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MODERNIZATION OF OHIO'S COAL RESERVES, PHASE I

Final Report

by

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EXECUTIVE SUMMARY

The Ohio Geological Survey has not revised the Ohio coal reserve database in its entirety since the publication of Coal resources of Ohio by Brant and DeLong (1960). In 1990, the Energy Information Administration, recognizing the inadequacy of the Ohio reserve estimates, awarded the Ohio Geological Survey \$80,000 through a cooperative agreement to modernize the coal reserves of Ohio. This final report is the result of an intensive one-year, Phase I project to update and revise the reserve estimates by coal quality of as many counties in Ohio as possible in the time allowed.

Results of this investigation indicate a large increase in the total coal resources for Ohio. We found approximately 1.3 times more coal resources than the Energy Information Administration's 1991 Demonstrated Reserve Base. This gain is due primarily to new information gathered over the last 30 years and incorporated into this study.

The new estimated economic resources of coal for Ohio total 23.939 billion short tons. This figure compares with 18.462 billion short tons in the Energy Information Administration's demonstrated reserve base of coal as of January 1, 1991. The new estimates are divided into three groups of counties based on the methods used to obtain the coal resource tonnages. The first group of counties includes revised resource calculations based on new or revised information for 14 high-priority counties. These 14 counties

account for 17.627 billion short tons, or 73.6 percent, of the total estimated economic resource found in 27 coal-bearing counties in Ohio.

The estimated economic resource tonnages for the second group of counties is based on depletion of historical coal production from the Energy Information Administration 1971 demonstrated reserve base or revised calculations on certain coal beds for which new information is available. These counties account for 1.969 billion short tons of estimated economic resource.

The resource tonnages for the third group of counties are based on depletions of historical production from the 1971 Demonstrated Reserve Base. These counties account for 4.344 billion short tons of estimated economic resource.

The new estimates also incorporate reanalyses of available sulfur and heat content data appropriate for characterizing Ohio's remaining coal resources. The new allocations place 64 percent of the estimated economic resources of Ohio in the high-sulfur category (>2.50 lbs sulfur/million Btu), as compared with 57 percent in the previous allocation used by the Energy Information Administration.

As part of the current study, certain restrictions affecting coal resource availability were examined for 14 counties. The adjustments to the estimated economic resources for 14 counties in Ohio resulted in estimates of 16.517 billion short tons of minable reserve base and 9.125 billion tons of recoverable coal. In these 14 counties

inaccessible surface coal represented 9.9 percent of the estimated economic resource and inaccessible underground coal 5.5 percent. The total inaccessible coal determined for the 14 counties is 6.3 percent of the estimated economic resource. This percentage is probably representative of the entire coal-producing region of Ohio. However, categories of inaccessible coal, such as oil and gas fields, which could increase the percentage of inaccessible coal in some counties, were not considered in our study.

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Special thanks are given to Richard DeLong, who graciously agreed to come out of retirement and help with all phases of this project. His remarkable knowledge of Ohio geology greatly improved the quality of our work.

INTRODUCTION

In February 1990 Richard Carlton of the Ohio Geological Survey (OGS) attended a Coal Reserves Assessment Conference sponsored by the Department of Energy, Energy Information Administration (EIA). As a result of this meeting and subsequent discussions with EIA officials, the OGS was awarded \$80,000 through a cooperative agreement to modernize the coal reserves for Ohio.

This project directly relates to one of the essential functions of the OGS, and comes at a time when the coal industry in Ohio faces a major crisis related to the marketability of high-sulfur coal. The EIA funded this project as a Phase I program designed to produce updated estimates of reserves by quality type, which could be obtained in one year. In this final report we have provided new coal reserve and resource data for 14 coal-producing counties, depleted production tonnages to January 1, 1991, for nine counties, and depleted tonnages with minor updates on certain coal bed reserves for four counties. The results of this project provide an updated, modern view of the coal resources and reserves of Ohio.

PREVIOUS WORK

In 1960 the OGS published Bulletin 58, Coal resources of Ohio (Brant and DeLong, 1960). This bulletin summarized the coal-resource studies performed in Ohio prior to 1960 and provided information on the original resources for each county by reliability category, bed thickness, and seam. Remaining resources at the end of 1957 were estimated at 42.7 billion tons by Brant and DeLong, but determination of minable reserves by mining method was not attempted.

Since the publication of Brant and DeLong's work, the OGS has produced a significant body of coal information, including geologic maps and measured-section and core descriptions, as well as published and unpublished coal resource studies. Most of this material has been successfully incorporated into this study.

Some of the more notable unpublished contributions since 1960 include the work of G. Botoman and D. A. Stith between 1975 and 1984 in