and may be screened by surrounding vegetation. The site is part of land that is zoned industrial. Flaring may be visible in the immediate area and from nearby residences, especially when the gases are burned at night.

5.1.9 Oil Spill

The risk of oil spill incidents is described in some detail in section 4.3.8. Normal operations are not expected to have significant adverse impacts on the environment because of the small volume of oil release and infrequent spills. Oil storage in underground caverns, as at the Ironton site, is probably the safest storage technique available.

There is a very slight chance that a major spill (3000 barrels) may occur during transport of the oil. The oil spill contingency plan is designed to minimize impacts of such an occurrence. Only a relatively small area of Lawrence or Boyd County or the nearby watershed would be affected, and recovery would probably be complete in 2 or 3 years. Thus, impacts from even the maximum credible oil spill would be temporary and local in importance.

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

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 and is particularly important in the vicinity of Ironton because of the rugged to moderately rolling topography.

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.

5.2.3 Air Quality

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 engineer 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.

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 5.2.9.

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 activities 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. 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 mitigative 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 minimize erosion. The stream banks can be protected against erosion by providing additional riprap. Vehicles should cross drainage-ways, 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 of the distubed areas along the pipeline corridor can help prevent erosion and provide suitable habitat for small animals and birds within months of construction. 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 Socioeconomics

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.

5.2.7 Oil Spills

An oil spill contingency plan will be designed to minimize impacts from a spill and to speed recovery (see Appendix I). 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. Some possible rehabilitation measures are discussed in Section 4.3.3.8.

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 to divert any oil spillage to the containment area.
4. Installation of a modern supervisory control system for observance of operations by 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 or retard 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 can 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 32 percent reduction in the risk of total oil spill release.
14. Design and construction of a vapor recovery system, resulting in elimination of hydrocarbon loss by flaring during cavern filling and positive control of vapor pressure within the cavern during storage.
15. Design of the concrete shaft plug to withstand the impact of soil and rock resulting from a shaft failure.

5.2.8 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.

5.2.8.1 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 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 Catlettsburg 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 Ironton 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 the 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 on 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.

5.2.8.2 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 ground water 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.

5.2.9 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 187,100 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 system are estimated to be: 1) a maximum rate of 189 BPD; 2) a maximum annual emission of 7184 barrels; and 3) a total release of 35,930 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 of venting through a flare during cavern fill at the storage site to eliminate loss of vapors and to provide a means of continuous control of cavern storage pressures. A vapor condensation system requires a considerable capital investment, depending on the size of the unit required.

A third possibility is to flare the vapors before release, at a safe distance from the oil. Flaring essentially eliminates air quality effects but does not allow hydrocarbon recovery. A fourth possibility is permanent ballasting of tankers. This would nearly eliminate hydrocarbon emissions associated with transfer activities at 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 Ironton Mine oil storage system and may be economically advantageous.

An estimate of the mitigative effects of vapor recovery may be made by assuming the following: 1) at the Ironton 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 Ironton system. The reduction is estimated hydrocarbon release to the atmosphere may be summarized as follows: 1) maximum system daily emission rate reduced by 37 percent to 118 BPD; 2) maximum annual release to the atmosphere reduced by 37 percent to 4530 barrels of oil (equivalent); and 3) total release of hydrocarbons to the atmosphere during the project lifetime reduced by 37 percent to 22,700 barrels of oil. The reduction in total hydrocarbon loss from Ironton storage sysetm would be approximately 56 percent to 83,140 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 Ironton 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 Ironton 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 use of an abandoned limestone mine for oil storage will take practical advantage of an otherwise unprofitable facility at Ironton.

The use of Ironton for underground oil storage will add a potential reserve of 21 million barrels of oil for immediate use in the future. This amount will account for approximately 4.5 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 minimal.

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 should result (section 4.3.8).

If Ironton Mine is developed for storage, approximately 1.5 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.

Disturbance of the sites for construction of new 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 have already been disturbed for over 60 years 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 Lawrence and Boyd Counties.

6.2 ENHANCEMENT OF NATIONAL ECONOMIC PRODUCTIVITY

The Ironton oil storage facility will provide a potential reserve supply of about 21 million barrels of petroleum during the 20- to 25-year 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 small beneficial economic impact on both Lawrence and Boyd Counties.

6.3 ADVERSE IMPACTS ON PRODUCTIVITY

6.3.1 Impacts on Land Use

Construction and operation of the storage area will remove about 1.5 acres of land and a relatively small volume of limestone from other uses for the life of the storage project. Limestone is not the primary resource of Lawrence or Boyd County. At the storage site,the surface area is occupied by existing mining facilities. Surface productivity along the pipeline route, which is hardwood forest, pasture, and cropland, will be temporarily affected by the project.

Short-term impacts on resources caused by construction will include the temporary loss of 65 acres of forest and pasture habitats in the pipeline corridor and the resulting stress on terrestrial wildlife species inhabiting the component of the ecosystem. There will also be a short-term reduction in the carrying capacity of the land plus a reduction in grazing land and 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 2-year 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 1.5 acres of mixed mesophytic hardwood habitat at the mine site is the only example of long-term use of resources. The effects will be insignificant for most species of flora and fauna on the site. Considering the size and present location of the site, the common species of flora and fauna now present, the existing site conditions, and the low probability of severe damage to the environment occurring as a result of the proposed action, the overall affects on the productivity of the regional ecosystem will be minimal.

Most of the land area affected could be restored to a better condition than currently exists at the site, once 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 use 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 Ironton Mine (42 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 (38 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) constuction 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 1.5 acres. Except for areas occupied by the pumphouse, pipelines, and other small structures, which will be situated on about 1 acre 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 C. During plant operation, air resources must be used to receive these discharges. An estimated 40 million gallons of water will be pumped from the mine and discharged to Ice Creek prior to construction; less than 10 gpm of seepage will be treated and released during storage. Effluent will conform to Ohio water quality standards. 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 Ironton Mine is the energy required to convert the existing mine and to store and recover oil. This includes the energy content of the materials used in construction. 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.

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 Ironton Mine have roughly rectangular dimensions of 3500 x 3000 x 40 feet. A layer of the dolomitic formation 150 feet thick below the cavity contains about 1.6 billion cubic feet of material. A layer of limestone 150 feet thick around the perimeter of the mine contains about 78 million cubic feet of material. If 30 percent of this is minable rock of the same quality as the present excavation, then 23 million cubic feet of material are excluded by the project from future recovery. Total production at the Ironton Mine to date is 120 million cubic feet. Since the mine is now closed, and will be available for mining after project abandonment, there may be no actual loss of useful resources during the project's lifetime.

The mined caverns have a volume of about 120 million cubic feet, with about 3.2 million square feet of floor area and 6.1 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 21,000 barrels of oil will be unrecoverable (0.1 percent of storage volume). In time, with sludge buildup, the amount of unrecoverable oil on the mine floor could nearly double, making about 33,000 barrels irretrievable (0.2 percent of storage volume).

Estimates of construction materials 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 shaft entries	22,000	3,900
Steel	20,000	3,600
Concrete	25,000	4,500
TOTAL	67,000	12,000
Indirect Construction		
Labor Support	11,000	1,900
Steel (manufactured, 150 tons)	6,000	1,100
TOTAL	17,000	3,000
Handling		
Tanker pumping	750,000	136,400
Tanker transport	1,000,000	181,800
Pipeline steel	170,000	30,800
Pipeline construction	40,000	7,300
Pipeline transport	10,150,000	1,845,500
Cavern life	220,000	40,000
TOTAL	12,330,000	2,241,800

These tabulations indicate that energy equivalent to 15,000 barrels of oil are consumed in converting the cavern and relocating the limestone mine. Approximately 38,100 barrels of oil are required to construct the pipeline facilities. Approximately 2,203,700 barrels of oil are expended in handling the oil during the assumed 5 storage cycles (not including delivery from Ashland Terminal to refineries). In terms of the total energy equivalent of the storage capacity of the facility (105 million barrels in 5 cycles), the energy commitments are:

	Percent of Potential Cavern Storage Capacity (105 million barrels)	Barrels of Oil
Construction	0.05	53,100
Handling (5 cycles)	2.10	2,203,700
Unrecovered oil	0.03	33,000
Oil released as vapor by leakage during transportation of oil	0.034	35,930
Oil lost by flaring during cavern fill	0.144	151,200
Spill expectation	0.001	1,086
Maximum credible spill	0.057	60,000
TOTAL (5 cycles) ENERGY USE	2.42	2,538,000

The energy used is irretrievable. It represents an investment of approximately 2.4 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 Ironton.

7.6 BIOTIC RESOURCES

Construction of the oil storage facilities and pipeline will result in habitat alterations of approximately 70 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 Ironton 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 the Ironton Mine site. 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 that 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 Ironton Mine; they address the larger question of optimum program policy.

8.2 NONSTRUCTURAL ALTERNATIVES

A description of the no action alternative and its impacts, as it applies to the entire program, is provided in the programmtic EIS (DES-76-2, 1976). Within the program a decision not to develop the Ironton Mine facility would result in the development of one of the other candidate sites to take its place. In this case, the impacts described in section 4.0 would not occur and the existing environment of Ironton (as described in section 3.0) would be maintained. However, the decision to develop another facility in lieu of Ironton 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 similar to those for Ironton. The range of impacts for any particular facility are very site specific and, therefore, are discussed in the EIS for that site.

8.3 STRUCTURAL ALTERNATIVES

Structural alternatives available to the FEA can be discussed in terms of alternative storage methods, alternative mine sites, alternative shaft and oil recovery systems, and alternative distribution systems.

8.3.1 Alternative Storage Methods

The Strategic Petroleum Reserve EIS (DES-76-2, 1976) includes consideration of all feasible oil storage methods and their impacts, including relatively small volume product storage in aboveground tanks and high-volume crude storage in underground caverns. Alternative storage methods include use of: 1) existing and new solution mined caverns; 2) existing and new conventional mines; 3) existing and new conventional storage tanks; and 4) surplus oil tankers.

8.3.2 Alternative Storage Sites Considered

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 Ironton 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. 8.3-2). These five sites include the West Hackberry salt dome (Cameron Parish, Louisiana), the Bayou Choctaw salt dome (Iberville Parish, Louisiana), the Bryan Mound salt dome (Brazoria County, Texas), The Cote Blanche salt mine (St. Mary Parish, Louisiana), and the Weeks Island salt mine (Iberia Parish, Louisiana). All except Cote Blanche have been selected for the ESR. Bayou Choctaw, Bryan Mound and West Hackberry have been acquired and site development has begun and geotechnical testing is about to begin at Weeks Island.

The remaining three sites, Ironton limestone mine (Lawrence County, Ohio), Central Rock limestone mine (Fayette County, Kentucky), 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 pipeline. Ironton and Central Rock 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 involves two steps. The first decision in the process was to choose four 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 were alternatives for accomplishing this purpose. Site specific EISs have been prepared for all five 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 candidate 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, Ironton, Central Rock, and Cote Blanche are possible sites in this group.

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 μgm/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 Central Rock

Conversion of the Central Rock limestone mine into a 14-million barrel oil storage facility would require relocation of the existing mining operations; construction of a new pump shaft and appurtenant facilities at the storage site; construction of an oil pipeline from Central Rock Mine to Tate Creek Terminal; and construction of terminal facilities (including two 120,000 barrel stroage tanks) at Tates Creek Terminal. Construction of this facility is not expected to have long term adverse environmental impact. Any negative impact is expected to be short term and minor in nature.

Storage Site Conversion and Construction

Conversion of the Central Rock limestone mine to an oil storage facility requires removal of the existing shaft equipment, sinking of a new pump shaft, installation of oil pumps and casings, and sealing the existing production decline and service shaft. A minimal amount of surface grading would be required over an area of about 2 acres including surface area required by new mine development. During the construction activity there would be an increase in fugitive dust levels, pollutants from construction vehicle emissions, and ambient noise levels. However, these effects would be localized and temporary and would cease upon completion of construction.

Development of new mine site

Relocation of the mining operation would require the excavation of a production and access decline, and the drilling of a service shaft. The surface equipment and construction technique employed would be similar to those used at the storage site; however, the excavation process would require use of explosives. Both ambient and impact sound level would increase in the vicinity of the project during construction and excavation. As construction activity proceeded further underground, audible sould levels would decrease.

Construction of the storage facility and relocation of the mining operation would provide about 9,000 man-weeks of labor for a 79-week period (59 weeks with the temporary mine shut down option) and total earnings of about $2.9 million. Economic gain resulting from an interruption in mining to accelerate the storage schedule would be offset by unemployment and underemployment of up to 120 mine workers and a loss of $.7 million.

Pipeline Construction

A 13.5 mile long pipeline 16 inches in diameter would be required to connect the Central Rock storage facility with the Ashland oil booster Terminal at Tates Creek. The 40-foot wide right-of-way corridor of the pipeline would affect 65 acres of land. Construction activity, with the use of trucks, heavy equipment and blasting, would cause increased noise levles, 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 the runoff-erosion process. Because the pipeline right-of-way corridor is in an area developed in valuable racehorse pasture lands, restoration of this land would be a necessity.

Terminal Construction

Expansion of the Tates Creek Terminal to accommodate the oil from Central Rock storage facility will require construction of two 120,000 barrel storage tanks, plus pumps, meters, and a control system. About 9 acres of land presently zoned for residential use will be required for the expansion. Environmental impacts from construction would be similar to those resulting from mine relocation and pipeline construction, and would be short term and minor in nature. Construction fo the pipeline and terminal facilities would require approximately 20 weeks.

Facility Operations

Periods of fill and withdrawal would last 500 days and 150 days respectively. The storage facility would be filled by pipeline through the Tates Creek Terminal at a minimum rate of 28,000 BPD. Withdrawal of oil would be made at a rate of 93,000 BPD through the Tates Creek Terminal.

Approximately 42 pounds of hydrocarbons per day would be emitted from the storage cavern during fill periods; a temporary flare system would be used as a safety precaution to reduce concentrations of combustible gases and SO_2 in the mine area. During each fill-withdrawal cycle, oil would be stored at Tates Creek Terminal, and approximatley 85 pounds of hydrocarbons per day would be lost to the atmosphere from the two 120,000 barrel, floating roof storage tanks. Such hydrocarbon emissions might result in ambient concentrations exceeding 160 g/m^3 in the immediate vicinity of the site.

Eight to ten trained employees would be required during the 150 day withdrawal and the 500 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 Central Rock Storage facility and the Tates Creek Terminal has been estimated at 0.007 spill incidents per single filling cycle, and 0.07 spill incidents over the project lifetime. The average spill volume is calculated to be 300 barrels, with a maximum credible spill being 2500. However, the expected volume of spillage over the project lifetime is 21 barrels.

The pipeline from the Central Rock cavern storage site to the Tates Creek Terminal would be laid through Karst topography (a limestone plateau marked by dissolution features such as sinks, or karst holes, and underground caverns and tunnels) and would be subject to breakage in case of sinkhole collapse and foundation failure. Because of the karst topography, the risk of oil spill would be greater than normal for pipelines. The spill frequency expectation per single filling cycle would be 0.009, and 0.15 over the project lifetime. The average spill volume is estimated at 1083 barrels, with a maximum credible spill of 3500 barrels. The expected volume of spillage over the project lifetime is 161 barrels.

Transportation of Crude Oil from the Gulf of Mexico to Tates Creek Terminal

All facilities required for the transfer of crude oil from the Gulf of Mexico to Tates Creek Terminal presently exist and are in operation. No new would be required, therefore, there would be no construction related impacts.

There would be locally significant increases in hydrocarbon emissions during each fill operation. It is estimated that 400 tons of hydrocarbon emissions would be released to the atmosphere at the Gulf of Mexico south of the Mississippi River; 20 tons in transport up the Mississippi River to St. James, Louisiana; 280 tons at St. James Terminal; 6 tons at the Patoka, Illinois, tank farm; and 4.5 tons at the Owensboro, Kentucky tank farm. This amounts to 810.5 tons per fill cycle, and 4052.5 tons of hydrocarbon or approximately 24,630 barrels of oil for 5 cycles.

A total of 550 barrels of oil are expected to be spilled during project lifetime, with 390 barrels expected to be released into the Gulf of Mexico or the Mississippi River below St. James, Louisiana. The remaining 160 barrels are expected to be released accidently from Capline or Ashland pipelines. The maximum credible spill is estimated to be 60,000 barrels for tankers in the Gulf and 10,000 barrels from the pipeline system.

8.3.3 Alternate Shaft and Oil Recovery Systems

Currently at Ironton, both of the existing mine shafts bottom out at +74 feet MSL, which is approximately 15 to 17 feet higher than the lowest floor level in the mine. Additionally, seepage water is present in the lower portions of the mine up to +74 feet MSL.

Three alternative shaft and oil handling systems have been considered for Ironton:

1. Drill a new pump shaft from the ground elevation into the deepest portion of the mine to enable the total mine volume to be effectively utilized for oil storage after the mine water has been pumped out and treated.
2. Use one of the existing shafts as a pump shaft; leave the water in the mine and accept a loss of storage volume.
3. Deepen one of the existing shafts to form a sump and excavate channels to ensure drainage of oil from the lowest section of the mine back to the sump. (This option was chosen as the primary design concept.)

The first alternative would involve a considerable amount of time and additional cost and manpower. Following an extensive underground geotechnical exploration to locate the optimum shaft site, a new pump shaft would be sunk; one of the two existing shafts would serve temporarily as a service entrance. The pump shaft would be lined with concrete and separated from the existing shafts by a minimum of 300 feet. This alternative is feasible from an engineering standpoint, but in view of the time and cost constraints, is viewed as being impractical at the present time.

The second alternative offers significant cost and schedule benefits compared with the first alternative, but results in the loss of about 1 million barrels of oil storage volume, some 5 percent of the total capacity of the Ironton Mine. It avoids the need for pumping out the estimated 40 million gallons of water in the mine and the cost of treating the water to meet Ohio standards prior to discharging into Ice Creek.

If the full storage volume is required, the third alternative is preferred since the cost of deepening the shaft and providing drainage channels will be significantly less than sinking a new shaft. The ground surface at shaft No. 1 is 55 feet higher than at No. 2, and considerable debris and structures exist in the area of shaft No. 1. Shaft No. 2 was therefore selected to accommodate the pumping equipment, and shaft No. 1 will be left open for emergency access and ventilation until the underground work is complete, at which time it will be sealed.

8.3.4 Alternative Distribution Systems

8.3.4.1 Barges

Because the Ironton facility is situated along the Ohio River, it could utilize barges for crude oil distribution. Within a 250-mile radius of Ironton are 4 refineries, also located on the Ohio River:

1. Quaker - located about 200 river miles upstream near Parkersburg, West Virginia. This refinery processes 5000 BPD of domestic crude and receives oil from local production fields. The Quaker Refinery would be unaffected by an oil supply interruption and no means exist for diverting its domestic oil elsewhere; therefore, it was not considered further.
2. Chevron - located about 120 river miles downstream near Cincinnati, Ohio. This refinery processes residual oil to produce asphalt. Since it does not refine crude oil, it was not considered further.
3. Gulf - located near the Chevron Refinery at Cincinnati. This refinery processes 43,500 BPD of domestic crude oil received via the Mid-Valley Pipeline. Because the refinery uses only domestic crude oil, it would remain unaffected by a supply interruption. If FEA would divert domestic oil from the Mid-Valley Pipeline to other users, barging from Ironton would be possible; however, the oil would have to be compatible to the Gulf refinery. This alternative was not considered further because Gulf Oil barge facilities are currently in full use and the refinery does not have the facilities for receiving crude oil.
4. Ashland - located near Louisville, Kentucky, approximately 250 miles downstream. This refinery processes 26,000 BPD of crude oil which it receives via a spur pipeline from Ashland's Lebanon Junction Station on their 24-inch pipeline system. It would not be practical to barge crude oil 300 miles by river when a closer oil storage facility could serve the refinery's oil requirement during an import curtailment.

Presently, barges for handling oil on the Ohio River are used for hauling products from refineries to consumers. Barge facilities at both the Gulf Oil and Ashland Refineries are currently used to full capacity and do not have the facilities for receiving crude oil. As a result, dock facilities and oil handling equipment would have to be constructed. Further, because the flow rate attainable using barge transportation is much less than the required 150-day withdrawal rate, a pipeline would be required in addition to barge docks.

In summary, pipeline connection to the Ashland system was selected over barge transportation for detailed analysis for the following reasons: 1) the Gulf Refinery processes only domestic oil; 2) the construction of barge facilities at the site and terminal would be required in addition to a pipeline system; and 3) the flow rate attainable using barge transportation is much less than the required 150-day withdrawal rate, therefore a pipeline would be required in addition to barge docks.

8.3.4.2 Alternative Pipeline Systems

The Ironton facility could fill or withdraw oil by pipeline utilizing any of three alternative systems to supply the Ashland (Catlettsburg) Refinery.

The first alternative would involve construction of a pipeline from Ironton directly to the southwest across the Ohio River for several miles to a point at which it would be tied into the existing Ashland 24-inch oil pipeline. With this method, the available pressure in the Ashland pipeline could be utilized to preclude the need for mainline pumps during the Ironton fill cycle. The primary disadvantages of this method are: 1) a larger spur pipeline to Ironton would be required to fill the mine if mainline fill pumps were not used, and 2) this method would be dependent on the operating schedule of Ashland's pipeline and is therefore not flexible enough to be considered for the SPR program.

The second alternative (utilized as the proposed primary design in this EIS (Sections 2.1, 2.3.2, and 3.10; and Figure 2.1-4)) involves a tie-in at the Ashland Refinery Terminal at Catlettsburg, Kentucky. This system would require greater total horsepower to boost the oil to the Ironton site from the terminal. However, operation would be relatively independent of Ashland's operations. This method was chosen for detailed analysis (Section 4.2.4.1 et seq.) because it allowed for independent operation and greater operational flexibility.

A third alternative has been selected as a reasonable means to supply and withdraw oil by pipeline between the Ironton storage facility and the Ashland Refinery. This would involve a pipeline similar to that originally proposed in the draft EIS (Figure 2.1-4) and described in Sections 2.1, 2.3.2 and 3.10, except that this new alternative alignment would utilize more existing power line, railroad, and levee rights-of-way to avoid additional clearing and grading. The alignment of both the proposed pipeline and the alternative line is shown on Figure 8.3-3.

The selection of a distribution system depends to a very large extent on whether another nearby strategic storage facility is constructed and operational at the same time as Ironton. For purposes of analysis, another storage facility has been considered (Figure 8.3-1). The Ashland Refinery's capacity could be met adequately by either one of the two facilities. Therefore, since Ironton is much closer, the other storage facility would probably tie in with a different refinery in order to help 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 other storage facility could be directed through Tates Creek Terminal to the Lebanon Junction 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 Lebanon Junction to accommodate the required withdrawal demand. This modification accomplished, oil from the other storage facility would flow back through the Ashland 24-inch pipeline and be distributed to another refinery for processing. Oil from Ironton would go directly to Ashland's Catlettsburg Terminal as described in this report.

The interrelationship of the two strategic storage facilities could be accomplished simply, with addition of pump units at Tates Creek Terminal, Owensboro, and Lebanon Junction. Reversal of the section of Ashland's 24-inch pipeline would require check valves, modifications to distribution equipment and physical changes which could be accomplished at station and terminal facilities.

During withdrawal, the oil from Ironton will be pumped to the Ashland Refinery, which currently processes crude oil in the following proportions:

Total capacity:	135,000 BPD
Local production:	11,000 BPD
Foreign oil pumped through the Ashland pipeline:	65,000 - 85,000 BPD
Domestic oil pumped through the Ashland pipeline:	40,000 - 60,000 BPD
150-day withdrawal:	140,000 BPD

The Ashland Refinery was selected to be the recipient of the Ironton oil because: 1) it is the only refinery that processes foreign crude oil in the immediate vicinity of the Ironton Mine; and 2) the Ironton 150-day withdrawal rate nearly matches the current refinery capacity.

It was assumed that the FEA could divert all or part of the domestic oil, which currently flows in Ashland's pipeline, to other refineries during a foreign oil supply interruption so that the Ashland Refinery could utilize nearly all the Ironton 150-day design rate. Thus, the maximum refinery demand, based upon current throughputs, is 135,000 - 11,000 or 124,000 BPD.

Comparison of the Alternate Pipeline Rights-of-Way

The alignment of both the proposed pipeline and the alternative line 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 and land use 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 an existing powerline corridor from the Ironton mine for about one third of its distance through the Wayne National Forest southeast to the vicinity of Lick Creek where the alignment turns toward the southwest and subsequently crosses the Ohio River. It continues past the western part of Catlettsburg, Kentucky, the intersection of Highways I-64 and U.S. 23 and then turns to the east to terminate at the Ashland Oil Refinery (a total distance of approximatley 13.1 miles). This pipeline route was selected to avoid significant elevation differences or hydraulic control points between the storage facility and the terminal. It was also selected to avoid populated areas, but does cut through some industrial, low-income residential and forested lands.

The alternative route (ABC. . .K) crosses the Wayne National Forest in a more southerly direction and continues on from Ironton to the Ashland Terminal (a distance of about 11.5 miles) mainly using existing pipeline and railroad rights-of-way along the way. Both lines would connect with the Ashland pipeline at Catlettsburg. Oil could be transported to the Ashland Terminal during fill either by pipeline, or by barge up the Mississippi River to the Ohio River, or by pipeline through the Ashland oil distribution system. As this alternative is intended to illustrate the effect of using pipelines rather than barges for inland oil transport, the oil spill analysis will assume the use of the Ashland facilities. Distribution of oil from the Ashland terminal depends on allocation decisions which have not been made, therefore the oil spill analysis for withdrawal terminates at the Ashland Refinery.

Existing Environment

A. Physical Setting - Except for a small segment (G to H) along the Ohio River (Figure 8.3-3), two different pipeline routes would transport the oil between the mine and the terminal at Catlettsburg.

Except for the segments between the storage site and segment D, most of the land along the alternative route borders on the Ohio River or Big Sandy River. The original pipeline route crosses steep, rugged topography. Both of the routes cross land which is dedicated to the Wayne National Forest and generally cut across the regional northeast to southwest drainage patterns in Lawrence County.

The most distinctive physical features in the area are the high rolling hills (elevation about 800 feet MSL) and the Ohio River. The Ohio River at this point along the pipeline alignments flows to the north past the cities of Ashland, Kentucky and Ironton, Ohio. The relatively high dry land of the original proposed alignment contrasts with the low flood plain area of the alternative route. This lowland is the focus of most of the urban development and for industrially built up areas. The highlands are dotted by scattered mines and gas wells but are also the locations of numerous farms and agricultural area. The Ohio River is a main tributary of the Mississippi River and is important as a navigational waterway.

B. Ecological Characteristics - The major ecological systems encountered along the pipeline routes are deciduous forests, pasture and cropland, streams and river bottomland, residential-urban, and industrial land use.

Forest and croplands are the most prominent types of land use along the original pipeline corridor; residential-urban-industrial and river bottomland are the predominant land use characteristics of the alternative route. Dominant trees in the deciduous forest include northern red oak, chestnut oak, pignut hickory and black locust. The bottomland along the alternative right-of-way is well developed as an urban area. The elevated ground is characterized by a mixed mesophytic hardwood vegetation type in coves and on lower side slopes of the hills. This association is dominated by numerous broad-leaved deciduous species with no individual species occupying a major dominant position (see Figure 3.6-4). The understory vegetation includes both shrub and herb layer forms with various species of redbud, honeysuckle, wild rose and wild raspberry (Tables 3.6-2 and 3.6-4). Wildlife expected to be present along the pipeline right-of-way is discussed on pages 3.6-5 to 3.6-24.

The bottom or levee land crossed by the pipeline is usually cleared and drained for agricultural purposes or urban development. There are some field crops and numerous discontinuous areas of deciduous trees along the river banks. Diversity of both plants and animals is normally lower in this agricultural land or in urban areas compared to the hill areas. However, deer, dove, rabbits, songbirds and various species of mice and rats are common inhabitants along the bottomlands.

C. Land and Water Uses - Throughout the alternative pipeline alignment the major use of the land is for urban and industrial development (Table 8.3-7). Many of the roads and nearly all of the urban and industrial areas parallel the Ohio and Big Sandy River basins. These rivers are used for domestic and industrial water supply after treatment and these waterways are also important for transport of raw materials and manufactured products.

Description of the Pipeline System - A maximum withdrawal flow rate of 140,000 barrels per day for Ironton requires an 18-inch diameter pipeline. Both the proposed and alternative pipelines would be of this size. Construction of both lines would utilize the same size crew and the same type of equipment and laying methodology and would impact roughly the same amount, but different types of land (Table 8.3-7).

Construction Methods - Except for the Ohio River crossing 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.

Barge excavation will probably be used to cross the Ohio River. Once a ditch has been dredged, the coated pipe, already prepared in adequate length on one bank, is pulled into the trench by cable from the opposite bank until it spans the stream. The pipe would have a minimum cover of 5 feet below the maximum depth of the river scour, or as required by governmental regulations.

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 Ironton to Catlettsburg would be used for both filling and withdrawal of the storage cavern. Actual construction of the pipeline should take less than 9 months. However, surveying the route, obtaining property rights, letting contracts, and obtaining materials might require another year or longer. If necessary, oil could be initially barged to the site. 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 5 months.

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 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 powerline, railroad and levee rights-of-way and thus help to avoid extensive clearing and grading of undeveloped areas. For the purpose of route analysis of impact sensitivity with the areas traversed, the routes have been divided into approximately 5000-foot segments A through K, 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 each side of the alignment). Table 8.3-7 provides a summary of impact characteristics for each route.

Storage Site to A - From the Ironton storage facility to point A, both the proposed and alternative pipeline alignments traverse similar terrain, which is hilly and lies in a diciduous forest. The proposed alignment crosses one stream, Ice Creek, and an intermittent tributary to that stream. The alignment generally travels in a southeasterly direction, paralleling a powerline right-of-way. Elevations within the segment range from 520 feet in the Ice Creek stream valley to over 800 feet along the powerline. The proposed alignment crosses one improved road and would not have any residential involvement.

The alternative pipeline alignment travels in a southeasterly direction and also parallels a powerline right-of-way. Two streams, Ice Creek and an intermittent tributary, would be crossed. One unimproved road would be crossed and the alignment would have no residential involvement. Elevations in this segment, range from 520 feet in the valley of Ice Creek, to over 800 feet, along the powerline. This alignment would require about 1500 feet less clearing than the proposed alignment.

Segment A to B - In segment A to B, the proposed pipeline alignment continues in a generally southeasterly direction and continues to parallel a powerline right-of-way. The terrain traversed is wooded and hilly, with elevations ranging from 570 feet to 800 feet. Two streams, Little Ice Creek and an intermittent tributary, are crossed. Two roads, a light-duty, access road and Route 243, a secondary highway are crossed in this segment. There are about 20 residences and other structures located within 750 feet of either side of the proposed pipeline alignment.

The alternative pipeline alignment travels in a southeasterly direction and continues to parallel, generally, the powerline right-of-way. The terrain traversed is wooded and hilly, with elevations ranging from 600 to 760 feet. One stream, an intermittent tributary of Little Ice Creek, is crossed. Two roads, Route 243, a secondary highway, and a light-duty road, are also crossed. Approximately 40 structures, primarily residences, are within 750 feet of either side of the alignment. These residences are located, principally, in the vicinity of Route 243.

Segment B to C - In segment B to C, the proposed pipeline alignment travels in a southeasterly direction and continues to parallel a powerline right-of-way. The alignment traverses hilly wooded terrain with elevations ranging from 577 feet to over 800 feet. There are no stream crossings involved in this segment of the proposed alignment. The alignment does cross one unimproved access road; ten residences and other structures are within 750 feet of either side of the alignment.

The alternative pipeline alignment continues in a southeast direction paralleling a powerline right-of-way. The terrain traversed in this segment is more favorable to pipeline construction clearing procedure. Much of the alignment lies within the floodplain of Little Ice Creek, which it crosses at two points. Two roads, an unimproved access road and Crabapple Hollow Road, a light duty road, are crossed by the alternative alignment in the segment. Land uses affected by this alignment are woodlands and crop and pasturelands. Approximately halfway between points B and C, the alternative alignment passes very near a deep mine shaft entrance. Another mine shaft entrance, near point C, is located about 500 feet from the alignment but is across Little Ice Creek. There are 12 residences and other structures within 750 feet of either side of the alternative pipeline alignment in this segment.

Segment C to D - The proposed pipeline alignment, in segment C to D, continues in a southeasterly direction, paralleling a powerline right-of-way. The terrain traversed in this segment is wooded and hilly, with elevations ranging from 600 to 800 feet. Three streams are crossed: Little Ice Creek, and an intermittent tributary of Lick Creek that is crossed twice. The Little Ice Creek crossing is at a point where the stream valley has steep, nearly vertical banks. Three roads are crossed in this segment: two light-duty roads and an unimproved access road. Near point D, this alignment would affect 11 residences in the Possum Hollow vicinity.

The alternative pipeline alignment also continues in a southeasterly direction, paralleling a powerline right-of-way. Near point C, the alternative alignment leaves the Little Ice Creek floodplain for steeper, more elevated terrain. This area is wooded and has elevations ranging from 600 to over 800 feet. There are no roads or streams crossed by this alignment in this segment, nor are any residences or structures located near the alignment.

Segment D to E - In segment D to E, the proposed pipeline alignment continues in a southeastly direction and continues to parallel a powerline, although not within its right-of-way. One road, an unimproved road giving access to a farm pond, is crossed. There are no stream crossings in this segment. The terrain is hilly, having elevations ranging from 680 feet to 820 feet, and is wooded. There are no residences or other structures near the proposed pipeline alignment in this segment.

The alternative pipeline alignment, to avoid steep slopes, leaves the powerline right-of-way near point D and travels in an easterly direction along the crest of the ridge. Near Possum Hollow, the alternative shifts direction to the southwest and, within the valley formed by a tributary of Lick Creek, descends from the higher elevations to the Ohio River. At the River, the pipeline again shifts direction, changing to more a southerly course between the Ohio River and the Norfolk and Western Railroad tracks. In the course of this segment, the alternative alignment passes near a deep mine shaft entrance at Possum Hollow. Three roads are crossed: two light-duty roads and Route 52, a four-lane, dual highway. The Norfolk and Western Railroad tracks are also crossed. There is one stream crossing in this segment, Lick Creek. About 69 residences and other structures within 750 feet of the alignment would be affected.

Segment E to F - From point E, the proposed pipeline alignment continues in a southeasterly direction for about 3500 feet, then shifts to a southerly direction. The terrain traversed is hilly and wooded, with elevations ranging from 560 feet, in the valley formed by Lick Creek, to over 800 feet. One stream, Lick Creek, is crossed by the alignment. One road is crossed, Lick Creek Road, a light-duty road. There are 24 residences and other structures within 750 feet of either side of the proposed alignment. These are principally located along Lick Creek Road.

The alternative pipeline alignment continues in a southerly direction, lying between the Norfolk and Western Railroad tracks and the Ohio River. The terrain traversed in this segment is relatively flat. One stream, Solida Creek, and one pond are crossed by the alignment. One light-duty road is also crossed. There are four residences and other structures within 750 feet of either side of the alternative alignment in this segment.

Segment F to G - At point F, the proposed pipeline alignment shifts to a southwesterly direction. The terrain traversed in this segment represents a transition from more elevated areas to river areas. The elevations in this segment range from 540 feet at the Ohio River to 800 feet at point F. There are seven road crossings in this segment: Route 52, a four-lane, dual highway; five light-duty roads; and one unimproved road. One stream, Solida Creek, is crossed; near this, the alignment passes through an area of industrial waste ponds. There are 21 residences and other structures within 750 feet of either side of the proposed pipeline alignment in this segment.

The alternative pipeline alignment continues, in this segment, to travel south between the Norfolk and Western Railroad tracks and the Ohio River. There are no streams crossed in this segment. Two light-duty roads providing access to residences are crossed. There are 26 residences and other structures within 750 feet of either side of the alternative alignment.

Segment G to H - In segment G to H, the proposed pipeline alignment travels south, between the Norfolk and Western Railroad right-of-way and the Ohio River, for about 2600 feet and then crosses the Ohio River to the north of Big Sandy Junction, Kentucky. It then traverses a wooded area to the north of Catlettsburg. In this segment, the proposed alignment crosses two four-lane, dual highways, Routes 23 and 60, the Chesapeake and Ohio Railroad right-of-way, and two light-duty roads. The Ohio River crossing is about 1375 feet in length. There are about 17 residences and other structures within 750 feet either side of the proposed alignment in this segment.

The alternative pipeline alignment continues to travel south between the Norfolk and Western Railroad right-of-way and the Ohio River. There are no stream crossings in this segment. The alternative alignment crosses five light-duty roads in this area of mixed urban development. About 60 residences and other structures are within 750 feet of either side of the alternative pipeline alignment.

Segment H to I - In segment H to I, the proposed pipeline alignment travels in a southwest direction through an area in forest and agricultural uses. There are four road crossings, three light-duty roads and one secondary road, Route 168. Two powerline corridors are crossed and one stream, Catletts Creek, is crossed. Elevations in this segment range from 520 feet to 800 feet.

The alternative pipeline alignment, in this segment, crosses the Ohio River near point H to Big Sandy Junction, Kentucky, near the confluence of the Big Sandy River and the Ohio River. The alignment then travels south, parallel to Route 60. The alignment crosses five light-duty roads in this segment as it travels toward Catlettsburg. There are 123 residences and other structures within 750 feet of either side of the alignment as it traverses an area of mixed urban development.

Segment I to J - In segment I to J, the proposed pipeline alignment travels southwest for about 3500 feet, then it changes direction to the southeast. The area traversed by the alignment is undeveloped and is hilly and wooded terrain, with elevations ranging from 600 feet to 800 feet. One stream, Ice Dam Creek, and three roads, one unimproved and two light-duty roads, are crossed by the proposed alignment.

The alternative pipeline alignment continues, in this segment, to travel south, paralleling the Big Sandy River. The area traversed is in mixed urban development. Approximately halfway between point I and point J, the alignment crosses Route 60, a primary highway. The alignment then passes about 125 feet from a filtration plant. The remainder of the alignment, from the filtration plant to point J, is on the river side of the flood protection levee. There are 173 residences and other structures in the town of Catlettsburg that are within 750 feet of either side of the alternative alignment for this segment.

Segment J to K - In segment J to K, the proposed pipeline alignment travels in an almost southerly direction, traversing hilly, wooded terrain, having elevations from 700 to 800 feet. The alignment crosses two streams, Paddle Creek and an intermittent tributary of Chadwick Creek. Two light-duty roads are also crossed by the alignment. Near point J, about 375 feet west of the alignment, is a deep shaft mine entrance. There are eleven residences and other structures within 750 feet of either side of the proposed alignment in this segment.

The alternative pipeline alignment travels in a southwesterly direction and continues to lie on the river side of the flood protection levee. Approximately 1875 feet from point J, the alignment begins to parallel the Chesapeake and Ohio Railroad right-of-way, and shifts direction to the south. There are three stream crossings: Ice Dam Creek, Paddle Creek, and the confluence of these two streams. Two light-duty roads are also crossed by the alignment in this segment. There are 27 residences and other structures within 750 feet either side of the alternative pipeline alignment in this segment.

Segment K - Catlettsburg Terminal- From point K to the Catlettsburg Terminal, the proposed pipeline alignment traverses crop and pastureland in a southeasterly direction. The Catlettsburg Terminal is the point of oil distribution for the Ironton oil storage facility. The alignment in this segment crosses Routes 538 and 3, both of which are secondary highways, and U.S. 64, an interstate highway, near its interchange with Route 23 in an area where the road cut has high, nearly vertical, rock back slopes. No residences would be affected by the proposed alignment. One stream, Chadwick Creek, would be crossed.

The alternative pipeline alignment continues in a southerly direction, crossing to the west side of the Chesapeake and Ohio Railroad right-of-way at point K. This alignment would cross Chadwick Creek and one of its tributaries in this segment. One unimproved road, two light-duty roads, and Route 64, an interstate highway, would be crossed. Eleven residences and other structures would be within 750 feet either side of the alternative alignment.

Summary - Construction of the alternative pipeline alignment appears to offer several advantages over the orginally proposed alignment. The alternative alignment results in a shorter route (11.5 miles as opposed to 13.1 miles for the proposed alignment). This shorter route, in addition to the use of existing right-of-way for much of its length, could result in reduced construction costs. In addition, the alternative pipeline alignment would reduce the use of land in the Wayne National Forest. On the other hand the alternative alignnment would require increased use of floodplain areas compared to the amount required for the proposed alignment. The use of previously developed areas by the alternative line would result in a lesser construction impact on the environment.

The alternative route parallels existing linear elements such as powerlines, highways, railroads, and the Ohio River levee. Interference with water movement in these areas would be minor because of these existing conditions. On the other hand an increase in the amount of wetland environment traversed would be involved, since the stream beds are wider near the river than in the upland areas through which the proposed alignment would cross. High impact sensitivity would be encountered in these wetland areas. Although the proposed route fringes on existing residential and urban areas the upland in the Wayne National Forest is relatively unmodified and represents a potentially productive biological area. Both alignments also cross a large number of natural streams, at right angles and thus could interfere with natural drainage patterns.

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	Alternative
Wooded	38.5 Acres	18.2 Acres
Crop or Pastureland	9.6 Acres	11.4 Acres
Residential	6.3 Acres	2.7 Acres
Mixed Urban Development	6.3 Acres	15.5 Acres
Streams and Canals	1.9 Acres	8.6 Acres
Industrial and Commercial	1.0 Acres	1.0 Acres
TOTAL	63.6 Acres	57.4 Acres

Comparison of the data shows that the proposed pipeline would affect a total of about 64 acres of land consisting mostly of woodland (60 percent); the alternative route would impact on 57 acres distributed between wooded (32 percent) crop or pastureland (20 percent) and mixed urban development (27 percent). The wooded land and streams and canals can be considered as undisturbed areas compared to the other land uses as described above.

Because of the similarity in estimated lengths for both the alternative (11.5 miles) and proposed (13.1 miles) pipelines the frequency of a spill for either of the lines would be about the same; thus the estimated spill risk (Appendix G) per year for the alternative route would be 0.00575 compared to 0.00655 for the proposed pipeline (Section 4.3.8.1). 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 to 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	-	86.5 percent
One	-	12.6 percent
Two or More	-	0.9 percent

The maximum credible spill for either the alternative or the proposed route is estimated to be 3000 barrels (126,000 gallons). Appendix G and Section 4.3.8 contain a more detailed treatment of oil spill risks for the storage and terminal facilities which are the same for both the proposed and alternative routes.

Physical Impacts

A. Construction - The primary physical impact of either the proposed or the 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 through upland and agricultural land, and that the barge-excavation method will be used across the Ohio River 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 131,000 cubic yards for the proposed route and 115,000 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 would 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 pipe 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 area, 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 through mixed urban development 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. <u>Operation</u> - 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.

An oil spill is the major potential source of physical and ecological impact during pipeline operation. A scenario for a maximum credible spill of 3000 barrels is as follows: Despite warning signs indicating pipeline crossing and burial of 5 feet or more, a large boat anchor is dragged across the pipeline in the Ohio River rupturing the line. Lack of wind and waves results in only 10 percent evaporation of the volatile oil fractions and 10 percent sinking of heavy fractions. Only 50 percent of the remainder is recovered, leaving 1200 barrels to spread along the river banks and flow down stream. Because of the high toxicity of recently spilled unweathered oil, total plant loss could be assumed to occur along the river banks at an average coverage of only 15 barrels per acre, compared to 25 barrels per acre for weathered oil. Thus, a worst case loss of 80 acres would occur. Since the expected total pipeline spill volume during the life of the project is only 156 barrels, the expected loss of acreage (10 acres) due to pipeline spills in the river is much smaller than that estimated for the maximum credible spill.

Spills that occur on dry land or wetlands will probably not spread as far as in a major waterway such as the Ohio River. 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.

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.

As an indication of potential direct displacement effects on wildlife, data on carrying capacities of typical habitats in Ohio and Kentucky can be used. Using the estimated acreage for construction impacts described above, and estimates of faunal carrying capacity given in the Corps of Engineers Environmental Inventory (1975), an estimate of the number of certain species displaced from the pipeline right-of-way can be made.

Table 8.3-8 summarizes the potential impact on selected species due to direct habitat disruption. 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 listed, but probably not for the less common species (e.g., black bear, fox), 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 greatest impact to numbers of individuals and species occurs in the woodlands as a result of the large acreage affected and the relatively high quality of wildlife habitat. The originally proposed route is particularly damaging in this habitat compared to the alternative route.

The data on faunal carrying capacity used in computing wildlife impacts (Tables 8.3-8 and 8.3-9) do not distinguish between modified and relatively unmodified sections of the area in terms of habitat quality. However, most of the 38.5 acres of woodland crossed by the proposed route is relatively unmodified and amounts to 63 percent of the total acreage impacted, while 53 percent of the alternative route acreage is significantly modified (primarily by cropland, agricultural, urban and industrial areas in segments C through K. The alternative route crosses roughly the same number of minor water bodies, highways, levees and railroads but impacts significantly more acreage of water bodies, and less purely residential land.

The total loss of vegetation and wildlife along the pipeline routes is not a signficant portion of the vast resources of similar kind still existent in both Ohio and Kentucky. 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 pipeline rights-of-way for almost 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 the 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 and the Ohio River 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 clean up 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. Table 8.3-9 presents the worst case estimates for animals to be killed for various terrestrial habitats affected by a maximum credible spill of 3000 barrels.

Expected oil spill (156 barrels) impacts would be much lower than those from a maximum credible spill (3000 barrels). A total of 3000 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.

Because of the proximity of a major portion (about 90 percent) of the alternative pipeline alignment to the Ohio and Big Sandy Rivers, (compared to less than ten percent for the proposed pipeline) the potential for oil spill impact on these aquatic environments is greatly increased. This increase is especially true since segments D through K of the alternative pipeline are within the 100-year floodplain and are also on the river side of the railroad embankments and the river levee. If a major spill would occur along these segments the potential for oil to be carried downstream and rapidly spread to the lower reaches of the river is increased. This impact would affect a much larger portion of the aquatic community than if the spill occurred in an isolated streambed.

Pipeline spills of up to 3000 barrels are considered possible for either of the pipeline routes. 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 this amount. Spills which would occur along the Big Sandy or Ohio River would be carried downstream if not contained or recovered. The generally slow currents (usually less than 3 feet per second) and meandering channel would promote lateral dispersion of the oil, but would also increase the opportunity for oil recovery before the spill moved far downstream.

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 Catlettsburg will impact water traffic only for short periods during construction at the Ohio River crossing. Domestic water supplies will not be affected. Land-use restrictions will be required for a 20 to 50-foot wide right-of-way, but these may alter current or potential usage only in developed areas. Possible conflicts with future zoning plans could be avoided as long as existing development corridors were used.

Assuming that the 11.5-mile alternative route is selected, construction will require the expenditure of an estimated $11.5 million in capital costs. Construction of the pipelines might require up to 1 year for either route and would employ an average of 150 workers full time. Energy costs in constructing the pipelines and pumping of oil to and from storage 5 times over the life of the project would be the same for both lines. Operation costs for either pipeline alignment will be from $1.5 million (for fill) to $3.7 million (for withdrawal) per month, in addition to labor required for inspection, equipment maintenance, etc. (see Section 2.3.5 and Table 2.3-2).

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.

8.3.4.3 Expansion of Ashland Pipeline Capacity

The present capacity of Ashland's 24-inch pipeline from Owensboro Station to the Catlettsburg Refinery (Figure 8.3-1) is 152,000 BPD. Presently 124,000 BPD are processed at the refinery, leaving a potential 28,000 BPD for filling the Ironton 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 Ironton Mine.

As indicated above, another site in the vicinity of the Ashland pipeline 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 Ironton 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 other storage site is not developed, the potential fill rate at Ironton could be as high as 61,000 BPD. This would reduce the fill time from 750 days (107.1 weeks) to 344 days (49.1 weeks). It would also mean that the full 21 million-barrel storage capacity would be available during the ESR period (see Figure 2.3-1).

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 duration of perhaps 5 to 7 jobs created by the filling operation would be reduced by 55 percent, but this effect is not significant.

8.3.4.4 Alternative Transportation System, Gulf Coast to Catlettsburg

It is assumed in estimating impacts of transporting oil from the Gulf Coast to Ashland's Terminal at Catlettsburg for storage in Ironton 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 deliver the oil to Catlettsburg. 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 Catlettsburg 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 21 million barrels of oil from VLCCs to the LOOP pipeline would result in an estimated 0.18 spill incidents, totaling 33 barrels of oil (183 barrel average spill). Pipeline transport would require approximately 11 to 22 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 0.915 spill incidents resulting in release of 180 barrels of oil into the environment; 92 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 69 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 22 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 168 tons per fill or 16 tons/day for 11 days. Thus, for 5 fill periods, there would be a total release of 840 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 11 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 150,000 MMBTU, or 27,000 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 traveled 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 Ironton, associated environmental impacts should be smaller than for tanker transport up the Mississippi River. Impacts north of St. James would be unchanged.

West Hackberry

Table 8.3-1

ENVIRONMENTAL IMPACT SUMMARY

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 (312 tons) of marsh productivity during construction.	Greater impact than proposal due to longer pipeline.
Connect to existing pipelines (A)	Temporary surface disruption.	Disruption of 76 acres of brackish marsh and 50 to 80 acres of rice farming.	Slight increase in turbidity in marsh during construction.	Slight hydrocarbon emissions.	Noise impact zone up to 500 feet.	Temporary wildlife disruption.	Loss of $32,800 in rice farming income.
New pipeline to Texoma Terminal (A)	Temporary soil disruption.	180 acres of brackish marsh, 106 acres of intermediate marsh, 48 acres of fresh marsh, 24 acres of dry land.	Slight increase in turbidity in marshes during construction.	Slight hydrocarbon emissions.	Noise impact zone up to 500 feet.	Temporary disruption of wildlife; disruption of benthic community in waterways where dredging required.	Greatest impact due to length of pipeline.
Pipeline accidents	Soil fouled in vicinity of pipelines.	Land unsuitable for farming until oil dispersed through soil.	Local degradation of water quality.	Slight hydrocarbon emissions.	Noise from cleanup operations.	Temporary destruction of local soil organisms and vegetation (on land) and non-mobile organisms in water.	Temporary loss of farm production over small area.
OIL DISPLACEMENT WATER SOURCE							
Black Lake Bayou (P)	No impact.	No impact.	Slight increase in salinity and temporary drop in surface level associated with withdrawal of 10,650 gpm for 150 days.	Slight hydrocarbon emissions.	Noise from pumps.	Entrapment of some organisms in intake structures; no effect on productivity; temporary loss of wildlife during construction.	Same as site construction.
Groundwater wells (A)	Surface disruption from drilling.	1-year loss of small area of coastal prairie grassland.	10,650 gpm for 150 days will result in local cone of depression and some temporary salt water intrusion.	Slight hydrocarbon emissions.	Noise impact zone up to 1,800 feet.	Temporary disuption of wildlife during drilling.	Greater impact than proposal.
MARINE OPERATIONS	Small amount of erosion on channel bottom.	No impact.	Expected oil spill of 273 bbls with tankers, 3,087 bbls with barges.	Barge hydrocarbon emissions of 781 lb/day during unloading; tanker emissions of 8,286 lb/day during unloading and 20,953 during loading; concentrations in excess of 160 µgm/m^3 would extend downwind for 6 miles and 30-45 miles during the barge and tanker operations respectively.	Very slight impact.	Destruction of non-mobile species and residual oily taste in fish from oil spills.	Reduced marketability of fish fouled by oil.
FACILITY OPERATION	No additional impact.	No additional impact.	Small quantities of sanitary waste; slight impact.	Evaporative hydrocarbon losses of 588 lb/day and 500 lb/day from the storage tanks at the barge dock and the tanker terminal respectively; concentrations would be 160 µgm/m^3 at 3 km (barge dock) and at >2km (tanker terminal).	Very slight impact; less than 70 dBa at 50 feet; no nearby residences.	No additional impact.	10 people employed during operation; 20-30 employed during oil recovery; payroll during operation of $18,000 per month; payroll during recovery of $43,850 per month.

(P) Proposed system design

(A) Alternative to the proposed system design

Bayou Choctaw

Table 8.3-2

ENVIRONMENTAL IMPACT SUMMARY

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.	128 acres of swamp forest changed to industrial use.	Increase in salinity in saline aquifers; possible contamination of fresh aquifers if old wells unplugged.	Slight impact from drilling operations.	95-100 dBA at 50 feet; noise impact zone at 1,800 feet; no residences within 1 mile.	Loss of wildlife habitat and production; <1% probability of brine spill that could destroy some marshland over 128 acres.	Included in storage site construction.
116-Mile Pipeline to Gulf (A)	Temporary surface disruption.	182 acres of sugar cane and 350 acres of wetlands lost.	0.1-ppt salinity increase in Gulf waters over 450 acres; increase of 2.5 ppt over 1 acre; no increase more than 3.5 ppt.	Slight impact.	Noise impact zone within 500 feet; no residences within one quarter mile.	Temporary loss of benthic organisms and fish; <1% probability of brine spill that could destroy marsh.	Loss of $882,500 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 $\mu gm/m^3$ as far as 10 km downwind; maximum concentrations of 7500 $\mu gm/m^3$ at 0.5 km.	Noise impact zone at 200 feet; no residences within ¼ mile.	Destruction of non-mobile species and residual oily taste in fish if oil spills occur.	Reduced marketability of fish fouled if oil spills occur.
FACILITY OPERATION	No impact.	No additional impact.	Small quantities of solid and sanitary waste; no adverse impact.	Vessel loading and unloading could produce 2,000 tons hydrocarbon emissions for each fill or withdrawal; worst case emissions could exceed 160 $\mu gm/m^3$ for considerable distance downwind (5-10 km); maximum concentration at 0.5 km of 6.125 $\mu gm/m^3$.	Noise impact zone at 200 feet; no residences within ¼ 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

Table 8.3-3

ENVIRONMENTAL IMPACT SUMMARY

ACTIVITY	IMPACTS DUE TO ACTIVITIES						
	GEOLOGY AND SOILS	LAND USE	WATER QUALITY AND SUPPLY	AIR QUALITY	NOISE	ECOLOGY	SOCIOECONOMIC
STORAGE SITE CONSTRUCTION							
58 million-barrel capacity involving 216 acres (P)	Short-term erosion from dikes, roads, and pipelines; 64,500 cubic yards of material involved.	216 acres previously used for production of sulphur; 20 acres involved in new construction; one new 65x100-foot building. 3,000 to 12,000 cubic feet of surplus lumber, paper waste, concrete and formation water for entire project to landfill sites.	Small increase in turbidity and levels of petroleum products, herbicides and pesticides, metals, salt additives, and construction chemicals.	Temporary degradation by construction vehicles and drill rig equipment, resulting in hydrocarbons, SO_2, NO_2; about 0.5 tons/acre of dust given off per month of activity.	Noise impact zone (greater than 55 dBA) at 2,500 feet; no nearby residences.	Minor additional disruption of wildlife habitat.	1,750 man-months of total construction employment on site; $250,000 per month payroll; 90 men involved in general site construction and drilling; slightly increased traffic and resulting maintenance costs for public facilities.
BRINE DISPOSAL							
Disposal of brine to chemical plants via existing pipeline (P).	No impact.	Brine disposed of in existing ponds at rate of 9,333 gallons per minute.	No impact.	No impact.	No additional impact.	No impact.	No impact.
Disposal of brine to Gulf via 4-mile pipeline (A)	Temporary surface disruption.	24 acres (100-foot right-of-way through 8 acres of coastal prairie, 2 acres of beach, 4 acres of marsh, and 10 acres of cleared land).	Crossing of Gulf Intracoastal Waterway (ICWW) near Brazos River; destruction of nonproductive benthic habitat.	Slight hydrocarbon and dust emissions during construction.	Temporary annoyance to beach visitors from construction equipment.	24 acres of benthic habitat destroyed temporarily along 100-foot corridor for 2 miles into Gulf; entrainment of low mobility unattached organisms near the intake.	No impact.
Deep well injection using 10 well spaced at 1,000 feet on the perimeter of the site (A)	Temporary surface disruption.	20 additional acres required outside site boundaries.	Less than 1% chance of brine spill due to pipeline or wellhead failure; possibility that overpressurization could fracture aquiclude to cause freshwater contamination.	Slight hydrocarbon emissions during drilling.	Drilling noise for 12 months.	Minor additional disruption of wildlife habitat.	No impact.
STORAGE TANK CONSTRUCTION							
Four 400,000-barrel above-ground floating roof storage tanks on site (P)	Permanent surface disruption.	30 acres of cleared land to be modified for tanks.	During construction, some petroleum products, herbicides, pesticides, and sediment.	Vapors from solvents during spray painting of tanks 1 km downwind for several of 90 days, depending on wind.	Noise impact zone up to 2,500 feet; no nearby residences.	Minor additional disruption of wildlife habitat.	25 welders and pipefitters for all pipeline and tank construction.
DOCK FACILITY CONSTRUCTION							
Use of Seaway, Inc. dock facilities under construction; 100,000 barrel ballast treatment system and pump building (P)	Suspension of some sediment from channel.	3 acres of cleared and already disturbed land for Ballast Treatment System.	Same as storage tanks.	Paint solvent emissions from spraying 1.18 gram per second during initial painting.	70 dBA at dock facilities.	3 acres of land for ballast treatment tanks; no critical wildlife habitat; no impact.	No impact.
New barge docks in ICWW (A)	Temporary surface disruption.	Precise location not determined but approximately 1 mile southeast of storage site.	Dredged materials to be placed on 184-acre disposal area 3 miles east; oil spills from associated barge traffic to be contained in the ICWW.	Slight hydrocarbon emissions.	Slight impact from construction.	Marshland, the waterway, a sand dune (disposal site) affected by dredged material; stagnant ICWW water; increased barge traffic.	Construction payroll less than that for storage site construction.
PIPELINES							
30-inch pipeline from site to dock at Freeport, 3.7 miles east (P)	Temporary surface disruptions.	45 acres, 100-foot right-of-way (ROW) through disturbed land.	Local and temporary increase in turbidity and levels of toxic heavy metals and hydrocarbons, and pesticides from dredging and dredge disposal for Brazos River, crossing.	Slight hydrocarbon emissions.	Noise impact zone up to 500 feet; no nearby residences.	Little effect except temporary displacement of transient species like waterfowl and small mammals.	50-man labor force for all pipeline construction.
30-inch pipeline from site to Seaway storage tank facility, 4.5 miles west (P)	Temporary surface disruptions.	53 acres, 100-foot ROW through 18 acres of marsh, 9 acres of developed land, and 26 acres of coastal prairie.		Slight hydrocarbon emissions.	Noise impact zone up to 500 feet; no nearby residences.	Temporary disturbance of marsh and coastal prairie to displace wildlife until vegetation reestablished; dredging on Brazos River crossing to eliminate 0.5 acres of benthic habitat, but with repopulation after 1 to 2 months.	
Pipeline accidents	Soil fouled to 10 cm depth in buried pipeline for 1,000 barrel spill, covering 0.4 acres.	Local land unsuitable for current use until oil dispersion through soil complete.	Only local and minor degradation of water quality.	Slight hydrocarbon emissions.	Slight impact during cleanup.	4.3 barrels; annual spill expected with mean spill size approximately 1,000 barrels; would destroy local soil organisms (if underground) and vegetation (if aboveground).	Small area involved not commercially productive; no impact.
OIL DISPLACEMENT WATER SOURCE							
Water supply from Brazoria and Harris reservoirs via Dow plant and 5-mile pipeline (P)	Temporary surface disruption.	15 acres, 50-foot ROW through 6 acres of coastal prairie, 4 acres of developed land.	Displacement at maximum rate of 14,000 gallons per minute; no significant impact on reservoirs or Brazos River replenishment source; reservoir volume 10 times projected displacement water requirement during one cycle.	Slight hydrocarbon emissions.	Noise impact zone up to 500 feet; slight temporary impact on residences and businesses. Slight impact from pumps during operations.	Plankton affected primarily during withdrawal phase due to impingement and entrainment in intake structure.	50-man labor force for all pipeline construction.
Gulf of Mexico water transported by 2-mile pipeline (A)	Temporary surface disruption.	1 to 2 acres onshore for pumping station; 14 acres of coastal prairie and marsh.	Crossing of ICWW; disturbance of land areas with possible turbidity due to runoff during construction.	Slight hydrocarbon emissions.	Temporary annoyance to beach visitors due to construction.	Benthic habitat along corridor temporarily destroyed; entrainment of low mobility unattached organisms at the intake.	50-man labor force as above for all pipeline construction.
Water from Brazos diversion channel adjacent to site (A)	Temporary surface disruption.	Less than 1 acre of disturbed industrial land involved.	Temporary increase in turbidity in diversion channel.	Slight hydrocarbon emissions.	Slight impact from construction and pumps.	Entrainment of low mobility, unattached organisms near intake; dredging for the intake would destroy small area of benthic habitat.	50-man labor force for all pipeline construction.
MARINE OPERATIONS	Small amount of erosion on harbor bottom.	No impact.	Increased turbidity due to tanker traffic; possibility that median oil spill of 5,500 barrels could affect 3,850 acres of surface water if spill not contained to harbor and entrance channel; 331 barrels total expected spillage during complete withdrawal cycle for tankers; for barges, 2,900 barrels total expected spillage during one fill/withdrawal cycle (higher than tankers because of number of trips required).	Tanker hydrocarbon emissions of 70,500 lb/day during loading and 46,100 lb/day during unloading; concentrations in excess of 160 $\mu gm/m^3$ for considerable distances (>10 km) downwind; maximum concentration of 57,000 $\mu gm/m^3$ at 0.5 km.	Slight impact.	Destruction of non-mobile species and residual oily taste in fish from spill.	Reduced marketability of fish fouled by oil.
FACILITY OPERATIONS	Possible compaction of aquifers and unconsolidated material in immediate vicinity of tanks.	No impact.	7 ppm oil from ballast water treatment to Freeport Harbor at onshore facility; small quantities of sanitary waste.	Evaporative hydrocarbon losses of ~1,000 lb/day for surge and storage tanks combined; storage tank emissions exceed 160 $\mu gm/m^3$ for ~0.5 km downwind; small quantities of emissions from pumps.	Slight impact.	No additional impact.	Crew of 10 during storage phase; 46 during loading and withdrawal phases.

(P) Proposed system design

(A) Alternative to the proposed system design

Cote Blanche

Table 8.3-4

ENVIRONMENTAL IMPACT SUMMARY

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[illegible] grams dry weight of oyster grass; adverse impact to 6 x 10[illegible] 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 $160 ugm/m^3$ 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 $160 ugm/m^3$ 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

Table 8.3-5

ENVIRONMENTAL IMPACT SUMMARY

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 towns due to distance.	Temporary displacement of local aquatic life by enlargement of slip; approximate loss of 50×10^6 grams dry weight marsh grass due to barge slip development and 8×10^6 grams of benthic organisms (9×10^3 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 60-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 $160\ \mu g/m^3$ 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 320 acres for 2 years if it reached wet marsh.	Significant increased demand for barges, tug boats, crews with resultant expanded employment and income in region; need for priorities in equipment use during emergency; possible impact to recreational use of water nearby from oil spill; significant clean-up costs.
Seagoing Barges (A)	Greater disruption of soils due to need for larger barge facilities and pipeline across island.	More land required for dock facilities.	Fewer water impacts due to expected spillage of 42% less oil.	Hydrocarbon emissions 46% lower than from smaller barges.	Same as dock facilities.	Less impact due to lower expected volume of spilled oil.	Slightly greater than dock operation.
FACILITIES OPERATIONS							
Filling (28 months); storage (unknown period); withdrawal (5 months)	No impact.	No impact.	No impact.	Hydrocarbon emissions during barge loading at an annual rate of 2410 tons/yr, causing concentrations in excess of $160\ \mu g/m^3$ 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

Central Rock

Table 8.3-6

ENVIRONMENTAL IMPACT SUMMARY

ACTIVITY	IMPACTS DUE TO ACTIVITIES						
	GEOLOGY AND SOILS	LAND USE	WATER QUALITY	AIR QUALITY	NOISE	ECOLOGY	SOCIOECONOMIC
Storage Site and Terminal Facilities Construction and New Mine Development	Surface Grading of 11 acres; no impact in mine structure; slight erosion of bare ground; minor destruction of weathered bedrock surface; excavation of 10,000 cubic yards of material; expanded access to limestone deposits.	11 acres total for site and terminal facilities.	Decrease in quality of water shed streams due to runoff erosion process; siltation and increased turbidity in stream; increased sedimentation within small impoundments downstream of project construction.	Increased dust, NO_x, SO_2, CO, and hydrocarbons due to construction vehicle activity.	Small increase of about 2 dB ambient L_d and 5 dB ambient L_n in city of Lexington during construction; impulse noise levels from blasting as high as 91 dB at 1000 feet.	Storage site already highly disturbed; negligible loss of habitat; about 9 acres of pasture-crop land habitat lost at the Tates Creek Terminal.	No impact to any known historical or archaeological resource; loss of about \$.7 million in salaries if 120 workers are laid off for 20 weeks and are unable to find replacement employment.
Pipeline Construction (13.5 mile pipeline between Tates Creek Terminal and site)	Temporary disruption of about 41 acre/feet of soil along right-of-way, about 8.2 acre/feet of soil subject to runoff erosion.	Temporary disturbance of 65 acres of agricultural and grazing land.	Increase in the runoff erosion process; temporarily higher infiltration rate along pipeline trench.	Increased dust, NO_x, SO_2, CO, and hydrocarbons during construction activities.	Increase of about 6 dB in ambient L_d at pasture lands 1 mile from construction activity.	Temporary removal of pasture habitat along pipeline; physical disruption of about 300 square feet of existing stream bed aquatic habitat.	Included in above impacts.
Pipeline Accidents (Between St. James Terminal and site)	Soil fouled in vicinity of pipeline.	Minimal impact to land use.	Possible contamination of surface water or shallow aquifer; total expected oil spillage is 203 barrels (between Tates Creek Terminal and site); maximum credible spill is 2500 barrels. Total expected volume of oil spilled is 165 barrels (between St. James and Tates Creek Terminal) and the maximum credible spill is 10,000 barrels.	Hydrocarbon vapor emission from spilled oil.	Noise from clean-up operations	Significant impacts likely to occur to terrestrial vegetation, mammals and birds, and to aquatic organisms.	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 incidents involving explosion from oil pressurization, seepage of oil from mine, or displacement of oil resulting from water inflow into mines.	Minor hydrocarbon and hydrogen sulfide emission from system leakage during pumping and minor SO_2 emissions from flaming of vapors during fill. Daily loss of approximately 85 pounds of hydrocarbons to atmosphere from storage tank during periods of fill; worst-case emissions would exceed 160 $\mu gm/m^3$ for less than ¼ mile downwind.	Ambient sound level anticipated to be 55 dB at 500 feet, or 11 dB lower than existing background ambient sound level.	No impact.	2-3 permanent employees needed to monitor equipment and provide site security; 8-10 employees required for 5 months during withdrawal and 16 months during fill.
Marine Operation	Small amount of erosion on harbor bottom.	No impact.	Maximum credible spill for Gulf-60,000 barrels; expected total oil spilled-390 barrels, 70 barrels at St. James and 320 barrels on Mississippi River or in the Gulf.	"Breathing" losses from tankers and barges-maximum annual atmospheric loading rate of 20 tons/yr.; maximum annual hydrocarbon emission rate for tanker transfers at St. James-280 tons/tr.; transfers at St. James would cause emissions in excess of 3-hour Federal standards 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 1680 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 the economy.

TABLE 8.3-7 Comparison of Ironton pipeline alternatives for number of streams, roads, structures and land use affected by right-of-way

PIPELINE SEGMENTS	STREAM CROSSINGS		ROAD CROSSINGS		STRUCTURES WITHIN 1500' ROW[a]		PREDOMINANT LAND USE[b]	
	Proposed Alignment	Alternative Alignment	Proposed Alignment	Alternative Alignment	Proposed Alignment	Alternative Alignment	Proposed Alignment	Alternative Alignment
Ironton Mine to A	2	2	1	1	0	0	F	F
A - B	2	1	2	2	20	40	F,A	F,R
B - C	0	2	1	2	10	12	F,A	F,A
C - D	3	0	3	0	11	0	F,A	U,A
D - E	0	1	1	4	0	69	F	A
E - F	1	2	1	1	24	4	F,R	A
F - G	1	0	7	2	21	26	F,A,I	U
G - H	1[c]	0	4	5	17	60	A,I	U
H - I	1	1[d]	4	5	7	123	A,F	U
I - J	1	0	3	1	12	179	F	U
J - K	2	3	2	2	11	27	F	U,R
K - Catlettsberg Terminal	1	2	3	4	0	3	F,U,A	A,C
TOTALS	15	14	32	29	133	543		

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[a] Structures Include: Residences, Churches, Offices and Schools

[b] Land Use Code:

R - Residential
I - Industrial
C - Industrial and Commercial Complexes
U - Mixed Urban Development
A - Crop and Pastureland
F - Deciduous Forest

[c] 1375-foot Ohio River Crossing

[d] 1600-foot Ohio River Crossing

TABLE 8.3-8 Biological losses from pipeline construction.

ECOLOGICAL ZONE	CARRYING CAPACITY	ACREAGES AFFECTED		WORST CASE LOSSES	
		Proposed Alignment	Alternative Alignment	Proposed Alignment	Alternative Alignment
Forests	White-tailed Deer: 1 per 40-50 acres	38.5 acres	18.2 acres	1	1
	Wild Turkey: 1 per 75 acres			1	1
	Ruffed Grouse: 1 per 20-30 acres			2	1
	Squirrel: 1-2 per acre			78	36
	Beaver: 1 per 9 acres			4	2
	Migrant Waterfowl: 1 per 10 acres			4	2
	Raccoon: 1 per 10-20 acres			4	2
Cleared Lands	Bobwhite Quail: 200-300 per square mile	9.6 acres	11.4 acres	31	37
	Songbirds: 1 pair per acre			10 pairs	12 pairs
	Cottontail Rabitt: 5-6 per acre			60	66
	Ringnecked Pheasant: 1 cock per acre			10	11
	Mourning Dove: 3.3 pairs per 100 acres			1 pair	1 pair
Wetlands	Deer: 1 per 300 acres	1.9 acres	8.6 acres	1	1
	Waterfowl: 1 per 1-4 acres			1	9
	Wood Duck: 1 per 500 acres			1	1
	Mink: 1 per 75 acres			1	1
	Nutria: 1 per 2 acres			1	4

TABLE 8.3-9 Biological losses from maximum credible oil spill

Ecological Zone	Carrying Capacity	Acreage Affected[a]	Worst Case Losses
1. Deciduous Forest	White-tailed Deer: 1 per 40-50 acres	120 Acres	3
	Wild Turkey: 1-32 per square mile	" "	6
	Ruffed Grouse: 1 per 20-30 acres	" "	6
	Squirrel: 1-2 per acre	" "	240
2. Floodplain Forest	Beaver: 1 per 9 acres	120 Acres	13
	Squirrel: 1 per .77 acres	" "	155
	Migrant Waterfowl: 1 per 10 acres	" "	12
	Wild Turkey: 1 per 75 acres	" "	2
	Raccoon: 1 per 10 - 20 acres	" "	12
3. Cleared Lands	Bobwhite Quail: 200-300 per square mile	120 Acres	1
	Songbirds: 1 pair per acre	" "	120 Pairs
	Cottontail Rabbit: 5-6 per acre	" "	720
	Ringnecked Pheasant: 1 cock per acre	" "	120 Cocks
	Mourning Dove: 3.3 pairs per 100 acres	" "	4 Pairs
4. Wetlands	Deer: 1 per 300 acres	120 Acres	1
	Waterfowl: 1 per 1-4 acres	" "	120
	Wood Duck: 1 per 500 acres	" "	1
	Mink: 1 per 75 acres	" "	2
	Nutria: 1 per 2 acres	" "	60

[a] Affected acreage determined by dividing the maximum credible spill (3000 bbl) by the number of barrels per acre necessary for 100 per cent destruction (25 bbl/AC).

TABLE 8.3-10 Comparison of Ironton pipeline alternatives: acres of floodplain affected by construction

	Proposed Alignment	Alternative Alignment
Intermediate Flood Overflow Areas	1.37 Acres	8.61 Acres
1937 Flood Areas	4.13 Acres	20.71 Acres
Total Floodplain Area (including Ohio River Crossing)	6.77 Acres	30.53 Acres

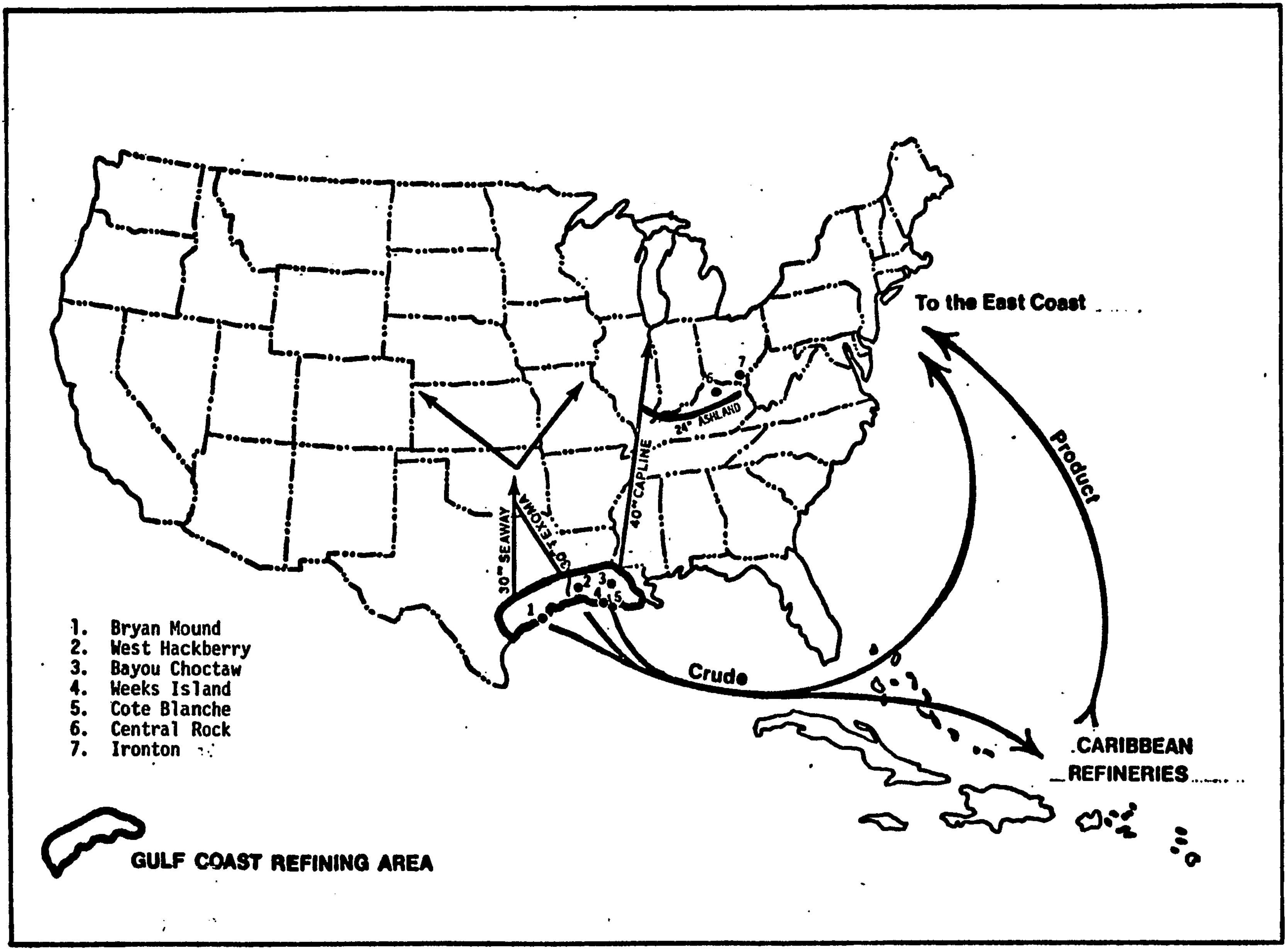

FIGURE 8.3-1 SPR distribution network

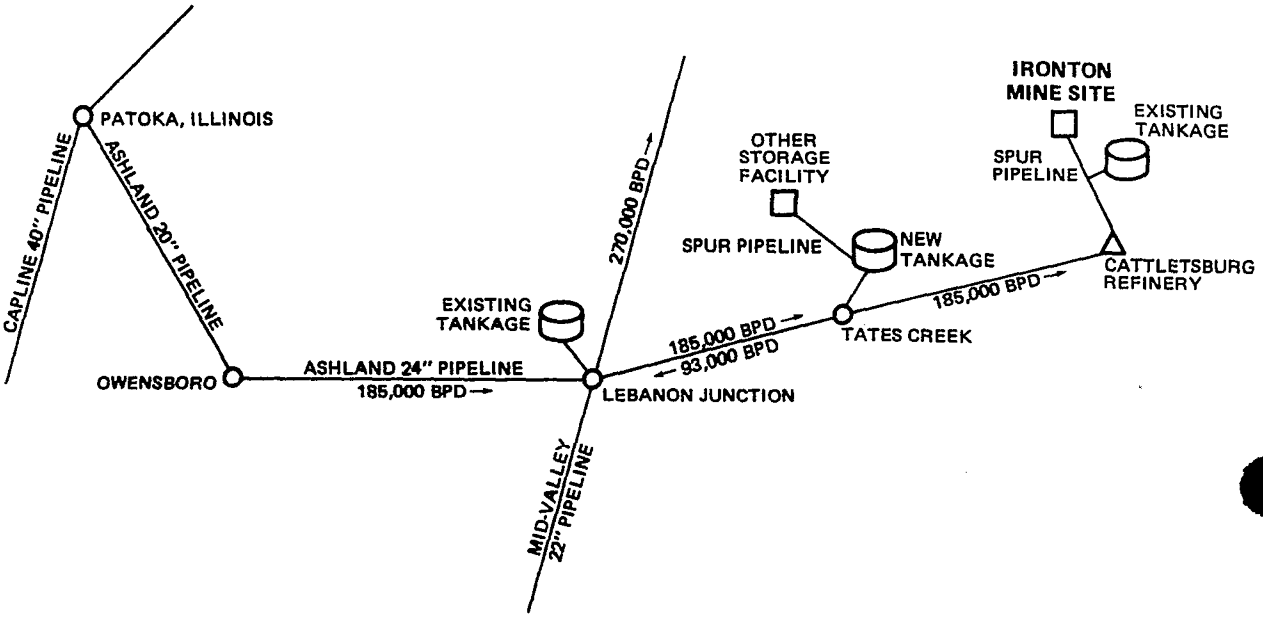

FIGURE 8.3-2 Alternative pipeline systems for Ironton

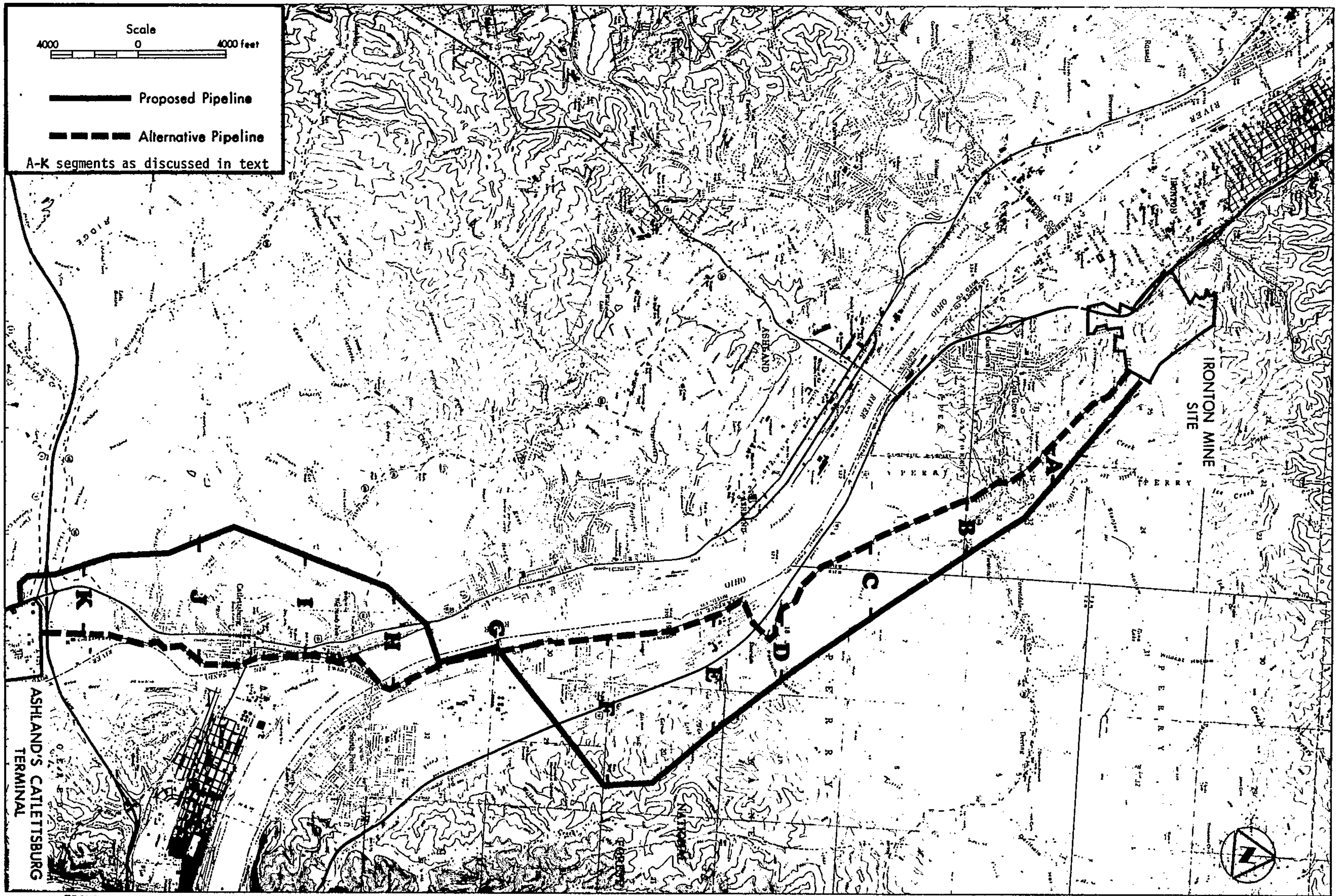

FIGURE 8.3-3 Proposed and alternative pipeline routes from the Ironton Mine site to Ashland's Catlettsburg Terminal

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
Army Corps of Engineers, Huntington District	Huntington, West Virginia
Dept. of Agriculture, Soil Conservation Service	Ashland and Catlettsburg, Kentucky; Ironton, Ohio
U.S. Geological Survey, Water Resources Division	Louisville, Kentucky and Columbus, Ohio

AGENCY-STATE	LOCATION
Kentucky Dept. of Fish and Wildlife Resources, Division of Game	Ashland, Kentucky
Kentucky Dept. of Mines and Minerals, Division of Oil and Gas	Frankfort, Kentucky
Kentucky Dept. for Natural Resources and Environmental Protection, Water Quality Division	Frankfort, Kentucky
Kentucky Dept. of Transportation	Frankfort, Kentucky
Kentucky Fire Marshal	Frankfort, Kentucky
Kentucky Geological Survey, Division of Water	Lexington, Kentucky
Kentucky Public Service Commission	Frankfort, Kentucky
Morehead State University, Dept. of Biology	Morehead, Kentucky

AGENCY-STATE	LOCATION
Ohio Biological Survey, Ohio State University	Columbus, Ohio
Ohio Dept. of Natural Resources, Fish Management	Athens, Ohio
Ohio Dept. of Natural Resources, Game Management	Columbus, Ohio
Ohio Dept. of Natural Resources, Scenic River Planning	Columbus, Ohio
Ohio Dept. of Natural Resources, Small Watershed Planning	Columbus, Ohio
Ohio Environmental Protection Agency, Division of Oil and Gas	Columbus, Ohio
Ohio Environmental Protection Agency, Ground Water	Columbus, Ohio
Ohio Environmental Protection Agency, Water Pollution	Columbus, Ohio
Ohio Fire Marshall	Columbus, Ohio
Ohio Geological Survey	Columbus, Ohio
Marshal State University Dept. of Biology	Huntington, West Virginia

AGENCY OR COMPANY-LOCAL	LOCATION
Alpha-Portland Cement Company	Easton, Pennsylvania and Ironton, Kentucky
Gas Processors Association	Tulsa, Oklahoma
Ohio Historical Society	Columbus, Ohio
University of Kentucky, Biology Department	Lexington, Kentucky
University of Kentucky, Museum of Anthropology	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 Sancturaries 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 (PL 89-665 and PL 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. Final determination has not been made as to what state and local regulations or permits are specifically applicable to this project. The Office of the State Archaeologist, Commonwealth of Kentucky, has indicated that a permit is required for archaeological exploration on land owned by the Commonwealth of Kentucky or municipal agencies within it. 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 governmental agencies will lead to implementation of useful mitigative measures on and adjacent to the mine site facilities.

Local construction and blasting permits may be required from the Ironton City Hall. A local storage permit may also be required. The Ohio and Kentucky Highway Departments, and possibly KYOVA, will probably require excavation permits for pipeline laying.

The Ohio Geological Survey (Division of Mines), and the Kentucky Division of Reclamation will review the project plans. Liaison with Lawrence County engineers and KYOVA planners is recommended.

TABLE 9.2-1 Environmentally oriented permits and licenses

Agency	Permit Type	References
U.S. Corps of Engineers, District Engineer (Huntington)	(a) Discharge of dredged material into navigable waters	33 CFR 209, 120 (b) (3), (b)(7) (e) (i), (g)(5)(ii), (g) (17) (iii);
	(b) Structures or activities affecting the navigability of navigable waters; includes structures <u>under</u> a navigable waterway.	33 CFR 209, 130
U.S. Environmental Protection Agency, Region V	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
Ohio and Kentucky Stream Control Commissions	(a) Certificate of Approval required for permission to discharge wastes into the public waters.	Section IIIA; 40 CFR 123
	(b) State must approve applications for NPDES permits before submission to U.S. Environmental Protection Agency.	
Ohio Air Control Commission (enforcement agency is the Ohio Division of Air Control and Occupational Health) (Columbus)	Certificate of Approval for construction of sources of air pollution emissions. Applys to some petroleum handling equipment.	Ohio Air Control ommission Regulations, Sections 6.1

TABLE 9.2-1 Continued

Agency	Permit Type	References
Ohio Air Control Commission Division of Air Control and Occupational Health (Columbus)	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.	
Ohio 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.	
Ohio 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.	
Kentucky Office of the State Archaeologist	Permit for archaeological survey on land owned by the Commonwealth of Kentucky or municipal agencies within it.	Kentucky Regulations, KRS, 164.720

9.3 REQUEST FOR COMMENTS

Comments on the Draft EIS for Ironton 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:

- Department of Agriculture
- Department of the Army (Corps of Engineers)
- Department of Commerce
- Department of Defense
- Department of Health, Education and Welfare
- Department of Housing and Urban Development
- Department of Interior
- Department of Labor
- Department of State
- Department of Transportation
- Department of Treasury
- Advisory Council on Historic Preservation
- Appalachian Regional Commission
- Council on Environmental Quality
- Energy Research and Development Administration
- Environmental Protection Agency
- Federal Energy Administration
  - 10 Regional Offices
- Federal Power Commission
- Interstate Commerce Commission
- National Science Foundation
- Nuclear Science Foundation
- Nuclear Regulatory Commission
- Tennessee Valley Authority
- Water Resources Council

States:

- Indiana
- Kentucky
- Louisiana
- Ohio
- West Virginia

Local:

- Boyd County
- Lawrence County

Others:

- Alpha-Portland Cement Company
- American Petroleum Institute
- Appalachian Regional Commission
- Center for Law and Social Policy
- 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 of America
Kentucky Utilities Company
KYOVA Interstate Planning Commission
Marshall State University, Dept. of Biology
Morehead State University, Dept. of Biology
National Audubon Society
National Parks and Conservation Association
National Wildlife Federation
Natural Resources Defense Council
Ohio Historical Society
Sierra Club

9.4 DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

The list of agencies and groups included with the Summary in the front of this statement indicates those who furnished written comments on the Draft Environmental Impact Statement to the Federal Energy Administration within the allotted comment period. Copies of the comment letters are included in Appendix J.

All of the review comments received by FEA have been considered in the preparation of this Final Environmental Impact Statement. The EIS has been expanded and modified where appropriate as a result of comments received. In other cases, either no substantive issues were raised or no change to the EIS was considered appropriate. The following listing presents a summary of the disposition of substantive issues raised in the comments.

9.4.1 Comments Received From Federal Agencies

A. Department of the Army; March 4, 1977.

Comment 1: Clarification to the Ohio River flood levels should be made in Sections 3.3-6 and 4.3-3; no location of the elevations for the greatest flood of record is specified. Records show that the elevation of the 100-year flood at the mouth of Ice Creek is 547 feet, mean sea level.

Response: The text has been clarified on pages 3.3-6 and 4.3-3 to specify that the Ohio River reached an elevation of 553.7 feet above MSL at the Ironton-Russel Highway Bridge and 555.2 feet MSL at the Ashland Coal Grove Highway Bridge, and the 100-year flood at the mouth of Ice Creek is 547 feet MSL.

Comment 2: The first sentence on page 4.3-33 is "About 25 miles downstream from the city of Ironton, there is a lock and dam in the river channel that would help prevent the spill from moving further downstream." The first structure of this type downstream, Greenup Locks and Dam, is about 14 miles downstream from Ironton. The second part of the sentence should be qualified. Under flood conditions the gates of the dam are raised to pass flows with minimal restriction; spills also would pass with negligible restriction. Under high flows, oil contamination on the surface may be drawn down and passed under the gates. Under normal lock and dam operating procedures for any river flow, a portion of a surface spill would be passed. In sum, the Greenup Locks and Dam may have little effect in containing spills.

Response: Greenup Locks and Dam is the structure referred to in the text on page 4.3-33. The text has been revised to reflect that the Dam and Locks could be utilized as a locus for the cleanup strike force if an oil spill extended to this reach of the Ohio River under conditions of normal river flow, and that the impact of an oil spill on navigation in this reach of the river would be minor and of a temporary nature.

Comment 3: Should this portion of the Ohio River be closed to navigation as a result of an oil spill cleanup operation, other industries, which depend on the waterway for transportation of their raw materials or products, would be affected. The EIS should discuss the possibility of a temporary closure of the navigation system.

Response: As described in the Response to Comment 2, the text has been revised to reflect the use of Greenup Locks and Dam as a deployment area for the strike force in the case of an oil spill in this portion of the Ohio River. This would preclude the use of the locks for normal navigation of the river and could have an impact on industries which depend on the waterway. The short duration of any cleanup effort, as described on page 4.3-33, should not present a major impact on these industries.

Comment 4: The discussion on page 5.2-1 of measures to be taken to minimize erosion and sediment transport during construction has been noted. Considering the rugged topography of the project area and the several crossings of waterways, the use of these measures should be emphasized throughout the construction period.

Response: The FEA acknowledges and endorses the use of mitigative measures to minimize erosion and sediment transport during construction of both the storage facility and the oil distribution pipeline. These measures include stream bank stabilization and erosion control techniques such as coffer dams and the revegetation of disturbed areas. Where proper mitigative measures are undertaken, most adverse impacts of construction on the aquatic biota can be minimized.

Comment 5: The third paragraph on page I-2 discusses the preparation of the Spill Prevention Control and Countermeasure Plan (SPCC). The timing of preparation is questioned, since the full potential for a spill is established at the beginning of pipeline operation.

If approval of the plan by a specific agency is required, that agency might be identified.

Additionally, coordination of the SPCC with affected agencies is recommended to include this office because of permit responsibilities, and for navigation structures which would possibly be affected.

Response: According to the Environmental Protection Agency Regulations On Oil Pollution Prevention (40 CFR 112), a Spill Prevention Control and Countermeasure (SPCC) Plan should be prepared within six months after commencement of operations of a facility and the plan should be implemented within one year after these operations have begun. The actual contents of the plan are not evaluated by the EPA unless the facility experiences a spill.

The FEA will work with the Huntington District of the U.S. Army Corps of Engineers to coordinate efforts in the development of the SPCC plan for the Ironton storage facility if this facility is selected as a Strategic Petroleum Reserve storage site.

Comment 6: Permits that would be required under the Department of the Army Permit Program, if the Ironton Mine and pipeline are developed, are listed on page 9.2-2. Close coordination of construction plans with the Huntington District Office should eliminate undue delays and potential permit problems.

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 as soon as possible, since time is of the essence in the Strategic Petroleum Reserve program.

B. Department of Commerce; March 11, 1977.

Comment 1: On page 3.4-1 (2nd paragraph, 4th sentence), it is stated that "There are no bodies of water large enough or close enough to Ironton 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 Ohio, 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 Ironton Mine site; therefore, the sentence has been revised to reflect a "local climate."

Comment 2: On page 3.4-6 (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.

C. Environmental Protection Agency; March 22, 1977.

Comment 1: An exemplary Spill Prevention Control and Countermeasure (SPCC) plan should be prepared to prevent oil spills.

Response: FEA acknowledges the responsibility and authority of the EPA with regard to regulations on oil pollution prevention as required under the Federal Water Pollution Control Act and amendments (Pub. L. 92-500). The Oil Spill Prevention Program of the Environmental Protection Agency (40 CFR 112) requires Spill Prevention Control and Countermeasure (SPCC) plans for facilities with oil storage capacity greater than 42,000 gallons that are in operation after January 11, 1974. The purpose of this regulation is to reduce to a minimum the likelihood of an oil spill reaching navigable waters and to reduce the extent of damage if a spill should occur. The plan must be certified by a registered engineer. The actual contents of the plan are not evaluated by the EPA unless the facility actually experiences a spill which is greater than 1000 gallons or two spills within a 12-month period. The regulations also state that the SPCC Plan should be prepared within six months and implemented not later than one year after the date that the facility begins operation.

In this regard, a SPCC Plan, as generally described in Appendix I, would be required for the Ironton Mine if this mine is selected to be developed as part of the Strategic Petroleum Reserve. Since the EIS is a document which is prepared prior to detailed engineering design specifications and the mine has not yet been selected as a SPR site, and since the law states that the SPCC Plan is not required until operations begin, it is not appropriate at this time to prepare an exemplary SPCC Plan.

Comment 2: Automatic pressure-reduction shut-off valves should be installed on each side of a stream crossing to reduce the probability of a large spill impacting on the local streams and the Ohio River. Consideration should be given to the use of two pipelines, one inside the other at or near river crossings.

Response: The EIS is a document which is prepared prior to development of detailed engineering design specifications. The proposed project systems and components used in determining probable environmental effects are those components established in the preliminary engineering feasibility studies. In addition, reasonable alternatives and mitigative measures have been considered for their effect on project impacts. Should detailed engineering studies indicate that selection of automatic pressure-reduction shut-off valves be installed at each side of a stream crossing or pipeline sleeve liners used for river crossings, these measures will be fully considered. It should be noted that manual control devices are preferred for several parts of a pipeline system, since more control can be maintained over the rate of flow in the lines and the resultant increase or decrease in pipeline pressures. The use of automatic devices has sometimes presented the problem of shutting down a system too rapidly with a resultant marked increase in pipeline pressures, which increases the potential for pipeline rupture since the pumps (which control the rate of flow and therefore the pressure) have not been shut off prior to valve closing or opening.

Comment 3: The chemical characterization of the Ironton Mine seepage water appears to be inadequate. Table 4.2-2 lists only five parameters measured in a sample of seepage water. In order to adequately consider the effects of pumping out and treating an initial 40 million gallons of water plus maintenance pumpage over the life of the project, additional chemical studies of heavy metals, nutrients, sulfates, hardness, alkalinity, etc., should be made. The tests should be conducted to determine what effect high metal, hardness, and nutrient levels would have on the biota of the receiving waters of Ice Creek. Such studies might have an influence on the type of treatment system designed for the facility. Figure 2.3-4 of the EIS diagrams a conventional secondary treatment plant incorporating an API (oil) separator plus ammonia scrubbing.

Response: Table 4.2-2 (page 4.2-22) presents the estimated concentrations of various air pollutants 0.5 km downwind from the site. Table 4.2-7 (page 4.2-27) lists sample concentrations of various constituents in Ironton Mine seepage water. In addition, Table 3.3-3 (page 3.3-16) lists representative chemical analyses of ground water in aquifers local to the Ironton Mine, including Ice Creek alluvium which is adjacent to the mine site. The FEA agrees that studies should be made in order to adequately consider the effects of pumping out and treating the mine seepage water. The original sampling was conducted as part of the engineering feasibility studies; further work would be required to determine the level of treatment necessary, and therefore this work would also influence the type of treatment plant to be designed for the Ironton Mine facility.

Comment 4: Once the mine has been filled with oil, seepage water will be pumped out from a sump and treated before it is pumped to Ice Creek. Consideration should also be given to monitoring the effluent to Ice Creek for phenols and hydrocarbons.

Response: An outline of a monitoring program was described on page 5.2-5 of the Draft EIS. An environmental protection plan is now in the process of being prepared for implementation during the construction and operating phases of the Strategic Petroleum Reserve program. This plan will include a comprehensive monitoring program.

Comment 5: We understand that the material removed during construction of shafts will be disposed of on site or transported from the site and used as fill. Assurance should be provided in the EIS that any fill material produced from the project will not be placed within a 100-year flood plain or wetlands as defined by our Agency. This provision should be conditioned on the contractor.

Response: As stated on pages 2.1-2 and 2.1-3, the waste associated with mine conversion would consist of overburden and limestone removed during construction of the shafts. As described on page 4.2-2, the surface facilities at the site are being demolished and since the plant area is highly disturbed the site would be very suitable for the disposal of the minor amount of tailings generated by mine conversion. Therefore, where possible, this material will be disposed of on-site, which is neither on the 100-year flood plain nor is considered to be a wetland area. If the material is of commercial grade and is suitable as fill for land or for highway construction, the material will be utilized in this manner.

Comment 6: We have special concern regarding the construction of the 13-mile pipeline and its potential water quality impact. Every effort must be made to minimize erosion and sedimentation and disturbance of the aquatic habitats at each of the nine stream crossings. Construction techniques should be employed to prevent any degradation of water quality in these streams during and after construction. Should any sensitive stream reaches be impacted and can not be avoided, such as meanders, riffles or pools, these features should be retained or replaced at a point adjacent to the crossing. Consideration should be given to avoid construction during spawning periods.

Response: The FEA also acknowledges that consideration should be given to minimizing erosion and sedimentation and disturbance to aquatic habitat at each of the stream crossings. (See also Comment #3 and Response, U.S. Army.) Since construction of the pipeline will take a relatively short time (about 2 to 3 months), it is likely that the construction period would not overlap into the aquatic spawning period.

Comment 7: The EIS points out that there will be a temporary loss of 65 acres of forest and pasture habitats, plus a permanent loss of 1.5 acres of mixed mesophytic hardwood habitat. We suggest that the final plans of this project incorporate recommendations for re-forestation and revegetation in order to balance out those habitat losses.

Response: An environmental plan is now in the process of being developed (see also Comment 4 and Response, EPA; above). As discussed on page 3.2-3 revegetation of the disturbed areas along the pipeline corridor can help to prevent erosion and provide suitable habitat for small animals and birds within months of construction.

Comment 8: The EIS should discuss the need to construct storage facilities in a geologically brittle rock area subject to seismic risk. The effect of past earthquakes on the limestone formation and mine should be discussed in more detail.

Response: The earthquake history in the region of the Ironton Mine (discussed in Section 3.2.4) indicates that the seismicity in the Ironton region is infrequent and mild. The recorded earthquake closest to the site was located about 25 miles from the mine, in southeastern Cabell County, West Virginia (Table 3.2-3). Only seven quakes have been recorded within 100 miles of the site. Most likely, the strongest historic motion at the site has been of Intensity VI or less, which is below the threshold of significant surface damage. Furthermore, no underground damage from earthquakes has ever been recorded at Ironton.

Earthquake motions in deep underground structures is typically far less than that which occurs at the surface (Leeds, 1972). Seldom is earthquake motion felt underground according to Legget (1962). Deep underground structures are rarely affected by earthquakes unless they are disrupted by offsets on pre-existent faults. As described in the EIS, no such faults exist in or adjacent to the Ironton Mine area. A particularly rigorous demonstration of the relative insensitivity of deep underground structures to major earthquakes is provided by Campbell and Dodd, 1968.

D. Federal Power Commission; March 1, 1977.

Comment 1: Throughout the draft there is a confusion and missuse of the words cement and concrete.

Response: Changes have been made in the text to reflect the correct use of the words cement and concrete.

Comment 2: In Section 3.3.2.6, Groundwater at the Mine Site, the underground mine workings are not at a depth of about ± 74 feet. The elevation is about ± 74 feet MSL.

Response: A change has been made on page 3.3-13 to modify the sentence to read..."at an elevation of about ± 74 feet MSL".

Comment 3: It is strongly suggested that the entire mine cavity be hydrostatically tested with proper monitoring for a period of several weeks. This will identify areas of potential seepage for treatment prior to storage. Saturation of the adjacent porous media will also reduce the volume of unrecoverable petroleum losses.

Response: Hydrostatic testing is not considered necessary to identify areas of potential seepage. The fact that the mine is more than 400 feet beneath the water table shows that the cavity has always been subject to external hydrostatic pressures greater than those that would exist if the cavity were filled with liquid. In spite of this, the mine shows no evidence of significant ground water seepage (other than through shafts). Further, because no porous medium is adjacent to the mine cavity, migration of stored oil into country rock is not likely, as described in Section 4.3.2.1.

9.4.2 Comments Received from State Agencies

A. Kentucky Department of Natural Resources and Environmental Protection - Bureau of Environmental Protection; February 21, 1977

Comment: 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 land filling techniques for disposal or land spreading over a wide area. These methods should be discussed as possibilities under Section 4.3-3 and Section 4.3-4.

Response: The FEA acknowledges that recovery and cleanup activities after 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 Ironton 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 oil spilled. 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 since 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. Rehabilitation and revegetation programs would be designed to re-establish the natural vegetation and productivity of the area affected. These programs would be based on expert evaluation of vegetation 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 4.3-48.

B. Kentucky Heritage Commission; March 1, 1977

Comment: The project coordinator/sponsor should be reminded that the State Historic Preservation Officer must review and approve the archaeological survey report.

Response: FEA acknowledges the responsibility of the State Historic Preservation Officer to review and approve the archaeological survey report.

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 archaeologically 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 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 areas as noted on page 4.2-17. An in-depth archaeological analysis of the proposed pipeline route, including field reconnaissance, will be made in accordance with Federal regulations (Public Law 93-291) before the proposed route 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 Ironton Mine is selected as an SPR storage site or to recommend site excavation prior to pipeline construction.

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.

9.4.5 References

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APPENDIX A

KENTUCKY WATER QUALITY STANDARDS

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.

KENTUCKY WASTE DISCHARGE PERMITS REGULATIONS, WP-1

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

OHIO WATER QUALITY STANDARDS

EP-1-01 Classification of Waters of the State.

(A) Except as specified in subsection (B) below, all surface waters of the state are hereby classified as appropriate for warm water fisheries, for primary contact recreation, for processing by conventional treatment into public, industrial, and agricultural water supplies, and for such other uses as are identified for specific waters in subsequent sections of this Chapter, EP-1, of the Regulations of the Ohio EPA.

(B) The water quality standards set forth in this Chapter, EP-1, of the Regulations of the Ohio EPA, shall not apply in any of the following circumstances:

(1) Whenever the flow falls below the annual minimum 7 day average flow that has a recurrence period of once in ten years taking into account hydraulically altered flow regimes, calculated by the methods described in H. C. Riggs, "Techniques of Water-Resources Investigation of the United States Geological Survey," Chapter B 1, Low-Flow Investigations (Washington, D.C. 1972).

(2) Where a portion of a watercourse is determined to be a low-flow stream. The term "low-flow stream" means that portion of a watercourse where:

(a) the total upstream drainage area is less than five square miles, and

(b) less than 50% of the flow would be present if there were no point source waste-water discharges for 15% of any two consecutive year period during the ten years preceding July 1, 1974.

Discharges to low-flow streams as described by this subsection EP-1-01 (B) (2), commenced on or before July 1, 1974, will be required to either meet water quality standards or be treated by "the best available control technology economically achievable" as defined by the Director of the Ohio Environmental Protection Agency or the Administrator of the United States Environmental Protection Agency under the Federal Water Pollution Control Act Amendments of 1972, whichever is less stringent; and water discharge permits for such discharges will contain effluent levels that would be reached by such treatment. The standards set forth in this Chapter, EP-1, of the Regulations of the Ohio EPA, shall apply to low-flow streams for discharges commenced after July 1, 1974. Such discharges shall not interfere with the attainment or maintenance of the water quality standards set forth in this Chapter.

(3) Whenever chemicals are applied for control of aquatic plants or animals. Notice must be given to the Director before chemicals are applied. The Director, upon receiving such notice, may order that chemicals not be applied if he concludes that the proposed application would pose an unreasonable danger to human or aquatic life. This exemption shall apply only to the water quality standard or standards that would or might be violated by application of said chemicals, and shall not apply to any other standards.

(4) With respect to the standards for dissolved iron (storet number 01046), dissolved manganese (storet number 01056), dissolved solids (storet number 00515), and pH (storet number 00400), whenever the water fails to meet said standards as a result of discharges from mining operations abandoned before October 1, 1974.

(Former regulation EP-1-01, adopted July 27, 1973, effective July 27, 1973, is repealed.)

(Adopted January 8, 1975; Effective January 8, 1975)

EP-1-02 *General Standard.*

Except as other regulations in this Chapter, EP-1, establish different standards, the water quality standards of the state shall be as follows:

(A) Within 500 yards of any public water supply intake,

(1) dissolved solids may exceed one, but not both, of the following:

(a) 500 mg/l as a monthly average nor exceed 750 mg/l at any time, or

(b) 150 mg/l of dissolved solids attributable to human activities; and

(2) phenols (storet number 32730) shall not exceed 1.0 ug/l; and

(3) nitrate (N) (storet number 00620) shall not exceed 8 mg/l; and

(4) dissolved iron (storet number 01046) shall not exceed 300 ug/l; and

(5) chromium (hexavalent) (storet number 01032) shall not exceed 10 ug/l; and

(6) cyanide (storet number 00720) shall not exceed .005 mg/l; and

(7) dissolved manganese (storet number 01056) shall not exceed 50 ug/l.

(B) Within 500 yards of any water supply intake, dissolved solids may exceed one, but not both, of the following:

(1) 500 mg/l as a monthly average nor exceed 750 mg/l at any time, or

(2) 150 mg/l of dissolved solids attributable to human activities; and

(C) Dissolved oxygen shall not be less than a daily average of 5.0 mg/l nor less than 4.0 mg/l at any time.

(D) pH shall not be less than 6.0 and shall not be more than 9.0 at any time except that it may be less than 6.0 or more than 9.0 if there is no contribution of acidic or alkaline pollution attributable to human activities.

(E) (1) Geometric mean fecal coliform content (either MPN or MF count). based on not less than five samples within a 30-day period, shall not exceed 200 per 100 ml.

(2) Fecal coliform content (either MPN or MF count) shall not exceed 400 per/100 ml in more than ten percent of the samples taken during any 30 day period.

(F) Dissolved solids may exceed one, but not both of the following:

(1) 1500 mg/l

(2) 150 mg/l attributable to human activities.

(G) Lake or reservoir water temperature shall not exceed by more than three degrees fahrenheit (1.7 degrees centigrade) the water temperature which would occur if there were no temperature change of such waters attributable to human activities, and stream water temperature shall not exceed by more than five degrees fahrenheit (2.8 degrees centigrade) the water temperature which would occur if there were no temperature change of such waters attributable to human activities. In addition, at no time shall water temperature exceed the maximum temperatures indicated in the following table:

MAXIMUM TEMPERATURE IN DEGREES CENTIGRADE & FAHRENHEIT DURING MONTH

Water		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
All Waters Except Ohio River	C°	10.0	10.0	15.6	21.1	26.7	32.2	32.2	32.2	32.2	25.6	21.1	13.9
	F°	50	50	60	70	80	90	90	90	90	78	70	57
Main Stem Ohio River	C°	10.0	10.0	15.6	21.1	26.7	30.6	31.7	31.7	30.6	25.6	21.1	13.9
	F°	50	50	60	70	80	87	89	89	87	78	70	57

(H) The threshold-odor number attributable to human activities shall not exceed 24 at 40 degrees centigrade tested as described in "Standard Methods for the Examination of Water and Wastewater," 13th Edition, 1971, published by the American Public Health Association, the American Water Works Association, and Water Pollution Control Federation.

(I) Gross beta activity shall not exceed 100 picocuries per liter, nor shall activity from strontium 90 exceed 10 picocuries per liter, nor shall activity from alpha emitters exceed 3 picocuries per liter.

(J) The following chemical pollutants shall not exceed the following specified concentrations at any time:

Storet Number	Constituent*	Concentration mg/l	Concentration µg/l
00610	Ammonia	1.5	-
01002	Arsenic	-	50.
01007	Barium	-	800.
01027	Cadmium	-	5.
00940	Chloride	250.	-
01034	Chromium	-	300.
01032	Chromium (hexavalent)	-	50.
00722	Cyanide (free)	0.005	-
00720	Cyanide	0.2	-
00951	Fluoride	1.3	-
38260	Foaming Agents (MBAS)	0.5	-
01046	Iron (dissolved)	-	1000.
01051	Lead	-	40.
01056	Manganese (dissolved)	-	1000.
71900	Mercury	-	.5
00550	Oil & Grease (hexane soluble)	5.	-
32730	Phenols	-	10.
01147	Selenium	-	5.
01077	Silver	-	1.

*Total unless otherwise indicated.

(K) Total copper (storet number 01042) shall not exceed the following specified concentrations at any time:

Hardness as mg/l of $CaCO_3$ -	0-80	80-160	160-240	240-320	above 320
Concentration in µg/l -	5	10	20	50	75

(L) Total zinc (storet number 01092) shall not exceed the following specified concentrations at any time:

Hardness as mg/l of $CaCO_3$ -	0-80	80-160	160-240	240-320	above 320
Concentration in µg/l -	75	100	200	400	500

(M) (1) For Lake Erie and all waters tributary to Lake Erie, discharges of total phosphorous as P (storet number 00665) from point sources determined significant by the Ohio EPA shall not exceed a daily average of 1 mg/l as total P, or such stricter requirements as may be imposed by Ohio EPA NPDES permits.

(2) For the Ohio River and all waters tributary to the Ohio River, total phosphorus as P shall be limited to the extent necessary to prevent nuisance growths of algae, weeds, and slimes that result in a violation of the water quality standards set forth in this Chapter, EP-1. In areas where such nuisance growths exist, phosphorus discharges from point sources determined significant by the Ohio Environmental Protection Agency shall not exceed a daily average of one milligram per liter as total P, or such stricter requirements as may be imposed by Ohio EPA NPDES permits.

(N) All pollutants or combinations of pollutants shall not exceed at any time one-tenth of the 96 hour median tolerance limit for any indigenous aquatic species, except that other more stringent application factors shall be imposed where necessary to meet the minimum requirements of the National Technical Advisory Committee, "Water Quality Criteria", 1968. The median tolerance limit shall be determined by static or dynamic bioassays in accordance with standard methods described in "Standard Methods for the Examination of Water and Wastewater", 13th Edition, 1971, published by the American Public Health Association, and Water Pollution Control Federation.

(O) All waters of the state shall be free from substances attributable to human activities which result in sludge deposits, floating materials, color, turbidity, or other conditions in such degree as to create a nuisance.

(Former regulation EP-1-02, adopted July 27, 1973, Effective July 27, 1973, is repealed.)

(Adopted January 8, 1975; Effective January 8, 1975)

EP-1-03 *Mixing Zones.*

(A) The waters adjacent to a point of discharge of wastewater shall be recognized as a "mixing zone." Mixing zones shall conform to the size limitations and other limitations set forth in paragraph (B) below. The water quality standards set forth in paragraph (C) below shall apply to all waters within mixing zones and such waters shall be exempt from all other water quality standards.

(B) (1) Except as subsequent provisions of this paragraph provide different limits, no mixing zone shall:

(a) constitute more than one-half of the width of the receiving watercourse nor constitute more than one-third of the area of any cross-section of the receiving watercourse,

(b) extend downstream at any time a distance more than five times the width of the receiving watercourse at the point of discharge,

(c) exceed twenty-three acres of horizontal area of the Ohio River or twelve acres of horizontal area of any other receiving watercourse,

(d) include spawning or nursery areas of any indigenous aquatic species, or

(e) interdict the migratory routes of any indigenous aquatic species, or

(f) include a drinking water supply intake.

(2) For watercourses classified as cold water fisheries streams in Regulation EP-1-08, no mixing zone shall:

(a) constitute more than one-third of the width of the receiving watercourse nor constitute more than one-fifth of the area of any cross-section of the receiving watercourse, or

(b) exceed three acres of horizontal area of the receiving watercourse.

(3) No mixing zone in an inland lake or reservoir shall:

(a) extend in any direction more than 300 feet from the point of discharge, or

(b) include hypolimnetic waters.

(4) In Lake Erie,

(a) no mixing zone for a public treatment works shall extend from the point of discharge under calm meteorological and limnological conditions more than the distance given by the formula $R = 50 + Q$, where R = radius in feet and Q = treatment works design dry weather flow in millions of gallons per day; and

(b) no mixing zone for an industrial discharge other than heat shall extend from the point of discharge more than one-tenth (1/10) of the width of near-shore area (as defined in EP-1-07 (B) (1) at the point of discharge; and

(c) for discharges of heat, conditions in a mixing zone, and in the circulating water the discharge of which creates said mixing zone, shall be such that the temperature in said mixing zone and circulating water, considered in conjunction with the length of the period of residence therein of any indigenous aquatic species considered important and desirable by the Director of the Ohio Environmental Protection Agency, will not result in the death, impaired reproduction or growth, or increased vulnerability to predation, of a percentage of the total population of said species considered significant by the Director. In determining which species are desirable and important, and in determining what percentage of the total population is significant, the Director shall take into consideration the recommendations of the Great Lakes Water Quality Board of the International Joint Commission.

(d) No mixing zone shall include any bathing area where bathhouses and/or lifeguards are provided, and which was established prior to January 1, 1975.

Sources of wastewater (other than public sewerage systems and treatment works) having more than one discharge point in Lake Erie shall be limited to a total mixing area not larger than that which would be allowed if only one discharge point existed.

(C) (1) Except as subsequent provisions of this paragraph establish different standards, the water quality standards in mixing zones shall be as follows:

(a) All pollutants or combinations of pollutants shall not exceed at any time the 96-hour median tolerance limit for any indigenous aquatic species, determined by static or dynamic bioassays in accordance with standard methods described in "Standard Methods for the Examination of Water and Wastewater", 13th Edition, 1971, published by the American Public Health Association, and Water Pollution Control Federation.

(b) Water temperature shall not exceed the temperature of the receiving watercourse upstream of the mixing zone by more than 15 degrees Fahrenheit (8.3 degrees centigrade) during the months of May, June, July, August, September and October or by more than 23 degrees Fahrenheit (12.8 degrees centigrade) during the months of November, December, January, February, March and April.

(2) For all waters within mixing zones in watercourses classified as cold water fisheries streams in Regulation EP-1-08, water temperatures shall not exceed the temperature of the receiving watercourse upstream of the mixing zone by more than 5 degrees Fahrenheit (2.8 degrees centigrade) during the months of May, June, July, August, September and October.

(3) For all waters within mixing zones in inland lakes and in reservoirs, water temperature at any depth shall not exceed natural water temperatures outside the mixing zone by more than 15 degrees Fahrenheit (8.3 degrees centigrade) during the months of May, June, July, August, September and October or by more than 23 degrees Fahrenheit (12.8 degrees centigrade) during the months of November, December, January, February, March and April.

(4) For all waters in mixing zones in Lake Erie,

(a) Subsection (C)(1)(b) above shall not apply, and

(b) Subsection (B)(4)(c) above shall apply.

(Former regulation EP-1-03, adopted July 27, 1973, effective July 27, 1973, is repealed.)

(Adopted January 8, 1975; effective January 8, 1975.)

EP-1-04 *Non-Degradation of High Quality Waters.*

It is the policy of the Ohio EPA that waters whose existing quality is better than these standards as of July 1, 1973, will be maintained at their existing high quality, pursuant to the Ohio water pollution control statutes, so as not to interfere with or become injurious to any assigned uses made of, or presently possible, in such waters. This will require that any industrial, public or private project or development that would constitute a new source of wastewater discharge or an increased wastewater discharge to high quality waters as part of the initial project design, to provide the most effective waste treatment available under existing technology, as provided in the Regulations of the Ohio EPA governing installation of new sources of wastewater discharge.

(Former regulation EP-1-07, adopted July 27, 1973, effective July 27, 1973, is repealed.)

(Adopted January 8, 1975, effective January 8, 1975)

EP 1-05 *Analytical Testing.*

All methods of sample collection, preservation, and analysis used in applying any of the rules and regulations in this Chapter, EP-1, shall be in accord with those prescribed in 40 CFR, Part 136, as amended, "Test Procedures for the Analysis of Pollutants."

(Adopted January 8, 1975, effective January 8, 1975)

EP-1-06 *Mahoning River Basin.*

The Water Quality Standards for the Mahoning River and its tributaries in Ohio adopted by the Ohio Water Pollution Control Board on July 11, 1972, shall be the water quality standards for those watercourses and inland lakes to which they apply.

(Adopted July 27, 1973;
Effective July 27, 1973)

Water Quality Standards Adopted by the Board July 11, 1972, for the Mahoning River and its Tributaries in Ohio

The Ohio Water Pollution Control Board hereby adopts water quality standards for the interstate waters of the Mahoning River and its tributaries in Ohio.

Minimum Conditions Applicable to All Waters at All Places and at All Times

(1) Free from substances attributable to municipal, industrial or other discharges, or agricultural practices that will settle to form putrescent or otherwise objectionable 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.

(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.

Protection of High Quality Waters

Waters whose existing quality is better than the established standards as of the date on which such standards become effective will be maintained at their existing high quality, pursuant to the Ohio water pollution control statutes, so as not to interfere with or become injurious to any assigned uses made of, or presently possible, in such waters. This will require that any industrial, public or private project or development which would constitute a new source of pollution or an increased source of pollution to high quality waters will be required, as part of the initial project design, to provide the most effective waste treatment available under existing technology. The Ohio Water Pollution Control Board will cooperate with other agencies of the state, agencies of other states, interstate agencies and the Federal Government in the enforcement of this policy.

Mixing Zones

Mixing zones shall be determined on a case by case basis with the requirement that each mixing zone shall be limited to the greatest practical extent and where possible not to overlap another one. In addition a reasonable zone of passage will be preserved for the movement of fish and other aquatic biota.

Water Quality Design Flow

Where applicable for the determination of treatment requirements the water quality design flow shall be the minimum seven consecutive day average that is exceeded in 90 percent of the years. On the lower main stem of the Mahoning River the regulated flow shown below shall be used for the determination of treatment requirements.

Regulated Stream Flows in the Main Stem of the Mahoning River

River Reach	Winter cfs	Summer cfs
1. Eagle Creek to Mosquito Creek	145	315
2. Mosquito Creek to Meander Creek	200	415
3. Meander Creek to Youngstown wastewater treatment plant	225	480
4. Youngstown wastewater treatment plant to Ohio-Pennsylvania stateline	290	515

Stream-Quality Criteria

For Public Water Supply

Waters designated as a source of public water supply will be of such quality that Federal Drinking Water Standards for finished water can be met by conventional treatment which includes coagulation, filtration and disinfection.

The following criteria are applicable to stream waters used as a potable supply:

1. *Bacteria:* Coliform group not to exceed 5,000 per 100 ml as a monthly average value (either MPN or MF count); nor exceed this number in more than 20 percent

of the samples examined during any month; nor exceed 20,000 per 100 ml in more than five percent of such samples.

2. *Threshold-odor number:* Not to exceed 24 (at 60 deg. C.) as a daily average.

3. *Dissolved solids:* Not to exceed 500 mg/l as a monthly average value, nor exceed 750 mg/l at any time.

4. *Radioactivity:* Gross beta activity not to exceed 1,000 picocuries per liter (pCi/1), nor shall activity from dissolved strontium 90 exceed 10 pCi/1, nor shall activity from dissolved alpha emitters exceed 3 pCi/1.

5. *Chemical constituents:* Not to exceed the following specified concentrations at any time.

Constituent	Concentration (mg/1)
Arsenic	0.05
Barium	1.0
Cadmium	0.005
Chromium (hexavalent)	0.05
Cyanide	0.025
Fluoride	1.0
Lead	0.05
Selenium	0.005
Silver	0.05
Mercury	0.005

For Industrial Water Supply

The following criteria are applicable to stream waters for use (either with or without treatment) for industrial cooling and processing:

Dissolved solids: Not to exceed 500 mg/1 as a monthly average value nor exceed 750 mg/1 at any time.

For Aquatic Life (Warm Water Fishery)

The following criteria are for evaluation of conditions for the maintenance of a well-balanced, warm-water fish population. They are applicable at any point in the stream except for the minimum area necessary for the admixture of waste effluents with stream water:

1. *Dissolved oxygen:* Not less than an average of 5.0 mg/1 per calendar day and not less than 4.0 mg/1 at any time.

2. *pH:*

A. No values below 6.0 nor above 8.5.

B. Daily fluctuations which exceed the range of pH 6.0 to pH 8.5 are correlated with photosynthetic activity may be tolerated.

3. *Temperature*

A. No abnormal temperature changes that may affect aquatic life unless caused by natural conditions.

B. For the main stem of the Mahoning River (Warren to Lowellville Dam) water temperatures shall not exceed natural levels (as measured by the water quality monitor station at Leavittsburg) by 5 degrees F. during April through November and 10 degrees December through March.

C. For all waters except the main stem of the Mahoning River (Warren to Lowellville Dam) the maximum temperature shall not exceed natural temperatures by more than 5 degrees F. provided that at no time shall they exceed those indicated in the following table:

Maximum Temperature in Deg. F. During Month

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
50	50	60	70	80	90	90	90	90	78	70	57

4. *Toxic substances:* Not to exceed one-tenth of the 96-hour median tolerance limit, except that other limiting concentrations may be used in specific cases when justified on the basis of available evidence and approved by the appropriate regulatory agency.

For Recreation

The following criterion is for evaluation of conditions for waters designated to be used for recreational purposes:

Primary Contact – (swimming and water-skiing)

Bacteria: The fecal coliform content (either MPN or MF count) not to exceed 200 per 100 ML as a monthly geometric mean based on not less than five samples per month; nor exceed 400 per 100 ML in more than ten percent of all samples taken during a month.

Secondary Contact – (boating, fishing and wading)

Bacteria: The fecal coliform content (either MPN or MF count) not to exceed 1,000 per 100 ML as a monthly geometric mean based on not less than five samples per month; nor exceed 2,000 per 100 ML in more than ten percent of all samples taken during a month.

For Agricultural Use and Stock Watering

The following criteria are applicable for the evaluation of stream quality at places where water is withdrawn for agricultural use or stock water purposes:

1. Free from substances attributable to municipal, industrial or other discharges, or agricultural practices that will settle to form putrescent or otherwise objectionable 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.

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.

Stream Water Uses

The stream water uses for the waters of the Mahoning River basin are to be as follows:

1. Mahoning River upstream of Warren and all tributaries

a. Primary contact recreation
b. Public water supply
c. Well-balanced warm water fishery
d. Industrial water supply
e. Agriculture use and stock watering

2. Mahoning River main stem Warren to Lowellville Dam

a. Secondary contact recreation

b. Well-balanced warm water fishery
c. Industrial water supply
d. Agriculture use and stock watering

3. Mahoning River (main stem) Lowellville Dam to Ohio-Pennsylvania stateline

a. Primary contact recreation
b. Public water supply
c. Well-balanced warm water fishery
d. Industrial water supply
e. Agriculture use and stock watering

EP-1-07 *Lake Erie.*

(A) *Water Quality Standards.*

The Water quality standards in Lake Erie [outside of the excepted areas established in subsection (B) (2) below] shall be the water quality standards set forth in EP-1-02, except that, to the extent that the following paragraphs establish different standards, the latter standards shall apply:

(1) Dissolved oxygen in the Western Basin and in the epilimnion of the Central Basin shall not be less than 6.0 mg/1, or 80 percent of saturation, whichever is greater. Dissolved oxygen in the hypolimnion of the off-shore area of the Central Basin shall not be less than 80 percent of saturation except between June 1 and October 15, during which period neither the foregoing standard nor any other dissolved oxygen standard set forth in this chapter, EP-1, need be met.

(2) (a) Water temperature of the epilimnion shall not exceed by more than 3 degrees Fahrenheit (1.7 degrees C) the water temperature which would occur if there were no temperature change of such waters attributable to human activities. In addition, at no time shall water temperature exceed at a depth three feet below the surface the maximum temperatures indicated in the following table:

PERIOD	MAXIMUM TEMPERATURE	
	Degrees F	Degrees C
January 1-31	35	1.7
February 1-28	38	3.3
March 1-15	39	3.9
16-31	45	7.2
April 1-15	53	11.7
16-30	60	15.6
May 1-15	64	17.8
16-31	72	22.2
June 1-15	78	25.6
16-30	83	28.3
July 1-31	85	29.4
August 1-31	85	29.4
September 1-30	81	27.2
October 1-31	71	21.7
November 1-30	58	14.4
December 1-31	46	7.8

(b) The temperatures of bottom waters of the off-shore area of the Western Basin shall not exceed those set forth in the following table:

PERIOD	MAXIMUM ALLOWABLE TEMPERATURE	
	Degrees F	Degrees C
April 1-22	42	5.6
April 23-30	46	7.8
May 1-15	53	11.7

(c) The temperature of the hypolimnetic waters of the Ohio portion of the Central Basin of Lake Erie shall not as a result of human activities exceed 60 degrees Fahrenheit (15.6 degrees Centigrade).

(3) Radioactivity shall not exceed the lowest practicable levels, and in any event shall not be present in amounts that may pose a health hazard. In addition, after the date of adoption of Lake Erie radioactivity criteria by the Great Lakes Water Quality Board of the International Joint Commission, those criteria shall be deemed incorporated by reference into this Chapter, EP-1.

(4) The following pollutants shall not exceed the following specific concentrations:

Lake Segment Storet Number	Constituent (Total unless otherwise stated)	Units	W. Basin Near Shore	W. Basin Off Shore	Central Basin Off Shore	Central Basin Near Shore W. of Avon	Central Basin Near Shore E. of Avon
000515	Dissolved Solids Mo. Ave/Max. day	mg/l	200/300	160/180	160/180	180/200	200/250
000940	Chlorides Mo. Ave/Max. day	mg/l	25/30	25/30	25/30	25/30	35/50
000945	Sulfates Mo. Ave/Max. day	mg/l	35/50	25/40	25/40	25/40	25/40
00900	Hardness Mo. Ave/Max. day	mg/l	130/180	110/130	110/130	110/130	130/180
00400	pH Monthly Min/Max.	S.U.	7.0-8.8	6.7-8.5	6.7-8.5	7.0-8.8	7.0-8.8
31616	Fecal Coliforms *	No./100 ml					
	Mo. Mean/10% time 1. At Water Works Intake		50/100	5/10	5/10	20/50	100/200
	2. General Standard		200/400	100/200	10/50	200/400	200/400
00085	Threshold Odor No. Mo. Ave/Max.	T.N.	15/25	10/15	5/10	10/15	10/15
	Nutrients						
00665	Total Phosphorus (P)	mg/l	0.025	0.025	0.015	0.025	0.025
00640	Total Inorganic Nitrogen (N)	mg/l	0.30	0.30	0.30	0.30	0.30

*Fecal Coliforms are expressed as a geometric mean per 100 ml based on not less than 10 samples per 30 day period and the values not to be exceeded in more than 10 per cent of such samples.

Lake Segment Storet Number	Constituent Heavy Metals	Units	W. Basin Near Shore	W. Basin Off Shore	Central Basin Off Shore	Central Basin Near Shore W. of Avon	Central Basin Near Shore E. of Avon
01002	Arsenic	µg/l	1.	1.	1.	5.	5.
01007	Barium	µg/l	1.	1.	1.	1.	1.
01027	Cadmium	µg/l	5.	0.5	0.5	5.	5.
01034	Chromium	µg/l	50.	.3.	3.	50.	50.
01042	Copper	µg/l	10.	5.	5.	10.	10.
01045	Iron	µg/l	300.	300.	300.	300.	300.
01051	Lead	µg/l	50.	50.	50.	50.	50.
01055	Manganese	µg/l	50.	50.	50.	50.	50.
71900	Mercury	µg/l	0.3	0.1	0.1	0.3	0.3
01067	Nickel	µg/l	50.	50.	50.	50.	50.
01147	Selenium	µg/l	5.	1.	1.	5.	5.
01077	Silver	µg/l	1.	.2	.2	1.	1.
01092	Zinc	µg/l	50.	15.	15.	50.	50.
	Other Chemicals						
00335	COD	mg/l	15.	10.	7.	12.	15.
32005	Carbon Chloroform Extract (CCE)	mg/l	0.05	0.05	0.05	0.05	0.05
00720	Cyanide	µg/l	.5	.5	.5	.5	.5
00950	Fluoride	mg/l	0.15.	0.15.	0.15.	0.15.	0.15.
38260	Methylene Blue Active Substances (MBAS)	mg/l	0.05.	0.05.	0.05.	0.05.	0.05.
00550	Oil & Grease	mg/l	0.05.	0.05.	0.05.	0.05.	0.05.
32730	Phenols	µg/l	1.0	.5	.5	1.0	1.0
	Un-ionized Ammonia as N **	mg/l	0.02	0.02	0.02	0.02	0.02

**Un-ionized Ammonia as N. That amount of ammonia which when dissolved in water does not form ammonium ions.

(5) (a) Concentrations of materials that are nonpersistent (defined as materials having a half-life of less than 96 hours) and that have no cumulative effects shall not exceed the following limitations:

(i) Such concentrations shall not exceed 1/10 of the 96-hour median tolerance limit value, and

(ii) The 24-hour average of such concentrations shall not exceed 1/20 of the 96-hour median tolerance limit, and

(b) Concentrations of materials that are persistent (defined as materials having a half-life of 96 hours or more) or have cumulative effects shall not exceed the following limitations:

(i) Such concentrations shall not exceed 1/20 of the 96-hour median tolerance limit value, and

(ii) The 24-hour average of such concentrations shall not exceed 1/100 of the 96-hour median tolerance limit value, and

(c) When two or more toxic materials that have additive effects are present at the same time, their concentrations shall not be greater than those given by the formula:

$$\frac{Ca}{La} + \frac{Cb}{Lb}\ldots + \frac{Cn}{Ln} \leq 1$$

where Ca, Cb, Cn are the measured concentrations of the several toxic materials in the water and La, Lb, Ln are the respective permissible concentration limits derived for the materials on an individual basis.

(B) *Segmentation of Lake Erie; Excepted Areas.*

(1) Lake Erie shall be divided into five regions: the Eastern Basin, the near-shore area of the Central Basin, the offshore area of the Central Basin, the near-shore area of the Western Basin, and the offshore area of the Western Basin. These regions shall be as shown in figure 1 and as defined herein. The boundary between the near-shore and offshore areas of the Western Basin shall follow the 18 foot lake contour line from the Ohio-Michigan border (all reef areas being considered part of the offshore area) to Scott Point on Catawba Island, then shall follow the 18 foot contour line 82 degrees 42 minutes. The boundary between the near-shore and offshore areas of the Central Basin shall follow the 18 foot contour line west of Avon Point and the 24 foot lake contour line east of Avon Point. All Contour lines shall be those referring to depth below water datum [mean water level at Father Point, Quebec (International Great Lakes Datum-1955), which is 568.6 feet above mean sea level].

(2) The areas illustrated in the Appendix shall be designated as excepted areas, and the water quality standards therein shall be those that would apply if this regulation, EP-1-07, did not exist.

(Former Regulation EP-1-05, adopted July 27, 1973, effective July 27, 1973, is repealed.)

(Adopted January 8, 1975; effective January 8, 1975)

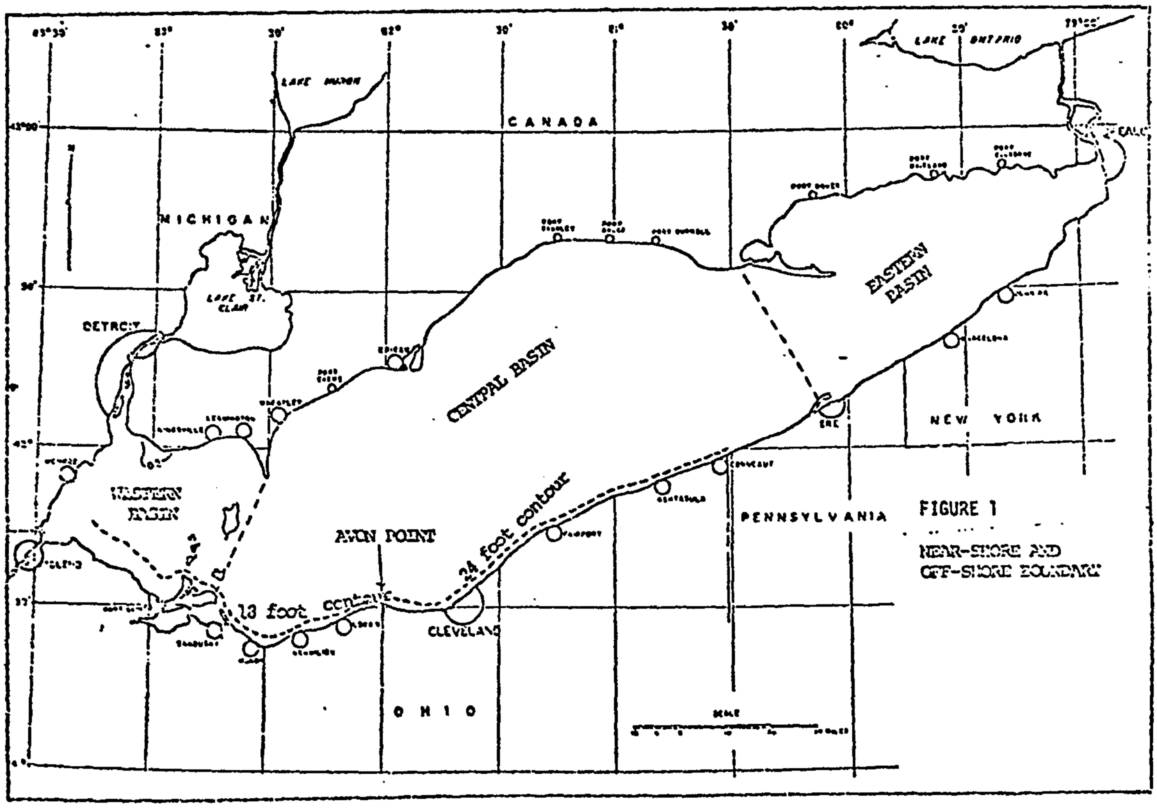

FIGURE 1

NEAR-SHORE AND OFF-SHORE BOUNDARY

EP-1-08 *Cold Water Fisheries.*

(A) The water quality standards in watercourses classified as cold water fisheries streams in subsection (B) shall be the water quality standards in Regulation EP-1-02 except that, to the extent that the following paragraphs establish different standards, the latter standards shall apply.

(1) Dissolved oxygen shall not be less than six milligrams per liter. In spawning areas dissolved oxygen shall not be less than seven milligrams per liter.

(2) pH shall not be less than 6.5 and shall not be more than 9.0.

(B) The following watercourses are hereby classified as cold water fisheries streams (the county designations are for the purpose of identifying the general location of the stream only, and do not limit the classification to a portion of the stream):

(1) Mad River and its tributaries upstream of Urbana.

(2) Beaver Creek upstream of the confluence with Green Creek (Seneca County).

(3) Cold Creek upstream of the confluence with Sandusky Bay (Erie County).

(4) Pine Run upstream of the confluence with Mohican River (Ashland County).

(5) Turkey Creek upstream of the confluence with Lake Erie (Ashtabula County).

(6) Conneaut Creek upstream of the confluence with Lake Erie (Ashtabula County).

(7) East Branch of Chagrin River upstream of the confluence with Chagrin River (Geauga County).

(8) Apple Creek upstream of the confluence with Spring Run (Wayne County).

(9) North Fork upstream of the confluence with Little Beaver Creek (Columbiana County).

(10) Little Pickerel Creek upstream of the confluence with Sandusky Bay (Sandusky County).

(11) Cross Creek upstream of the confluence with Ohio River (Jefferson County).

(12) Medway Creek (Clark County).

(13) Cedar Run (Champaign and Clark Counties).

(14) Moore Run (Champaign and Clark Counties).

(15) Buck Creek proper north of the confluence with the East Fork of Buck Creek (Champaign County).

(16) Beaver Creek (Clark County).

(Former regulation EP-1-04, adopted July 27, 1973, effective July 27, 1973, is repealed.)

(Adopted January 8, 1975, effective January 8, 1975)

EP-1-09 *Lower Cuyahoga River.*

(A) The water quality standards in the Lower Cuyahoga River shall be the water quality standards in regulation EP-1-02, except that, to the extent that subsequent provisions of this regulation, EP-1-09, establish different standards, the latter standards shall apply:

(1) In that portion of the Cuyahoga River extending from the confluence of the Cuyahoga River and Big Creek to the mouth of the Cuyahoga River,

(a) the dissolved oxygen standards in EP-1-02 (c) need not be met during the months of July, August, September, and October, and

(b) at no time shall water temperature exceed the maximum temperatures indicated in the following table:

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Deg. F.	53	53	63	73	83	95	95	95	95	83	73	60
Deg. C.	11.7	11.7	17.2	22.8	28.3	35.0	35.0	35.0	35.0	28.3	22.8	15.5

(2) In that portion of the Cuyahoga River from the Cleveland Southerly Sewage Treatment Plant to the mouth of the Cuyahoga River,

(a) ammonia (storet number 00610) shall not be greater than 12.0 mg/l from December 1, 1974, to June 30, 1976; nor greater than 8.0 mg/l from July 1, 1976, to January 1, 1979, and

(b) the dissolved solids standards set forth in EP-1-02 (A) and (B) shall not apply.

(B) That portion of the Lower Cuyahoga River from the Cleveland Southerly Sewage Treatment Plant to the mouth of the Cuyahoga River is hereby classified as appropriate for industrial water supply and secondary contact recreational uses.

(Adopted December 10, 1974; effective December 10, 1974.)

Administering Agency: Ohio River Valley Water Sanitation Commission
414 Walnut St.
Cincinnati, Ohio 45202

(Pollution Control Standards No. 1-70 and No. 2-70, adopted November 13, 1970)

DEFINITIONS AND PROCEDURES FOR APPLICATION OF POLLUTION CONTROL STANDARDS NOS. 1-70, 2-70

The following definitions and application procedures are incorporated as part of Pollution Control Standards Nos. 1-70, 2-70:

(a) "Sewage" means the water carried human or animal wastes from residences, buildings, industrial, commercial or governmental establishments; public or private institutions, watercraft and floating facilities, or other places, together with such groundwater infiltration and surface-waters as may be present. The admixture with sewage, as defined, of industrial wastes, as hereinafter defined, shall also be regarded as sewage;

(b) "Industrial waste," other than cooling water, means any liquid, gaseous, solid material or waste substance or combination thereof including garbage, refuse, decayed wood, sawdust, shavings, bark, sand, lime, cinders, ashes, offal, oil, tar, dyestuffs, acids, chemicals, heat and all discarded matter resulting from any process or operation, including storage and transportation, manufacturing, commercial, agricultural and government operations, or from the development and recovery of any natural resources;

(c) "Cooling water" means water used as a heat transfer medium to which no process, waste or other materials, exclusive of chlorine, are added intentionally or unintentionally prior to discharge;

(d) "Substantially complete removal" means removal to the lowest practicable level attainable with current technology;

(e) Methods for determining waste constituents and characteristics shall be those set forth in the most recent edition of "Standard Methods for the Examination of Water and Wastewater," prepared and published jointly by the American Public Health Association, American Water Works Association, and the Water Pollution Control Federation, except that such other methods may be used as are approved by the Commission.

POLLUTION CONTROL STANDARD NO. 1-70

All sewage from municipalities or political subdivisions, public or private institutions, or installations, or corporations, or watercraft, and all industrial wastes, other than cooling water as hereinafter defined, discharged or permitted to flow into the Ohio River from the point of confluence of the Allegheny and Monongahela rivers at Pittsburgh, Pennsylvania, designated as Ohio River mile point 0.0, to Cairo Point, Illinois, located at the confluence of the Ohio and Mississippi rivers, and being 981.0 miles downstream from Pittsburgh, shall be so treated or otherwise modified as to provide for:

A. Substantially complete removal of settleable solids;

B. Substantially complete removal of oil (in whatever state, including free, emulsified, dispersed and dissolved oils), debris, scum, and other floating materials;

C. Reduction of suspended solids, dissolved solids and other materials to such degree that the discharge will not produce turbidity, color or odor in the river, or impart taste to potable water supplies, or cause the tainting of fish flesh;

D. Reduction of any and all constituent materials to such a degree that the concentration thereof, singly or in combination, in any discharge is not harmful to human health, and reduction of the following chemicals to such a degree that the concentrations thereof in any discharge do not exceed (1) the limits specified in the tabulation below or (2) such lower limits as may be required for compliance with subparagraph (E) of this Pollution Control Standard No. 1-70:

Inorganic chemicals	Limiting concentration (mg/1)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium (hexavalent)	0.05
Lead	0.05
Mercury	0.005
Selenium	0.01
Silver	0.05
Organic chemicals	
Cyanide	0.2
Pesticides	
Aldrin	0.017
Chlordane	0.003
DDT	0.042
Dieldrin	0.017
Endrin	0.001
Heptachlor	0.018
Heptachlor epoxide	0.018
Lindane	0.056
Methoxychlor	0.035
Organic phosphates plus carbamates (as parathion equivalent cholinesterase inhibitors)	0.1
Toxaphene	0.005
Herbicides	
2,4-D plus 2,4,5-T plus 2,4,5-TP	0.1

E. Reduction of any material or, if necessary, all materials contained in any discharge which singly or in combination are toxic or harmful to aquatic life to such a degree or degrees that the calculated concentration(s) of such material or materials in the river does not exceed one-twentieth of the 96-hour median tolerance limit (96-hr. TL_m) for aquatic life;

F. Reduction of radioactive materials to such degree that (1) concentrations of *unidentified* radionuclides in the discharge do not exceed (a) 30 pcl or (b) limiting values specified by the Atomic Energy Commission for water in which certain radionuclides are known to be absent, as set forth in Column 2, Table II, Paragraph 3.C, Notes to Appendix B, Title 10, Chapter 1, Code of Federal Regulations (January 1, 1970), or (2) concentrations of *identified* radionuclides in the discharge do not exceed limiting values for water specified by the Atomic Energy Commission, as set forth in Column 2, Table II, Appendix B, Title 10, Chapter 1, Code of Federal Regulations (January 1, 1970);

G. Reduction of fecal coliform bacteria to such degree that (1) 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 samples per month), nor exceed 400 per 100 ml in more than ten percent of the samples examined during a month, and (2) 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 samples per month), nor exceed 2,000 per 100 ml in more than ten percent of the samples examined during a month;

H. Control of hydrogen ion concentration to such degree that the pH is not less than 5.0 nor greater than 9.0;

I. Reduction in 5-day biochemical-oxygen-demand load (pounds per day) of not less than 92 percent (as a monthly-average value), provided, however, that a lesser degree of reduction may be applied, but not less than 85 percent (monthly-average value), if as a result the biochemical-oxygen-demand (BOD) load does not exceed that amount which will increase the BOD of the river, on a calculated basis, by more than 0.05 milligrams per liter at flows equal to or exceeding "critical" flow values specified in the following table:

River Reach		Critical flow in cfs*
From	To	
Pittsburgh (mi. 0.0)	Willow Is. Dam (161.7)	6,600
Willow Is. Dam (161.7)	Gallipolis Dam (279.2)	7,700
Gallipolis Dam (279.2)	Meldahl Dam (436.2)	9,900
Meldahl Dam (436.2)	McAlpine Dam (605.8)	12,100
McAlpine Dam (605.8)	Uniontown Dam (846.0)	14,300
Uniontown Dam (846.0)	Smithland Dam (918.5)	20,000
Smithland Dam (918.5)	Cairo Point (981.0)	48,500

Minimum 7-day flow once in ten years.

J. Reduction of heat content to such degree that the aggregate heat-discharge rate from the municipality, subdivision, institution, installation or corporation, as calculated on the basis of discharge volume and temperature differential (temperature of discharge minus average upstream river temperature), does not exceed the amount calculated by the following formula, provided, however, that in no case shall the aggregate heat-discharge rate be of such magnitude as will result in a calculated increase in river temperature of more than 5 deg. F.:

Allowable heat-discharge rate (Btu/sec) =
$62.4 \times$ river flow (cfs) $\times (T_A - T_R) \times 90\%$

Where:

T_A = Allowable maximum temperature (deg. F.) in the river as specified in the following table:

	T_A		T_A
January	50	July	89
February	50	August	89
March	60	September	87
April	70	October	78
May	80	November	70
June	87	December	57

T_R = River temperature (daily average in deg. F.) upstream from the discharge

River flow = measured flow but not less than critical flow values specified in the following table:

River Reach		Critical flow in cfs*
From	To	
Pittsburgh, Pa. (mi. 0.0)	Willow Is. Dam (161.7)	6,500
Willow Is. Dam (161.7)	Gallipolis Dam (279.2)	7,400
Gallipolis Dam (279.2)	Meldahl Dam (436 2)	9,700
Meldahl Dam (436.2)	McAlpine Dam (605.8)	11,900
McAlpine Dam (605.8)	Uniontown Dam (846.0)	14,200
Uniontown Dam (846.0)	Smithland Dam (918.5)	19,500
Smithland Dam (918.5)	Cairo Point (981.0)	48,100

*Minimum daily flow once in ten years.

POLLUTION CONTROL STANDARD NO. 2-70

All cooling water from municipalities or political subdivisions, public or private institutions, or installations, or corporations discharged or permitted to flow into the Ohio River from the point of confluence of the Allegheny and Monongahela rivers at Pittsburgh, Pennsylvania, designated as Ohio River mile point 0.0 to Cairo Point, Illinois, located at the confluence of the Ohio and Mississippi rivers, and being 981.0 miles downstream from Pittsburgh, Pennsylvania, shall be so regulated or controlled as to provide for reduction of heat content to such degree that the aggregate heat-discharge rate from the municipality, subdivision, institution, installation or corporation, as calculated on the basis of discharge volume and temperature differential (temperature of discharge minus upstream river temperature) does not exceed the amount calculated by the following formula, provided, however, that in no case shall the aggregate heat-discharge rate be of such magnitude as will result in a calculated increase in river temperature of more than 5 deg. F.:

Allowable heat-discharge rate (Btu/sec) =
$62.4 \times$ river flow (cfs) $\times (T_A - T_R) \times 90\%$

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Meldahl Dam (436.2)	McAlpine Dam (605.8)	11,900
McAlpine Dam (605.8)	Uniontown Dam (846 0)	14,200
Uniontown Dam (846.0)	Smithland Dam (918.5)	19,500
Smithland Dam (918.5)	Cairo Point (981.0)	48,100

Minimum daily flow once in ten years.

1547.33 Watercraft sanitary systems prohibited; exception

Except on the waters specified in section 1547.331 of the Revised Code, no person shall launch, moor, dock, use, or operate on any of the waters of this state any watercraft which contains a sink, toilet or sanitary system which is capable of discharging urine, fecal matter, contents of a chemical commode, kitchen wastes, laundry wastes, slop sink drainage, or other household wastes into the waters of this state. Such sink, toilet or sanitary system shall be removed or sealed or made to drain into a tank or reservoir which can be carried or pumped ashore for disposal in a sewage treatment works approved by the director of environmental protection.

1547.331 Discharging sanitary systems prohibited on Lake Erie, Muskingum River, and Ohio River unless approved

No person shall launch, moor, dock, use, or operate on Lake Erie, the Muskingum River, or the Ohio River, or their immediately connected harbors and anchorage facilities, on or after July 1, 1973, any watercraft which contains a toilet which is capable of discharging sewage into such waters, unless the watercraft is equipped with a sewage disposal system which is approved by regulation of the director of environmental protection as providing treatment or disposal of effluent in a manner which is adequate to protect the public health and achieve and maintain the water quality standards applicable to the receiving waters, and which meets standards for safety established by regulation of the chief of the division of watercraft, and is maintained and used.

APPENDIX C

ESTIMATES OF EMISSIONS PRODUCED BY HYDROCARBON FLARING AND VAPOR LOSSES, AND MODEL USED TO CALCULATE DOWNWIND GROUND LEVEL CONCENTRATIONS

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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, and 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 interval 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 (0.075 lb/ft^3), which equals 0.09 lb/ft^3; the volume of a barrel of oil is 5.65 ft^3.

Therefore: 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 tankers 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:

$$C = \frac{Q}{\pi \sigma_y \sigma_z u}$$

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 southernmost region of Ohio 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 D

AMBIENT SOUND LEVELS

APPENDIX D

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:

Sound pressure level (dB) = $20 \log_{10} (\frac{P}{Po})$
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 E

BIRDS LIKELY TO OCCUR IN THE IRONTON MINE SITE REGION

APPENDIX E

BIRDS LIKELY TO OCCUR IN THE IRONTON MINE SITE REGION

Common Name	Scientific Name	Status[3]
Common loon[2]	*Gavia immer*	R
Red-throated loon	*Gavia stellata*	R
Red-necked grebe	*Podiceps grisegena*	R
Horned grebe[2]	*Podiceps auritus*	U
Pied-billed grebe[2]	*Podilymbus podiceps*	C
Double-crested cormorant[2]	*Phalacrocorax auritus*	R
Great blue heron[2]	*Ardea herodias*	U
Green heron	*Butorides virescens*	C
Little blue heron	*Florida caerulea*	R
Great egret	*Casmerodius albus*	R
Black-crowned night heron	*Nycticorax nycticorax*	U
Least bittern	*Ixobrychus exilis*	R
American bittern[2]	*Botaurus lentiginosus*	U
Canada goose[2]	*Branta canadensis*	U
Snow goose	*Chen caerulescens*	N.A.
Mallard[2]	*Anas platyrhynchos*	C
Black duck[2]	*Anas rubripes*	C
Gadwall[2]	*Anas strepera*	U
Pintail[2]	*Anas acuta*	U
Green-winged teal[2]	*Anas crecca*	U
Blue-winged teal	*Anas discors*	C
American wigeon[2]	*Anas americana*	N.A.
Northern shoveler	*Anas clypeata*	U
Wood duck[2]	*Aix sponsa*	C
Redhead	*Aythya americana*	C
Ring-necked duck	*Aythya collaris*	U
Canvasback[2]	*Aythya valisineria*	U
Greater scaup[2]	*Aythya marila*	U
Lesser scaup[2]	*Aythya affinis*	C
Common goldeneye[2]	*Bucephala clangula*	R
Bufflehead[2]	*Bucephala albeola*	U
White-winged scoter	*Melanitta deglandi*	R
Rudy duck	*Oxyrua jamaicensis*	R
Hooded merganser[2]	*Lophodytes cucullatus*	U
Common merganser[2]	*Mergus merganser*	U
Red-breasted merganser	*Mergus serrator*	U

APPENDIX E

Common Name	Scientific Name	Status[3]
Turkey vulture[2]	*Cathartes aura*	C
Black vulture	*Coragyps atratus*	R
Goshawk	*Accipiter gentilis*	R
Sharp-skinned hawk[2]	*Accipiter striatus*	U
Cooper's hawk[2]	*Accipiter cooperii*	N.A.
Red-tailed hawk[2]	*Buteo jamaicensis*	C
Red-shouldered hawk[2]	*Buteo lineatus*	C
Broad-winged hawk	*Buteo platypterus*	U
Rough-legged hawk[2]	*Buteo lagopus*	U
Golden eagle	*Aquila chrysaetos*	N.A.
Bald eagle	*Haliaeetus leucocephalus*	N.A.
Marsh hawk[2]	*Circus cyaneus*	U
Osprey	*Pandion haliaetus*	N.A.
Merlin	*Falco columbarius*	U
American kestrel[2]	*Falco sparverius*	C
Ruffed grouse[2]	*Bonasa umbellus*	C
Bobwhite[2]	*Colinus virginianus*	C
King rail	*Rallus elegans*	N.A.
Virginia rail	*Rallus limicola*	N.A.
Sora	*Porzana carolina*	N.A.
American coot[2]	*Fulica americana*	C
Ringed plover	*Charadrius hiaticula*	N.A.
Killdeer[2]	*Charadrius vociferus*	C
American golden plover	*Pluvialis dominica*	N.A.
Black-billed plover	*Pluvialis squatarola*	N.A.
Ruddy turnstone	*Arenaria interpres*	R
American woodcock	*Philohela minor*	C
Common snipe[2]	*Capella gallinago*	U
Upland sandpiper	*Bartramia longicauda*	N.A.
Spotted sandpiper	*Actitis macularia*	C
Solitary sandpiper	*Tringa solitaria*	U
Greater yellowlegs	*Tringa melanoleuca*	U
Lesser yellowlegs	*Tringa flavipes*	U
Pectoral sandpiper	*Calidris melanotos*	U
Baird's sandpiper	*Calidris bairdii*	N.A.
Least sandpiper	*Calidris minutilla*	U
Dunlin	*Calidris alpina*	N.A.

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Common Name	Scientific Name	Status
Semipalmated sandpiper	*Calidris pusilla*	N.A.
Western sandpiper	*Calidris mauri*	R
Sanderling	*Calidris alba*	N.A.
Short-billed dowitcher	*Limnodromus griseus*	N.A.
Stilt sandpiper	*Micropalama himantopus*	N.A.
Wilson's phalarope	*Steganopus tricolor*	R
Herring gull[2]	*Larus argentatus*	U
Ring-billed gull[2]	*Larus delawarensis*	U
Bonaparte's gull	*Larus philadelphia*	R
Forster's tern	*Sterna forsteri*	R
Common tern	*Sterna hirundo*	R
Black tern	*Chlidonias niger*	R
Rock dove[2]	*Columba livia*	C
Mourning dove[2]	*Zenaida macroura*	C
Yellow-billed cuckoo	*Coccyzus americanus*	U
Black-billed cuckoo	*Coccyzus erythropthalmus*	R
Barn owl[2]	*Tyto alba*	R
Screech owl[2]	*Otus asio*	C
Great horned owl[2]	*Bubo virginianus*	R
Snowy owl[2]	*Nyctea scandiaca*	N.A.
Barred owl[2]	*Strix varia*	C
Short-eared owl	*Asio flammeus*	R
Saw-whet owl	*Aegolius acadicus*	R
Whip-poor-will	*Caprimulgus vociferus*	C
Common nighthawk	*Chordeiles minor*	C
Chimney swift	*Chaetura pelagica*	C
Ruby-throated hummingbird	*Archilochus colubris*	C
Belted kingfisher[2]	*Megaceryle alcyon*	C
Common flicker[2]	*Colaptes auratus*	C
Pileated woodpecker[2]	*Dryocopus pileatus*	C
Red-bellied woodpecker[2]	*Centurus carolinus*	C
Red-headed woodpecker[2]	*Melanerpes erythocephalus*	R
Yellow-bellied sapsucker[2]	*Sphyrapicus varius*	R
Hairy woodpecker[2]	*Dendrocopos villosus*	U
Downy woodpecker[2]	*Dendrocopos pubescens*	C

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Common Name	Scientific Name	Status
Eastern kingbird	Tyrannus tyrannus	C
Great crested flycatcher	Myiarchus crinitus	C
Eastern phoebe[2]	Sayornis phoebe	C
Yellow-bellied flycatcher	Empidonax flaviventris	U
Acadian flycatcher	Empidonax virescens	U
Willow flycatcher	Empidonax traillii	U
Least flycatcher	Empidonax minimus	U
Eastern wood pewee	Contopus virens	C
Horned lark[2]	Eremophila alpestris	U
Tree swallow	Iridoprocne bicolor	R
Bank swallow	Riparia riparia	U
Rough-winged swallow	Stelgidopteryx ruficollis	C
Barn swallow	Hirundo rustica	C
Cliff swallow	Petrochelidon pyrrhonota	R
Purple martin	Progne subis	C
Blue jay[2]	Cyanocitta cristata	C
Common crow[2]	Corvus brachyrhynchos	C
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[2]	Troglodytes aedon	U
Winter wren[2]	Troglodytes troglodytes	R
Berwick wren	Thryomanes bewickii	R
Carolina wren[2]	Thryothorus ludovicianus	C
Long-billed marsh wren	Telmatodytes palustris	R
Short-billed marsh wren	Cistothorus platensis	R
Mockingbird[2]	Mimus polyglottos	C
Gray catbird	Dumetella carolinensis	U
Brown thrasher[2]	Toxostoma rufum	C
American robin[2]	Turdus migratorius	C
Wood thrush	Hylocichla mustelina	C
Hermit thrush[2]	Catharus guttatus	R
Swainson's thrush	Catharus ustulatus	R

Common Name	Scientific Name	Status
Gray-cheeked thrush	*Catharus minimus*	R
Veery	*Catharus fuscescens*	R
Eastern bluebird	*Sialia sialis*	U
Blue-gray gnatcatcher[2]	*Polioptila caerulea*	C
Golden-crowned kinglet[2]	*Regulus satrapa*	C
Ruby-crowned kinglet[2]	*Regulus calendula*	C
Water pipit	*Anthus spinoletta*	R
Cedar waxwing[2]	*Bombycilla cedrorum*	C
Loggerhead shrike[2]	*Lanius ludovicianus*	R
Starling[2]	*Sturnus vulgaris*	C
White-eyed vireo	*Vireo griseus*	C
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*	C
Black-and-white warbler	*Mniotilta varia*	R
Prothonotary warbler	*Protonotaria citrea*	R
Swainson's warbler	*Limnothlypis swainsonii*	R
Worm-eating warbler	*Helmitheros vermivorus*	U
Golden-winged warbler	*Vermivora chrysoptera*	U
Blue-winged warbler	*Vermivora pinus*	U
Tennessee warbler	*Vermivora peregrina*	U
Orange-crowned warbler	*Vermivora celata*	U
Nashville warbler	*Vermivora ruficapilla*	U
Northern parula	*Parula americana*	U
Yellow warbler	*Dendroica petechia*	C
Magnolia warbler	*Dendroica magnolia*	U
Cape May warbler	*Dendroica tigrina*	U
Black-throated blue warbler	*Dendroica caerulescens*	U
Yellow-rumped warbler[2]	*Dendroica coronata*	U
Black-throated green warbler	*Dendroica virens*	U
Cerulean warbler	*Dendroica cerulea*	U
Blackburnian warbler	*Dendroica fusca*	U
Yellow-throated warbler	*Dendroica dominica*	U
Chestnut-sided warbler	*Dendroica pensylvanica*	U
Bay-breasted warbler	*Dendroica castanea*	U
Blackpoll warbler	*Dendroica striata*	U
Pine warbler[2]	*Dendroica pinus*	U

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Common Name	Scientific Name	Status
Prairie warbler	*Dendroica discolor*	U
Palm warbler	*Dendroica palmarum*	U
Ovenbird	*Seiurus aurocapillus*	U
Northern waterthrush	*Seiurus noveboracensis*	U
Louisiana waterthrush	*Seiurus motacilla*	U
Kentucky warbler	*Oporornis formosus*	U
Connecticut warbler	*Oporornis agilis*	R
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*	R
Canada warbler	*Wilsonia canadensis*	R
American redstart	*Setophaga ruticilla*	U
House sparrow[2]	*Passer domesticus*	U
Bobolink	*Dolichonyx oryzivorus*	R
Eastern meadowlark[2]	*Sturnella magna*	C
Red-winged blackbird[2]	*Agelaius phoeniceus*	C
Orchard oriole	*Icterus spurius*	C
Northern oriole,	*Icterus galbula*	R
Rusty blackbird[2]	*Euphagus carolinus*	R
Common grackle[2]	*Quiscalus quiscula*	C
Brown-headed cowbird[2]	*Molothrus alter*	C
Scarlet tanager	*Piranga olivacea*	U
Summer tanager	*Piranga rubra*	C
Cardinal[2]	*Cardinalis cardinalis*	C
Rose-breasted grosbeak	*Pheucticus ludovicianus*	U
Indigo bunting	*Passerina cyanea*	C
Dickcissel	*Spiza americana*	R
Evening grosbeak[2]	*Hesperiphona vespertina*	U
Purple finch[2]	*Carpodacus purpureus*	C
Pine siskin[2]	*Spinus pinus*	U
American goldfinch[2]	*Spinus tristis*	C
Rufous-sided towhee[2]	*Pipilo erythrophthalmus*	C
Savannah sparrow[2]	*Passerculus sandwichensis*	U
Grasshopper sparrow	*Ammodramus savannarum*	U
Henslow's sparrow	*Ammodramus henslowii*	U
Vesper sparrow	*Pooecetes gramineus*	U
Lark sparrow	*Chondestes grammacus*	N.A.
Dark-eyed junco[2]	*Junco hyemalis*	C
Tree sparrow[2]	*Spizella arborea*	U
Chipping sparrow[2]	*Spizella passerina*	U
Field sparrow[2]	*Spizella pusilla*	C

APPENDIX E

Common Name	Scientific Name	Status
White-crowned sparrow[2]	*Zonotrichia leucophrys*	U
White-throated sparrow[2]	*Zonotrichia albicollis*	C
Fox sparrow[2]	*Passerella iliaca*	R
Lincoln's sparrow	*Melospiza lincolnii*	N.A.
Swamp sparrow[2]	*Melospiza georgiana*	R
Song sparrow[2]	*Melospiza melodia*	C

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[1] Source: U.S. Army Corps of Engineers Topographic Laboratories, 1975, Environmental Resources Inventory of the Metropolitan Region of Huntington, West Virginia, Ashland, Kentucky, and Portsmouth, Ohio.

[2] Species recorded during regional Christmas Bird Counts, 1974, Portsmouth, Ohio, Huntington and Ona, West Virginia, and Mason County, West Virginia.

[3] Status: C = Common
U = Uncommon
R = Rare
N.A. = Not Available

APPENDIX F

ANNOTATED SPECIES LIST OF FISHES THAT MAY OCCUR IN THE STUDY AREA

APPENDIX F

ANNOTATED SPECIES LIST OF FISHES THAT MAY OCCUR IN THE STUDY AREA

Family	Genus and Species	Common Name	Status*	Remarks
Petromyzontidae	I. bdellium (Jordan)	Ohio Lamprey	U	Records from southern Ohio
	Ichthyomyzon unicuspis (Hubbs & Trautman)	Silver Lamprey	U	Only found in extreme northern Ohio or along Ohio River drainage
	Lampetra aepyptera (Abbott)	Ohio Brook Lamprey	C	Abundant in small brooks of the study area
Polyodontidae	Polyodon spathula (Walbaum)	Paddlefish	U	Decreased markedly in Ohio River after its impoundment
Acipenseridae	Acipenser fulvescens (Raf.)	Lake Sturgeon	E	Declined sharply in Ohio River after its impoundment
	Scaphirhynchus platorynthus (Raf.)	Shovelnose Sturgeon	U	Drastic decrease in abundance in Ohio River after impoundment
Lepisosteidae	Lepisosteus platostomus (Raf.)	Shortnose Gar	R	Records from lower Scioto River; not reported from W. Va.
	L. osseus (Linnaeus)	Longnose Gar	X	Ohio River drainage
Amiidae	Amia calva (Linnaeus)	Bowfin	R	One record from an overflow pond of the Scioto River

APPENDIX F - Continued

Family	Genus and Species	Common Name	Status*	Remarks
Hiodontidae	Hiodon alosoides (Raf.)	Goldeye	X	Numerous in the lower Scioto River
	H. tergisus (LeSueur)	Mooneye	X	Decreased in abundance in Ohio River since 1850
Clupeidae	Alosa chrysochloris (Raf.)	Skipjack Herring	C	Abundant throughout the study area
	Dorosoma cepedianum (LeSueur)	Gizzardshad	C	
	D. petense (Gunther)	Threadfin Shad	-	Introduced in East Lynn Lake, Wayne County, West Virginia
Salmonidae	Salmo gairdneri (Richardson)	Rainbow Trout; Golden Rainbow Trout	-	Stocked in Twelvepole Creek, Wayne County. Golden Rainbow Trout, a mutation of the Rainbow is stocked in Turkey Creek Lake, Scioto County
Esocidae	Esox americanus vermiculatus (LeSueur)	Central Redfin Pickerel	C	Generally found in oxbows and lowland streams
	E. masquinongy ohioensis (Kirtland)	Ohio Muskellunge	X	Large populations found in unglaciated Ohio
Catostomidae	Cycleptus elongatus (LeSueur)	Blue Sucker	U	Found in deeper waters of the Ohio River
	Ictiobus cyprinellus (Valenciennes)	Bigmouth Buffalofish	C	Very tolerant of turbid water; numerous in deep pools of Ohio River
	I. niger (Raf.)	Black Buffalofish	X	
	I. bubalus (Raf.)	Smallmouth Buffalo fish	X	Decreased in abundance during past 50 years

APPENDIX F - Continued

Family	Genus and Species	Common Name	Status*	Remarks
Catostomidae - cont.	*Carpiodes cyprinus hinei* (Trautman)	Central Quillback Carpsucker	X	Type locality, Scioto River, Scioto County
	C. carpio carpio (Raf.)	Northern River Carpsucker	X	
	C. velifer (Raf.)	Highfin Carpsucker	C	
	Moxostoma anisurum (Raf.)	Silver Redhorse	X	Intolerent to increased turbidity and siltation
	Moxostoma erythrurum (Raf.)	Golden Redhorse	C	Abundant in the study area
	M. breviceps (Cope)	Ohio Redhorse	X	Small population in the lower Scioto River
	M. carinatum (Cope)	River Redhorse	C	Abundant in the deeper waters of the Ohio River
	Hypentelium nigricans (LeSueur)	Hog Sucker	C	Abundant throughout the streams of the study area
	Catostomus commersoni commersoni (Lacepede)	Common White Sucker	C	
	Minytrema melanops (Raf.)	Spotted Sucker	U	Intolerent to turbid waters
Cyprinidae	*Cyprinus carpio* (Linnaeus)	Carp	C	
	Carassius auratus (Linnaeus)	Goldfish	R	Few records from lower Scioto River
	Notemigonus crysoleucas (Mitchill)	Goldenshiner	X	Uncommon in Cabell and Wayne Counties

APPENDIX F - Continued

Family	Genus and Species	Common Name	Status*	Remarks
Cyprinidae - cont.	Hybopsis micropogon (Cope)	River Chub	E	Intolerent to turbidity and siltation
	Hybopsis storeriana (Kirtland)	Silver Chub	X	
	H. amblops amblops (Raf.)	Northern Bigeye Chub	C	
	H. x-punctata trautmani (Hubbs & Crowe)	Eastern Gravel Chub	X	Reported only from Ohio
	H. aestivalis hyostoma (Gilbert)	Ohio Speckled Chub	R	
	Rhinichthys atratulus meleagris (Agassiz)	Western Blacknose Dace	C	
	Semotilus atromaculatus atromaculatus (Mitchill)	Northern Creek Chub	C	
	Phenacobius mirabilis (Girard)	Suckermouth Minnow	C	Common in southern Ohio
	Chrosomus erythrogaster (Raf.)	Southern Redbelly Dace	C	
	Notropis atherinoides atherinoides (Raf.)	Common Emerald Shiner	C	
	N. photogenis (Cope)	Silver Shiner	C	
	N. rubellus (Agassiz)	Rosyface Shiner	U	Intolerent to turbidity and siltation
	N. umbratilis cyanocephalus (Copeland)	Northern Redfin Shiner	C	
	N. ardens lythrurus (Jordan)	Ohio Rosefin Shiner	X	Abundant in unglaciated portions of Scioto County

APPENDIX F - Continued

Family	Genus and Species	Common Name	Status*	Remarks
Cyprinidae - cont.	*N. cornutus chrysocephalus* (Raf.)	Central Common Shiner	C	
	N. blennius (Girard)	River Shiner	X	Only found in southern Ohio
	N. boops (Gilbert)	Bigeye Shiner	R	Not reported from Cabell and Wayne Counties; southern Ohio
	N. whipplei (Girard)	Steelcolor Shiner	C	Not reported from Cabell and Wayne Counties; abundent in southern Ohio
	N. spilopterus (Cope)	Spotfin Shiner	C	
	N. stramineus (Cope)	Northeastern Sand Shiner	C	
	N. volucellus volucellus (Cope)	Northern Mimic Shiner	X	
	N. volucellus wickliffi (Trautman)	Channel Mimic Shiner	U	
	N. buchanani (Meek)	Ghost Shiner	R	No records from Cabell and Wayne Counties, West Virginia
	Ericymba buccata (Cope)	Silverjaw Minnow	C	
	Pimephales vigilax perspicuus (Girard)	Northern Bullhead Minnow	X	
	P. notatus (Raf.)	Bluntnose Minnow	C	
	Campostoma anomalum anomalum (Raf.)	Ohio Stoneroller Minnow	C	
Ictaluridae	*Ictalurus furcatus* (LeSueur)	Blue Catfish	R	Ohio River
	I. punctatus (Raf.)	Channel Catfish	C	

APPENDIX F - Continued

Family	Genus and Species	Common Name	Status*	Remarks
Ictaluridae - cont.	I. natalis (LeSueur)	Yellow Bullhead	C	
	I. nebulosus (LeSueur)	Brown Bullhead	U	Uncommon in Cabell and Wayne Counties
	I. nulas (Raf.)	Black Bullhead	C	
	Pilodictis olivaris (Raf.)	Flathead Catfish	U	Ohio River; lower Scioto River
	Noturus flavus (Raf.)	Stonecat Madtom	U	Lower Scioto River; not reported from Cabell and Wayne Counties
	N. eleutherus (Jordan)	Mountain Madtom	U	Not reported from West Virginia; lower Scioto River
	N. furiosus (Jordan & Meek)	Northern Madtom	U	Not reported from West Virginia; lower Scioto River
	N. miurus (Jordan)	Brindled Madtom	C	
	N. gyrinus (Mitchill)	Tadpole Madtom	R	One record from southern Ohio
Anguillidae	Anguilla rostrata (LeSueur)	American Eel	X	Ohio River; extremely tolerent to Ohio River
Cyprinodontidae	Fundulus notatus (Raf.)	Blackstripe Topminnow	X	

APPENDIX F - Continued

Family	Genus and Species	Common Name	Status*	Remarks
Percopsidae	Percopsis omiscomaycus (Walbaum)	Troutperch	C	Common throughout southern Ohio; good population in Beech Fork of Twelvepole Creek, Wayne County; also in Fourpole Creek, Cabell County; prefers sandy bottom
Atherinidae	Labidesthes sicculus (Cope)	Brook Silverside	U	In turbid waters; forage for game fishes
Centrarchidae	Morone chrysops (Raf.)	White Bass	U	In lower Scioto River, Ohio River and Twelvepole Creek
	Pomoxis annularis (Raf.)	White Crappie	C	Tolerant to turbidity and siltation
	P. nigromaculatus (LeSueur)	Black Crappie	C	Not as generally distributed as the White Crappie; less tolerant to silty water
	[illegible]oplites rupestris (Raf.)	Rockbass	C	Uncommon in the Ohio River except during the colder months
	Micropterus dolomieui (Lacepede)	Smallmouth Blackbass	U	Common in a few streams; game fish
	M. punctulatus (Raf.)	Spotted Blackbass	C	Common in larger streams; game fish
	M. salmoides (Lacepede)	Largemouth Blackbass	C	Generally uncommon in streams; stocked in impoundments
	Lepomis cyanellus (Raf.)	Green Sunfish	C	Fairly common in ponds and streams

APPENDIX F - Continued

Family	Genus and Species	Common Name	Status*	Remarks
Centrarchidae - cont.	*L. gulosus* (Cuvier)	Warmouth Sunfish	U	Not reported from Cabell and Wayne Counties; few records from lower Scioto River
	L. macrochirus (Raf.)	Bluegill Sunfish	C	Common in ponds and impoundments
	L. megalotus (Raf.)	Longear Sunfish	C	Common in small streams
	L. gibbosus (Linnaeus)	Pumpkinseed Sunfish	U	Only one record from Lawrence County
Percidae	*[illegible]tizostedion canadense* (Smith)	Sauger	X	Uncommon in the Ohio River records from lower Scioto River and Twelvepole Creek; more tolerant of turbid waters then Walleye
	S. vitreum vitreum (Mitchill)	Yellow Walleye	X	Introduced in East Lynn Lake, Wayne County
	Perca flavescens (Mitchill)	Yellow Perch	U	Few records from Lower Scioto River; no records from Cabell and Wayne Counties
	Percina sciera sciera (Swain)	Northern Dusky Darter	U	Few records from Lower Scioto River and Twelvepole Creek
	P. maculata (Girard)	Blackside Darter	C	Uncommon in Cabell and Wayne Counties; abundant in southern Ohio
	P. phoxocephala (Nelson)	Slenderhead Darter	U	Few records from Lower Scioto River

APPENDIX F - Continued

Family	Genus and Species	Common Name	Status*	Remarks
Percidae - cont.	P. shumardi (Girard)	River Darter	R	Rare in southern Ohio; not reported from Cabell and Wayne Counties
	P. copelandi (Jordan)	Channel Darter	U	No records from Cabell and Wayne Counties
	P. caprodes (Raf.)	Logperch	C	Common in lower Scioto River; occasionally taken from Twelvepole Creek
	Ammocrypta asprella (Jordan)	Crystal Darter	R	Not reported from Cabell and Wayne Counties; one record from Lawrence County
	A. pellucida (Baird)	Eastern Sand Darter	R	Uncommon in Twelvepole Creek; populations declining in the Scioto River area result of habitat (sandy areas) destruction
	Etheostoma nigrum (Raf.)	Johnny Darter	C	
	E. blennioides (Raf.)	Greenside Darter	C	
	E. zonale zonale (Cope)	Eastern Banded Darter	C	Abundant on the riffles in Twelvepole Creek and lower Scioto River
	E. variatum (Kirtland)	Variegated Darter	U	Rare in Twelvepole Creek; more abundant in the lower Scioto River

APPENDIX F - Continued

Family	Genus and Species	Common Name	Status*	Remarks
Percidae - cont.	E. caeruleum (Storer)	Rainbow Darter	C	No records from Lawrence County; otherwise generally distributed in the study area
	E. spectabile (Agassiz)	Orangethroat Darter	U	Not reported from Cabell and Wayne Counties; record from lower Scioto River
	E. flabellare (Raf.)	Fantail Darter	C	
Sciaenidae	Aplodinotus grunniens (Raf.)	Freshwater Drum	X	Ohio River; few records from lower Scioto River
Cottidae	Cottus bairdi bairdi (Girard)	Central Redfin sculpin	R	Not reported from Cabell and Wayne Counties; few records from lower Scioto River

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*C = Common
E = Endangered
R = Rare
U = Uncommon
X = Unknown status

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

APPENDIX G

OIL SPILL RISK ANALYSIS METHODOLOGY

APPENDIX G

OIL SPILL RISK ANALYSIS METHODOLOGY

G.1 PIPELINE SPILLS

The risk for pipeline spills is considered by be a function of operation time and pipeline length. Historically, the U.S. rate of crude spills (1968-1973 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 1.1 spills/year/1000 miles. 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 13.1-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:

$$(13.1 \text{ miles})\ (50 \text{ X } 10^{-5}/\text{year/mile}) = 0.00655/\text{year}$$

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
$+ \ldots\ldots$ all other spills

Thus, $(0.99345)^{22}$ = 86.54 percent chance of no spills in 22 years
$22\ (0.865218)\ (\frac{0.00655}{0.99345})$ = 12.55 percent chance of one spill in 22 years
$(\frac{21}{2})\ (0.125671)\ (\frac{0.00655}{0.99345})$ = 0.87 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 (21 X 5 million bbl)/28,000 bbl/day = 3750
5 empties 150 days X 5 750
4500 days = 12 1/3 years

The spill probability is then:

none $(0.99345)^{12.33}$ = 92.22 percent
one $11.33\ (0.9222)\ (\frac{0.00655}{0.99345})$ = 6.89 percent
two $(10.33/2)\ (0.0689)\ (\frac{0.00655}{0.99345})$ = 0.23 percent

Thus, there is less risk than would be incurred by keeping the pipeline full at all times.

The spill probabilities for each watershed crossed can be computed similarly by apportioning the length of the pipeline to the annual spill probability.

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 will be spilled.

G.2 TANKER SPILLS

Tanker spill risk modes include collisions, ramming (collision with fixed objects), structural failures (generally leaks), foundering (buoyancy loss), fire and explosions, groundings, and breakdowns. For transport by 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 67 round trips, at 5 days each, would be required for each fill period (21 million barrels). Thus, 0.07 spills per fill, or 0.35 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 random events (earthquakes, rainfalls), and its position in the theory of extremes:

$$f(s) = \frac{1}{rs\sqrt{2\pi}} \exp\left(-\ln s/s_0\right)^2 / 2r^2$$

where $s_0 = 428$, 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.

G.3 TANKER TRANSFER SPILLS

The two most generally applied measures of loading and unloading spill occurrences are:

a. Volume loss rate: The amount of gross throughput spilled over a substantial operating period, generally ranging from 0.5×10^{-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 x 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 x 10^{-6} may be reasonable, but a more pessimistic rate of 1 x 10^{-6} has been assumed for unloading the vessels. For loading spills, the volume spill rate was assumed to double to 2 x 10^{-6}. Thus, lightering operations have a spillage rate of 3 x 10^{-6}.

The resultant projected transfer spills per fill cycle become:

Lightering operations

Number of calls	67
Number of spills	3.7 (1 in 18)
Volume spilled	63 barrels (3 x 10^{-6} of throughput)
Maximum credible spill	1000 barrels

St. James Terminal Transfer

Number of calls	67
Number of spills	.78 (1 in 90)
Volume spilled	21 barrels (1 x 10^{-6} of throughput)
Maximum credible spill	500 barrels

The maximum credible spill for the pipeline can be judged from various combined static and pumping losses. The maximum pumping rate would be about 97 barrels per minute to handle 21 million barrels in 150 days. An 18-inch line would contain about 1600 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	-	2570 barrels
10% Break :	1 mile of line + 1 hour pumping	-	2180 barrels
2% Break :	1 mile of line + 12 hours pumping	-	3000 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 3000 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	23	58 bbl
500 - 1500 bbl	56	560 bbl
1500 - 3000 bbl	21	472 bbl
		1090 bbl

1090/1083 bbl - 0.6 percent error

G.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 barrel per day throughput average associated with the systems reporting these discharges, the accident rate is 1.5 X 10^{-8} incidents per barrel throughput. However, oil moving from production to consumption can pass through from 5 to 15 separate terminals, so the average incident rate per terminal is much lower.

The chance of spilling oil in a terminal also varies with the number and type of operations involved. Distributing oil among several tanks is more risk-prone than filling a single tank because about a sixth of these spills are due to operator error, rather than equipment failures. The Ironton storage, with a single reservoir, is the simplest possible type of terminal.

A spill frequency of 1.5 X 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 Ironton 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 X 10^{-10} events per barrel throughput. Since the throughput per fill or withdrawal is 21 million barrels, the frequency of terminal spill per fill is 0.0105 or 1 chance in 95.

The chance of spills in 10 fill-empty events is:

no spills - $(0.9895)^{10}$ = 89.98 percent

one spill - $10\ (0.8998)\ \left(\frac{0.0105}{0.9895}\right)$ = 9.55 percent

two spills - $4.5\ (0.0657)\ \left(\frac{0.0105}{0.9895}\right)$ = 0.45 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:

$$210\ (0.9995)^{19}\ (0.0005)^2 = 0.005 \text{ percent}$$

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, and the use of judgemental models in describing terminal spills is necessary. Underground limestone mine storage, however, 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 Ironton (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 be 1083 barrels. However, with the elimination of storage reservoir spills, Ironton 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., 3000 barrels). Also, with pipeline supply the terminal could have periods of very low staffing levels, which increases the chance of larger spills.

The fitted spill distribution (by histogram approximation) is:

Spill Size	Percent Occurrence	Contribution To Expectation
0 - 200 bbl	47.6	48
200 - 500 bbl	39.4	138
500 - 1000 bbl	10.0	75
1000 - 2000 bbl	2.5	38
2000 - 3000 bbl	0.5	13
		312

Therefore: 312/300 = 4 percent error.

The terminal at Catlettsburg is not typical for the United States, since there is no tank storage proposed. The pumping station alone represe a spill hazard exposure equivalent to the surface facilities at the mine. Should tanks be built in the future, spillage from them can be discounted to the extent that they would be surrounded by dikes.

G.5 COMMENTS ON TECHNICAL ASPECTS OF RISK

G.5.1 Maximum Spills

The risk analysis in an EIS is aimed at revealing both a reasonable picture of what is likely to occur, and also a reasonable picture of the worst that may occur. The use of maximum credible spill events which are not the worst imaginable might seem incompatible with this latter goal. In particular, discounting the chances of a spill of 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. The pipeline was reported to have flowed ruptured 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 (5952 barrels) was attributed to cargo hatches not being secured completely. It can be considered likely that at some time in the program, someone will repeat such an error, but it will not go unnoticed beyond the required inspection period.

Another common factor in catastrophic incidents is frequently unrecognized risks. The primary factor in discounting the chances of releasing the total cavern contents is recognition of the necessity of a fail-safe shaft seal.

G.5.2 Expectation

Statements of expectation, such as: "the expected number of spills is 0.2;" "the spill expectation is 40 barrels per year with maximum credible spill of 1000 barrels;" frequently confuse readers not familiar with the concept. Expectation is the average over a hypothetical, large sample. If the event described above were hypothetically, or mentally, replicated 5 times, than a spill would be expected in one of them. If the situation were hypothetically extended over several thousand years, some of the events would be of thousand barrel size.

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 - 3000 barrel size has a return period of around 3500 years, including both the Catlettsburg and Ironton terminals. About 300,000 years would be needed to provide a sample period in which the spectrum of events would approach the average conditions, compared to the 22 years available. The spill could in fact occur during that 22 year period, but it is unlikely.

G.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, which does not detract from the descriptive usefulness of the results.

The suitability of the log normal distribution has been demonstrated only for certain types of spills, but not for the extremes of these spills. Its use in predicting pipeline and terminal spills descriptions is assumed here, based upon: 1) the fundamental position of the log normal in the theory of extremes (predicting large events from a sample of small ones); and 2) the wide range of random causes generating spills.

G.5.4 Accuracy

The parameters used to describe spill risks are subject to many sources of error, such as:

- 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 change event probabilities from those recorded in the data base. In many instances, such systemic changes have been projected in the parameters.

The accuracy of the data typically ranges from ± 2 to ± 10 percent; the accuracy of the exposure base, from ± 5 to ± 10 percent; and the overall accuracy of projection, from ± 10 to ± 20 percent. With the introduction of 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 3000 barrels. This variability of impact from the Ironton project makes the question of whether the return period for a 2000- to 3000-barrel spill should be 1800 or 1200 years, instead of 1500 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 as 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.

G.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 tensions spreading is a deceptively low 0.03 feet/second in still water, and up to 0.3 feet/second with the wind.

Oil skimmers concentrate the oil film behind sweeping booms, and then skim and separate the film, frequently with an oleophilic wick or belt. The relative velocity of a boom with respect to the water is limited to about 1.0 knot (maximum 1.5 knots) to avoid underflow of the oil. In open waters, 150- to 400-foot widths can be covered (20 to 50 acres per hour). In waters restricted by banks, jetties, sand bars, and so forth, widths of only 15 to 50 feet can be achieved (2 to 7 acres per hour). In particular, the Ohio River has an area of 150 acres per mile, so maximum skimming capacity is about 1/4 to 1/3 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 will have to do the cleanup by spreading and collecting sorbents.

Booms across the streams or tributaries are effective in holding oil spills in or out of low current areas and will be effective in reservoirs. Booming rivers and streams will not be effective if the current exceeds one knot, 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 water requires advance approval in developing the spill contingency plan. It is unlikely that detergents will be used more than sparingly for cleaning boats, and in some cases, perhaps rocks because of its toxicity. 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 H

NATURAL, HISTORICAL, AND CULTURAL RESOURCES

TABLE H-1 Historic and archaeological sites in the six-county project area

BOYD COUNTY, KENTUCKY

National Register of Historic Places

	Location	Description
Catlett, Alexander, House	25th and Walnut Streets, Catlettsburg	Ca. 1812. Original log cabin forms wing of the present house.
Catlettsburg National Bank	110 26th Street, Catlettsburg	1885. Late Victorian one-story brick and stone building.
First Presbyterian Church	1600 Winchester Avenue, Ashland	1858. Brick three-level building. Houses congregation formerly known as Bethesda Church, established in 1819.
Indian Mounds in Central Park	Central Park, Carter Avenue, Ashland	800 B.C.-800 A.D. Adena Culture.
Stone Serpent Mound	Route 2, Catlettsburg	500 B.C.-500 A.D. Wall construction stone. Probably ceremonial.
First United Methodist Church	2712 Louisa Street, Catlettsburg	1867. Largest of the remaining old churches in town. Building is basically unaltered and has been in continuous use.

Kentucky State Plan (not listed in National Register)

Ashland Furnace Site	Winchester Avenue at 6th Street, Ashland	1869. Site of iron furnace, the world's oldest known operating blast furnace, when dismantled in 1962.
Chadwick's Creek Church	Lake Bonita Road, near junction of Kentucky 538 and Chadwick Creek, 5.5 miles due south of Ashland	1842. Two-story log building moved to its present location in 1947. Now partitioned into rooms and used as a house.
Davis, Felix, House	On Kentucky 854	1871-73. Example of two-story log house.
Davis, William, House	Near junction of Kentucky 3 and Davis Branch Road, near Garner	1840. Architectural example.
Fannin, H. C., House	Ellingtons Bear Creek	Civil war era. Two-story log house built by Lindsey White.
Galligher, Ed, House	Near Laurel Hill, south of Catlettsburg	Ca. 1850-60. Example of log house built during iron furnace period.
Lockwood, David, House	On U.S. 23, near Lockwood, south of Catlettsburg	Ca. 1885. Architectural example.
Moore House	U.S. 23 south of Catlettsburg	Ca. 1875. Architectural example.

TABLE H-1 Continued

Norton Furnace	Winchester Avenue at 23rd Street, Ashland	1873. In 1967 was one of world's oldest known operating blast furnace.
Pritchard, Dr. Allen, House	On Kentucky 854, near Garner	Ca. 1855. Important figure in early political, business, and medical life of the county.
Pritchard, James, House	On Kentucky 773, near Boltsfork	Pre-Civil war. Birthplace of Boyd County jurist, Judge Watt M. Prichard. Fine example of log construction.
Sandy Furnace	West of intersection of Kentucky 3 and 773	1853. Iron furnace.
White, Sammuel, House	Junction of Bear Creek Road and Brooks Creek Road	Ca. 1830. Example of log construction.

GREENUP COUNTY, KENTUCKY

National Register of Historic Places

None listed

Kentucky State Plan (not listed in National Register)

Anvil Rock	Beside U.S. 23, north of Greenup Lock and Dam	Landmark for early surveyors and settlers.
Bennett's Mill Covered Bridge	Off Kentucky 7, about 7-8 miles south of South Shore	Ca. 1855. Longest (170 feet) one-span covered bridge in the county, still in use. Crosses Tygarts Creek.
Boone, Jesse, Cabin	One mile from U.S. 23, near Kentucky 1	Probably pre-1810. One-story log cabin with loft built by Jesse Boone. His brother, Daniel Boone, often visited the Boone cabin.
Buffalo Furnace	In Greenbo Lake State Park	1851. Iron furnace, a major producer of iron in the Hanging Rock Region 1851-1875, and an important Union Army supplier during the Civil War.
Buffalo School	In Greenbo Lake State Park	1900. One-room school used until 1950. not on original site.

TABLE H-1 Continued

Cole House	504 Laurel Street, Greenup	1837. Architectural example. Originally the home of Dr. William S. Kouns, member of an early Greenup family.
Greenup C&O Railroad Depot	Harrison Street, Greenup	One of the few remaining depots along the C&O line.
Laurel Furnace	Off Kentucky 1, near Oldtown	1800's. Iron furnace carved out of rock in a hill.
Leslie, Sam, House	West of U.S. 23 in Greenup	1820. Two-story brick with unusual double dental molding on front cornice. Once the home of Col. Worthington, a Col. in the Union Army and Lt. Gov. of Kentucky 1896-1900.
McConnell, John, House	On U.S. 23, in Wurtland	Ca. 1833-34. Two-story brick house built by John M. McConnell, an attorney from Pennsylvania, who moved to Wurtland and married Lucy B. Lewis, daughter of Hon. Charles N. Lewis the first Representative of Greenup County.
Mount Zion Methodist Church	On Kentucky 1215, at Frost	1873. Houses congregation of church organized in 1839. First Methodist Church in Greenup County.
New Hampshire Furnace	West of intersection of Kentucky 7 and Brushy Creek Road	1846. Iron furnace in operation until 1854
Oldtown Covered Bridge (Frazier's)	Off Kentucky 1, near Oldtown	1875. 195-foot long covered bridge across Little Sandy River.
Pine Grove Furnace	On Brushy Creek Road, west of junction of Kentucky 7 and 827	1881. Smallest blast furnace in the Hangin Rock Iron Region, operated with steam driv blast of air.
Raccoon Furnace	On Kentucky 2, 5.5 miles south of Greenup	1833. Iron furnace.

TABLE H-1 Continued

Other Sites

Brammer Building	Wurtland	Dr. Brammer established the first doctor's office (1850) in the Wurtland area.
Downs, Lucy Virgin, Gravesite	Oldtown	Lucy Downs was the first white child born west of the Appalachian Mountains.
Greenup Presbyterian Church	Greenup	One of the oldest churches in Greenup Coun
Hunnewell Furnace	On Kentucky 207, 5 miles south of Greenbo Lake State Park	Iron furnace ruins.
Kenton Furnace	At the crossroads village of York near the junction of Whiteoak and Stockholm Creeks	Iron furnace ruins.
Wurtland Union Church	Wurtland	1860. First Church in Wurtland.

LAWRENCE COUNTY, OHIO

National Register of Historic Places

None listed

Ohio Prehistoric and Historic Inventory (not listed in National Register)

Aetna Furnace	One mile southeast of village of Pedro, off Ohio 93, Elizabeth Township	Iron furnace.
Brick House	Burlington, Fayette Township	--
Buckhorn Furnace	Off Ohio 93, 1 mile southwest of the village of Buckhorn, Decatur Township	Iron furnace ruins.
County Jail	Burlington, Fayette Township	--

TABLE H-1 Continued

Covered Bridge	Off Ohio 217, crosses Indian Guyan Creek, 0.5 mile east of the village of Scottown, Rome Township	--
Getaway Mounds & Village Site	Getaway vicinity, Union Township	Prehistoric site.
LaGrange Furnace	Hecla vicinity, Upper Township	Iron furnace.
Lawrence Furnace	Off Ohio 93, 1 mile northwest of Pedro, Elizabeth Township	Iron furnace ruins.
Nelson Bridges Site	On Elkins Creek, 1.5 miles west of the junction of the Symmes and Elkins Creeks, Aid Township	Prehistoric site.
Newman Site	Coal Grove vicinity, Upper Township	Prehistoric site.
Norfolk & Western Railway Depot & Baggage Station	Ironton	--
Oak Ridge Furnace	Wilgus vicinity, Mason Township	Iron furnace.
Olive Furnace	Off Ohio 93, near village of Olive Furnace, Washington Township	Iron furnace.
Pioneer Furnace	On Ohio 93, in the vicinity of Blackfork, Washington Township	Iron furnace.
Proctorville Village Site	Elizabeth Street, Proctorville	Prehistoric site.
Schott, Robert, House	On Ohio 93, in the Vernon area, Decatur Township	--
Vesuvius Iron Furnace	At the south end of Lake Vesuvius, Elizabeth Township	Iron furnace.
Washington Furnace	On Ohio 93, near the village of Blackfork, Washington Township	Iron furnace.

TABLE H-1 Continued

Ohio Prehistoric and Historic Inventory (not listed in National Register and not shown on map)

Brown Campsite	Symmes Township	Prehistoric site.
Campsite	Aid Township	Prehistoric site.
Campsite	Aid Township	Prehistoric site.
Campsite-Village	Aid Township	Prehistoric site.
Campsite-Village	Aid Township	Prehistoric site.
Campsite	Decatur Township	Prehistoric site.
Campsite	Decatur Township	Prehistoric site.
Campsite	Decatur Township	Prehistoric site.
Campsite	Decatur Township	Prehistoric site.
Campsite	Mason Township	Prehistoric site.
Campsite	Symmes Township	Prehistoric site.
Clark Site	Mason Township	Prehistoric site.
Collins Site I	Decatur Township	Prehistoric site.
Collins Site II	Decatur Township	Prehistoric site.
Collins Site III	Decatur Township	Prehistoric site.
Crawford Site I	Aid Township	Prehistoric site.
Crawford Site II	Aid Township	Prehistoric site.
Crawford Site IV	Aid Township	Prehistoric site.
Crawford Site V	Aid Township	Prehistoric site.
Dalton Village Site	Aid Township	Prehistoric site.
Federal Village Site	Rome Township	Prehistoric site.
Forgeys Village Site	Windsor Township	Prehistoric site.

TABLE H-1 Continued

Haney Site	Elizabeth Township	Prehistoric site.
Harrel-Payne Village Site	Symmes Township	Prehistoric site.
Herrell Site	Aid Township	Prehistoric site.
Jenkins Site	Decatur Township	Prehistoric site.
Lick Creek Village Site	Perry Township	Prehistoric site.
McClure Mound	Aid Township	Prehistoric site.
McGlone Site	Washington Township	Prehistoric site.
McKee Village Site	Fayette Township	Prehistoric site.
Miller Site	Symmes Township	Prehistoric site.
Montgomery Site	Decatur Township	Prehistoric site.
Mound	Aid Township	Prehistoric site.
Mound	Decatur Township	Prehistoric site.
Mound	Elizabeth Township	Prehistoric site.
Mound	Washington Township	Prehistoric site.
Ohio Baptist Site	Hamilton Township	Prehistoric site.
Pratt Village Site	Union Township	Prehistoric site.
Rockshelter	Decatur Township	Prehistoric site.
Rockshelter	Mason Township	Prehistoric site.
Sanders Village Site	Perry Township	Prehistoric site.
Shirkey Village Site	Union Township	Prehistoric site.
Smith Site	Symmes Township	Prehistoric site.
Symmes Pratt Village Site	Windsor Township	Prehistoric site.
Trumbo Village Site	Hamilton Township	Prehistoric site.

TABLE H-1 Continued

Village	Decatur Township	Prehistoric site.
Village	Elizabeth Township	Prehistoric site.
Village	Goyan Township	Prehistoric site.
Village	Symmes Township	Prehistoric site.
Ward Site	Aid Township	Prehistoric site.
White Sites	Lawrence Township	Prehistoric site.
White Site	Mason Township	Prehistoric site.
3 Mounds	Elizabeth Township	Prehistoric site.

SCIOTO COUNTY, OHIO

National Register of Historic Places

Feurt Mounds and Village Sites	North of Portsmouth, Clay Township	Prehistoric site.
First Presbyterian Church	221 Court Street, Portsmouth	--
Horseshoe Mound	In Mound Park, Hutchins Avenue between Grant and 17th Avenues, Portsmouth	Prehistoric Indian Mound.
Kenney, Aaron, House	Waller Street, Portsmouth	--
Lyric Theater	820 Gallia Street, Portsmouth	--
Otway Covered Bridge	Southwest of Otway off Ohio 348	1870. Smith truss bridge.
Tremper Mound and Works	Along Ohio 73, at the junction of Ohio 104, northwest of Portsmouth, Rush Township	A large earthwork, the contour of which is believed to resemble a mammal.

TABLE H-1 Continued

Ohio Prehistoric and Historic Inventory (not listed in National Register)

Bonyfiddle Historic District	Market, 2nd, and Washington Streets, Portsmouth	--
Chaboudy Stone House (Methodist Building)	Portsmouth vicinity	--
Covered Bridge	Southeast of Minford on South Webster Road	--
Marlow, Julia, House	Portsmouth	--
Pech House	Portsmouth	--
Pixley's Grove Works	Southwest of Wheelersburg, 0.75 mile, Poter Township	Prehistoric site.

Ohio Prehistoric and Historic Inventory (not listed in National Register and not shown on map)

Biggs Works	4.5 miles from Portsmouth, Clay Township	Prehistoric site.
Caldwell Mound	Valley Township	Prehistoric site.
Schisler Village	Lucasville vicinity	Prehistoric site.
Tanner Farm Village	Portsmouth vicinity	Prehistoric site.
Village	Vernon Township	Prehistoric site.

CABELL COUNTY, WEST VIRGINIA

National Register of Historic Places

Baltimore & Ohio Railroad Depot	1100 Block of Second Avenue, Huntington	This depot, at the center of the business district, was so prominent that Theodore Roosevelt, Warren G. Harding, and Dwight D. Eisenhower addressed the public from the rear of their campaign trains prior to their elections.

TABLE H-1 Continued

Carroll, Thomas, House	234 Guyan Street, Huntington	Pre-1810. This two-story structure was built in several sections. In 1810 it was floated down the Ohio River from Gallipolis, Ohio and set up on its present foundation. In 1855 Thomas Carroll began to use the building as a Catholic church. In 1861 the building was used as an inn and boarding house. It served as an eating place for rivermen and stage coach passengers on the James River Turnpike.
Harvey House (Coin Harvey House)	1305 Third Avenue, Huntington	1874. The house was designed and built by William Hope Harvey. He was a gifted economist best known for his spectacular defense of his theory of free coinage of silver. Mr. Harvey was nominated for the presidency of the U.S. by the Independent Party in 1932.
Old Main-Marshall University	16th Street on the Marshall University Campus	Three-story brick and stone building measuring 140 by 400 feet. Built in five stages, each stage with a different style of architecture. Present front, and last stage, is of Tudor Gothic styling.

West Virginia Historic Preservation Plan (not listed in National Register)

Archaic Site	Huntington	--
Governor Hatfield House	1550 5th Avenue, Huntington	Former home of Dr. Henry D. Hatfield, Governor of West Virginia and later a U.S. Senator from West Virginia, who lived here from 1917 until his death (ca. 1960).
Marshall University	Bounded by 3rd Avenue, 5th Avenue, 16th Street, and 20th Street, Huntington	The university was named for John Marshall, formerly Chief Justice of the U.S. Supreme Court, and was opened in the fall of 1837.
Old Toll House	Barboursville	--

TABLE H-1 Continued

Steele Funeral Home	1303 3rd Avenue, Huntington	1896. The home stands with quiet dignity and represents its type of architecture as no home built in that era could.
Union Baptist Church	Milton	--
Petroglyph Site	Salt Rock vicinity	A.D. 1000-A.D. 1700. Probably carved by Late Prehistoric Indians of the Fort Ancient Culture.
Old Bank Building (Jesse James Bank)	1208 Third Avenue, Huntington	1873. This building was originally built as a bank in the summer 1873. Gossip has it that Jesse James and his gang robbed the bank.
<u>Other Sites</u>		
Covered Bridge	Crosses the Mud River at Milton	--
<u>West Virginia Historic Preservation Plan</u> (not listed in National Register and not shown on map)		
Big Bend Battle Site	--	Educational site.
Clover Site	--	Social science site.
General Jenkins (Greenbottom)	--	Educational site.
Morrow, Dwight D., House	--	--
<u>Other Sites</u> (not shown on map)		
May Moore Mound	--	--

TABLE H-1 Continued

WAYNE COUNTY, WEST VIRGINIA

National Register of Historic Places

None listed

West Virginia Historic Preservation Plan (not listed in National Register)

Camden Park Mound	Huntington	1000 B.C.-1 A.D. A truncated cone approximately 25 feet high and 70 feet wide. It is the third largest tumulus in West Virginia. Probably built by the Early Adena people.

Source: U.S. Army Corps of Engineers, 1975.

TABLE H-2 Scenic, natural and cultural resources

Name or Identification	State/County	Description
National Forest		
Wayne	OH-Lawrence	Offers fishing, natural scenery, hiking trails, and riding trails. 47,760 acres in Lawrence County and 6,023 acres in Scioto County.
State Forests		
Dean	OH-Lawrence	Natural environment area, fishing, hiking trails, hunting, picnicking, and riding trails. 1796 acres. 2 acre lake included

Research and Education Areas

Name or Identification	State/County	Description
Kitts Hill	OH-Lawrence	Natural environment area. 55 acres
Wiseman-Clark Woods	OH-Lawrence	Natural environment area. 260 acres

Recreation Areas not included above

Lawrence County, Ohio

Name or Identification	Description
Lake Vesuvius	Natural environment area in Wayne National Forest. Boating, camping, fishing, hiking trails, picnicking, nature study, swimming, and pleasure driving. 486 acres

Sites within Lake Vesuvius Recreation Area

Big Bend Beach	Fishing, hiking trails, natural scenery, and swimming
Big Bend Picnic Area	Hiking trails, natural scenery, and picnicking
Two Points Group Camp	Camping, hiking trails, and natural scenery
Vesuvius Bald Knob Beach	Fishing, hiking trails, natural scenery, and swimming
Vesuvius Bald Knob Picnic Ground	Hiking trails, natural scenery, and picnicking
Vesuvius Boat Dock	Boating, hiking trails, and natural scenery
Vesuvius Furnace Picnic Ground	Hiking trails and natural scenery

TABLE H-2 Continued

Name or Identification	State/County	Description
Vesuvius Iron Ridge Campground		Camping, hiking trails, and natural scenery
Vesuvius Oak Hill Campground		Camping, hiking trails, and natural scenery
Vesuvius Rock House Campground		Hiking trails, natural scenery and picnicking
Lawrence County Fairgrounds		20 acres
Roadside Park		Picnicking
Roadside Park		Picnicking. 1 acre
Lock #27		Launching ramp, boating, fishing, and picnicking. 16 acres
Lock #28		Boat launching ramp, court games, and picnicking. 15 acres
Symmes Creek Public Access Area		Boat launching ramp, boating, and fishing. 6 acres
Parks and Playgrounds in Ironton		
Beechwood Park		Court games, field games, swimming pool, picnicking and play equipment. 8 acres
Ironton National Little League		Field games. 3 acres
Ironton Playground		Court games and play equipment. 1 acre
Lions Club Little League Field		Field games. 3 acres
Metropolitan Playgrounds		Court games, field games, and play equipment. 4 acres
Moultan's Field		Field games and play equipment. 3 acres
Little League Fields		3 fields. 3 acres
Riverside Country Club		Swimming pool and golf course
Forest Hills Golf Course		53 acres
Riverside Drag Strip		25 acres
Mooring and Launching Facilities		Boating
Mooring and Launching Facilities		Boating

TABLE H-2 Continued

Name or Identification	State/County	Description
South Point Boat and Country Club		Paved launching ramp
Statan Pool		-
Ironton Boat Club		Mooring and repair facilities
Ironton Country Club		-
Trailer Campgrounds		-
City of Ironton Boating Facility		Paved landing. 3 acres
L. B. J. Boat Ranch		Mooring, paved launching ramp, and repair facilities
Roadside Park		Picnicking. 3 acres
Indian Guyan Creek Public Access		Launching ramp. 20 acres
Aid Ball Park		Field games. 2 acres
Community Playground		Picnicking and play equipment. 1 acre
South Point Little League Field		Field games. 7 acres
Proctorville Park		Court games, field games, and play equipment 5 acres
Our Lady of Fatima Shrine		Gardens. 1 acre
	Boyd County, Kentucky	
Catlettsburg Boat Club		Mooring facilities
Ashland Boat Club, Inc.		Mooring facilities
City of Ashland Boat Landing		Launching ramp. 3 acres
Sundowner Golf Course		-
Twin Valley Golf Course		-
Ponderosa Golf Club		-
Cedar Knoll Golf Course		-

TABLE H-2 Continued

Name or Identification	State/County	Description
Armco Park		Wooded area with 3 shelter houses and horseshoe pits. 250 acres
Grandview Lake		25 acres
Lake Bonita		4 acres
Wildwood Park		Shelter house, picnic sites, and playground equipment. 56 acres
Pine Acres		5 acres
Y. W. C. A. Building		.72 acre
Camp Verity		Boy Scout Camp. 38 acres
Fairgrounds and Exhibition Center		240 acres
Boyd County Recreation Site No. 2		16 acres
Municipal Pool		-
	Boyd County Recreation Sites	
Atkins A-1 Driving Range		2 acres
Armco Gun Range - Pool		1 acre
Ashland Gun Club		1 acre
Blue Ribbon Fox Hunters Club		1 acre
Boyd County Saddle Club		2 acres
Breezeland Swim Club		1 acre
Cherokee Horse Club		1 acre
Crystal Lake		2 acres
Rolling Meadows Golf Course		-
Stonewall Lake		-
Phillis Alley		150 acres
Greenbo Archery Club		1 acre

Source: U.S. Army Corps of Engineers, 1975.

TABLE H-3 Proposed, but not legally designated, areas

Name or Identification	State/County	Description
Union Branch Reservior	OH-Lawrence	Regional Park of 187 acres including lake of 50 acres.
Ice Creek Pond	OH-Lawrence	-
Neighborhood Park	OH-Lawrence	Park-playfield area
Chesapeake Neighborhood Park	OH-Lawrence	Between Chesapeake Junior and Senior High Schools. 10 acres
Neighborhood Park	OH-Lawrence	Northeast of Fairland High School. 10 acres
Neighborhood Park	OH-Lawrence	5-10 acres
Community Park	OH-Lawrence	10-15 acres
South Point Community Park	OH-Lawrence	10 acres
Buckhorn Reservoir Area	OH-Lawrence	Regional park
Coal Grove Park	OH-Lawrence	10 acres
Ashland Tennis Center	KY-Boyd	-
Boyd County Recreation Site No.1	KY-Boyd	-
Park	KY-Boyd	Between 43rd & 44th Streets - Ashland. 9.3 acres
Park	KY-Boyd	Between Bradley Dr. & Blackburn Ave.-Ashland. 9.7 acres
Park	KY-Boyd	Terrace Blvd. area-Ashland. 25.7 acres
Park	KY-Boyd	Area bounded by 31st & 32nd Streets, Chatreroi St. & Central Ave.-Ashland. 2.5 acres
Park	KY-Boyd	Between 29th St. & Geiger La.- Ashland. 7.9 acres
Park	KY-Boyd	Triangle formed by Moon St., Sellars St., and Oakview Rd.-Ashland. 14.4 acres
Park	KY-Boyd	Between Dix & 13th Streets-Ashland. 9.1 acres
Park	KY-Boyd	Between Morgan & Blackburn Avenue-Ashland. 54.1 acres

TABLE H-3 Continued

Name or Identification	State/County	Description
Park	KY-Boyd	Adjacent to Fairview High School-Ashland. 19.2 acres
Proposed Management Areas		
Phillips Knob Wild Turkey Management Area	OH-Lawrence	Hunting, hiking, and nature study
Proposed Preserve Areas		
Compass Plant Habitat	OH-Lawrence	Compass plant and other rare plants
Proposed Natural Landmarks		
Alpha Portland Cement Quarries	OH-Lawrence	Mixed oak forest. 5000 acres

Source: U.S. Army Corps of Engineers, 1975.

APPENDIX I

OIL SPILL CONTAINMENT AND RECOVERY PLAN

OIL SPILL CONTAINMENT AND RECOVERY PLAN

Oil Spill Contingency Plans

A Spill Prevention Control and Countermeasure Plan (SPCC) must be prepared by an operator of a nontransportation-related oil facility that might be capable of discharging by accident, equipment failure, or operator error enough oil into navigable 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 Ironton 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 pipeline lies interstate and is engaged in the interstate transport of oil. Whether it would come under Ohio or 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 Ironton 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.

Since wastewater discharge from the facility is planned, the procedures for the National Pollution Discharge Elimination System (NPDES) will apply to the facility under Public Law 92-500, sections 402 and 405 (40 CFR 125, as amended). 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 wastewater system untreated, and that metal salt components of the mine discharge water would not contribute to the degradation of Ohio River water quality. Biodegradable rust inhibitors would be used in purging the pipeline systems. These do not use the metalic compounds previously used in the petroleum industry.

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 Ironton 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. If sewer service were not 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 Ironton facility and Ashland 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 alarm procedures which shut all appropriate valves. Activation switches will be located at several 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 shut down 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 Ironton storage site is controlled by operators at Ashland 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 Ironton, static draining of the line will 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 watercourses can be established in advance as part of the SPCC. Because the mobilization and assembly of the teams would 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 J - COMMENTS RECEIVED

I. FEDERAL

II. STATE

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
311 Old Federal Building, Columbus, Ohio 43215

March 4, 1977

Mr. Michael E. Carosella
Associate Assistant Administrator
Special Programs
Federal Energy Administration
Washington D.C. 20461

Dear Mr. Carosella:

The Draft Environmental Statement for the proposed Strategic Petroleum Reserve Facility at the Ironton Mine, Ironton, Ohio, was sent to the State Conservationist, US Soil Conservation Service, Columbus, Ohio, for review and comment.

We have reviewed the Draft Statement and wish to offer the following comments:

This Draft Statement concerns a deep underground facility. There is a general description of the surface area surrounding the mine. We can find little reason to comment on the facility except for the route of the proposed pipeline.

The route of the pipeline from the mine to the terminal, shown on page 3.3-17, will cross a limited amount of prime farmland near the Ohio River. This should not be an overriding consideration because so little farmland would be involved. We are not aware of any unique lands in the area of the proposed project.

We appreciate the opportunity to review and comment on this proposed project.

Sincerely,

Clifton H. Maguire Actg
Robert E. Quilliam
State Conservationist

DEPARTMENT OF DEFENSE UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 2127
HUNTINGTON, WEST VIRGINIA 25721

REPLY TO
ATTENTION OF:
ORHED

4 March 1977

Executive Communications
Room 3309
Federal Energy Administration
Washington, D.C. 20461

00004

Dear Sirs:

This letter is in response to your letter of 12 January 1977 transmitting to the Directorate of Civil Works of the Corps of Engineers two Draft Environmental Impact Statements (DEIS) for possible use in the initial phase of the Strategic Petroleum Reserve. A copy of your letter and the DEIS for the Ironton Mine were referred to this office for appropriate comment and direct reply.

Members of my staff have reviewed the report with respect to the specific interest and jurisdiction of the Corps of Engineers and have the following comments.

References to the Ohio River flood levels on pages 3.3-6 and 4.3-3 should be clarified. Elevations of the greatest flood of record and the 100-year flood are noted, but no location is specified. Our records show that elevation of the 100-year flood at the mouth of Ice Creek is 547 feet, mean sea level.

The first sentence on page 4.3-33 is "About 25 miles downstream from the city of Ironton, there is a lock and dam in the river channel that would help prevent the spill from moving further downstream." The first structure of this type downstream, Greenup Locks and Dam, is about 14 miles downstream from Ironton. The second part of the sentence should be qualified. Under flood conditions the gates of the dam are raised to pass flows with minimal restriction; spills also would pass with negligible restriction. Under high flows, oil contamination on the surface may be drawn down and passed under the gates. Under normal lock and dam operating procedures for any river flow, a portion of a surface spill would be passed. In sum, the Greenup Locks and Dam may have little effect in containing spills.

Should this portion of the Ohio River be closed to navigation as a result of an oil spill clean up operation, other industries, which depend on the waterway for transportation of their raw materials or products, would be affected. The EIS should discuss the possibility of a temporary closure of the navigation system.

The discussion on page 5.2-1 of measures to be taken to minimize erosion and sediment transport during construction has been noted. Considering the rugged topography of the project area and the several crossings of waterways, the use of these measures should be emphasized throughout the construction period.

The third paragraph on page I-2 discusses the preparation of the Spill Prevention Control and Countermeasure Plan (SPCC). The timing of preparation is questioned, since the full potential for a spill is established at the beginning of pipeline operation.

If approval of the plan by a specific agency is required, that agency might be identified.

Additionally, coordination of the SPCC with affected agencies is recommended, to include this office, because of permit responsibilities, and for navigation structures which would possibly be affected.

Permits that would be required under the Department of the Army Permit Program, if the Ironton Mine and pipeline are developed, are listed on page 9.2-2. Close coordination of construction plans with the Huntington District Office should eliminate undue delays and potential permit problems.

The opportunity to review the statement is appreciated.

Sincerely yours,

for SAMUEL L. BRITTEN
Lt Col, Corps of Engineers
Acting District Engineer

Copies furnished: (5 cy)
General Counsel
Council on Environmental Quality
722 Jackson Place, N.W.
Washington, D.C. 20006

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

March 11, 1977

Executive Communications
Room 3309
Federal Energy Administration
Washington, D.C. 20461

Dear Sir:

This is in reference to your draft environmental impact statement entitled, "Ironton Mine, Strategic Petroleum Reserve." The enclosed comments from the National Oceanic and Atmospheric Administration 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

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosure: Memo from NOAA, Environmental
Data Service 3/3/77

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL DATA SERVICE
Washington, D.C. 20235

FEB 23 1977

February 18, 1977 Dx61/DL

TO: William Aron, Director
Office of Ecology and Environmental Conservation, EE

Douglas Le Comte

FROM: Douglas Le Comte
Special Projects

SUBJECT: EDS Review of DEIS 7701.38 - Strategic Petroleum Reserve, Ironton 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, 4th sentence:

"There are no bodies of water large enough or close enough to Ironton 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 Ohio, especially during the summer. The quoted sentence probably is referring to local climatic influences, in which case this should be made clear.

Page 3.4-6, 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

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION 5
18209 DIXIE HIGHWAY
HOMEWOOD, ILLINOIS 60430

March 8, 1977

IN REPLY REFER TO
05-00.5

Executive Communications
Room 3309
Federal Energy Administration
Washington, D.C. 20461

00003

Gentlemen:

The draft environmental statement for strategic petroleum reserve, Ironton Mine, Ohio has been reviewed. We find the proposed action will have no effect on Federal-aid highways and therefore have no comments on the statement.

Sincerely yours,

Donald E. Trull
Regional Administrator

W G Emrich

By:
W. G. Emrich, Director
Office of Environment and Design

DEPARTMENT OF THE TREASURY
WASHINGTON, D.C. 20220

March 7, 1977

Dear Mr. Carosella:

This is in response to your letters of January 12 and 21 requesting comments regarding the draft environmental impact statements on the proposed Central Rock, Ironton, and Kleer mines candidate sites for petroleum storage facilities for the Early Storage Reserve. The impact statements appear to be objectively directed towards their stated purposes and the Department has no comments beyond those provided on July 29 and November 1, 1976 concerning the draft statements for the Strategic Petroleum Reserve and the first five proposed candidate sites for petroleum storage.

Sincerely,

Anthony V. DiSilvestre
Assistant Director (Environmental Programs)
Office of Administrative Programs

Mr. Michael E. Carosella
Associate Assistant Administrator
for Special Programs
Federal Energy Administration
Washington, D.C. 20461

cc: Mr. Perry

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

MAR 22 1977

Mr. Michael E. Carosella
Associate Assistant Administrator
Special Programs
Federal Energy Administration
Washington, D.C. 20461

Dear Mr. Carosella:

We have completed our review of the Draft Environmental Impact Statement (EIS) for Ironton Mine Strategic Petroleum Reserve, near Ironton, Ohio. In general, we have environmental reservations regarding this project's potential impacts upon water quality. We request that additional measures be incorporated into the design of the pipeline between Ironton Mine and the Catlettsburg Terminal to prevent and minimize spills. We also recommend that oil transport pipelines between Catlettsburg and the Gulf be upgraded or replaced such that spills can be reduced. We offer the following comments.

We request that an exemplary Spill Prevention and Contingency Counter (SPCC) Plan be prepared to prevent oil spills. After having conducted a study of pipeline spills in the project area, we found that a considerable number of spills have resulted in the past years. While most of the cleanup efforts were good, impacts upon water quality were still adverse and unpreventable. The two major pipeline spillers were Marathon Pipeline Company (29 spills) and Ashland Pipeline Company (23 spills).

To reduce the probability of a large spill impacting local streams and the Ohio River, automatic pressure-reduction shut-off values should be installed on each side of the stream crossing. Consideration should be given to the use of two pipelines, one inside the other at or near river crossing. Our evaluation of past pipeline spills reveal that the primary cause of the spills is pipeline corrosion. Secondary causes are pipeline and valve fractures and accidents caused by construction equipment (grades, plows, bulldozers) hitting the lines. These causes reveal the need to improve pipeline inspection programs and techniques and public awareness of the pipeline's location. These needs should be incorporated into the design, operation and maintenance of the proposed pipeline.

The chemical characterization of the Ironton mine seepage water appears to be inadequate. Table 4.2-2 lists only five parameters measured in a sample of seepage water. In order to adequately consider the effects of pumping out and treating an initial 40 million gallons of water plus maintenance pumpage over the life of the project, additional chemical studies of heavy metals, nutrients, sulfates, hardness, alkalinity etc. should be made. The tests should be conducted to determine what effect high metal, hardness, and nutrient levels would have on the biota of the receiving waters of Ice Creek. Such studies might have an influence on the type of treatment system designed for the facility. Figure 2.3-4 of the EIS diagrams a conventional secondary treatment plant incorporating an API (oil) separator plus ammonia scrubbing.

Once the mine has been filled with oil, seepage water will be pumped out from a sump and treated before it is pumped to Ice Creek. Consideration should also be given to monitoring the effluent to Ice Creek for phenols and hyrocarbons.

We understand that the material removed during construction of shafts will be disposed of on site or transported from the site and used as fill. Assurance should be provided in the EIS that any fill material produced from the project will not be placed within a 100-year flood plain or wetlands as defined by our Agency. This provision should be conditioned on the contractor.

We have special concern regarding the construction of the 13-mile pipeline and its potential water quality impact. Every effort must be made to minimize erosion and sedimentation and disturbance of the aquatic habitats at each of the nine stream crossings. Construction techniques should be employed to prevent any degradation of water quality in these streams during and after construction. Should any sensitive stream reaches be impacted and can not be avoided such as meanders, riffles or pools, these features should be retained or replaced at a point adjacent to the crossing. Consideration should be given to avoid construction during spawning periods.

The EIS points out that there will be a temporary loss of 65 acres of forest and pasture habitats, plus a permanent loss of 1.5 acres of mixed mesophytic hardwood habitat. We suggest that the final plans of this project incorporate recommendations for re-forestation and revegetation in order to balance out those habitat losses.

The EIS should discuss the need to construct storage facilities in a geologically brittle rock area subject to seismic risk. The effect of past of past earthquakes on the limestone formation and mine should be discussed in more detail.

As indicated in the above discussion, we have classified our comments on the proposed action as ER (environmental reservations) and on the EIS as Category 2 (additional information required). The date and classification of our comments on the proposed action and the EIS will be published in the Federal Register in accordance with our responsibility to comment on other Agencies' projects. Should you have any questions regarding our comments or desire to meet with us, please contact me or Robert L. Kay at 312-353-2307.

Sincerely yours,

Barbara Jean Taylor for

Ronald L. Mustard
Acting Chief
Environmental Review Section

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

March 1, 1977

Federal Energy Administration
Executive Communications
Room 3309
Washington, D. C. 20461

00006

Dear Sir:

I am replying to your request for comments on the Draft Environmental Impact Statement for Strategic Petroleum Reserve Storage, Ironton Mine, Ohio.

Our review concentrated basically on those areas of electric power and natural gas use or developments for which the Federal Power Commission has jurisdiction by law. It does not appear that there would be any significant impacts in our areas of concern nor serious conflicts with Federal Power Commission responsibilities.

The following comments are forwarded for your consideration:

(1) Throughout the draft there is a confusion and misuse of the words cement and concrete.

(2) 3.3.2.6 Ground Water at the Mine Site. The underground mine workings are not at a depth of about ±74 feet. The elevation is about ±74 feet M.S.L.

(3) It is strongly suggested that the entire mine cavity be hydrostatically tested with proper monitoring for a period of several weeks. This will identify areas of potential seepage for treatment prior to storage. Saturation of the adjacent porous media will also reduce the volume of unrecoverable petroleum losses.

Thank you for the opportunity to review this statement.

Sincerely,

J. M. Heinemann

Jack M. Heinemann
Advisor on Environmental Quality

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

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)

Clearinghouse Use Only
St. Identification No.
77011680000
Date Received
1-31-77
Review Terminated
3-11-77

Indiana State Clearinghou
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.

Sally Corn
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. 7701168

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)

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, 19

FROM: William T. Paynter, M. D. WTP
State Health Commissioner

SUBJECT: A-95 Project Review
State Identification No. 77 01168 0000

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

ate Clearinghouse
udget Agency
tate House
anapolis, Indiana 46204

St. Identificati
770111 3 ccc
Date Received
1-31-77
Suspense Date
3-2-77

PROJECT REVIEW

FEB 2 1977

TO: Tom Kibler
Energy Office
[illegible]

Date 2-1-77

PROJECT NAME: EIS - Central Rock Mine and [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.

Thomas F. Kibler
Reviewers Signature

Date: March 1, 1977

Thomas F. Kibler

Director
Title

317/633-6753
Telephone Number

Indiana Energy Office

tate Clearinghouse
udget Agency
tate House
dianapolis, Indiana 46204

RECEIVED
FEB 5 1977
STATE BUDGET AGENCY

[illegible]
Date Received
1-31-77
Suspense Date
2-[illegible]-77

PROJECT REVIEW

TO: [illegible]

Date 2-1-77

PROJECT NAME: EIS - [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
_____ 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

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 Ironton 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

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

COMMISSIONER
FRANKFORT, KENTUCKY 40601

February 21, 1977

MEMORANDUM

TO: Office of Planning and Research

THROUGH: Commissioner
Bureau of Environmental Protection

Norman E. Schell NES
Director, Division of Solid Waste

FROM: Samuel N. Johnson, Jr., P.E.
Chief Sanitary Engineer

SUBJECT: Environmental Impact Statement 77-5D.E.I.S.

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 4.3-3 and Section 4.3-4.

Transportation of oil by pipeline has long been practiced by industry and considerable experience exists in handling spills.

Construction of such a pipeline, through a portion of Boyd County, as the one from the Ashland Oil Company Terminal to the Ironton Mine in Ohio, 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.

RECEIVED
[illegible] 1977
OFFICE OF
PLANNING AND RESEARCH

Kentucky Heritage Commission
404 Bridge Street
Frankfort, Kentucky 40601

RECEIVED
977
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: 77-5 DEIS - Strategic Petroleum Reserve, Ironton Mine

DATE: March 1, 1977

My staff and I have reviewed the subject DEIS. I should like to remind the project coordinator/sponsor that the **State Historic Preservation Officer must review and approve the archeological survey report.**

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, Ironton Mine Storage Site, DES 76-10, December 1976.

Dear Mr. Bell:

I appreciate the opportunity to review the referenced DEIS for the Ironton Mine storage site. I note on page 4.2-17 that an in-depth archaeological analysis of the proposed pipeline route, including a field reconaissance, will be made in accordance with Federal regulations (Public Law 93-291). May I add to this in the interests of clarification that all **undisturbed portions** of this project area **should be subjected to an on-site archaeological survey** by a competent archaeologist. Speaking for the Commonwealth of Kentucky, the area of the proposed pipeline in Kentucky is an archaeologically 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 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 archaeological exploration** will be **required** for this survey issued from this office.

Please contact me if I can be of further assistance.

Sincerely Yours,

R. Berle Clay

R. Berle Clay

State Archaeologist

RECEIVED
1977
OFFICE OF
PLANNING AND RESEARCH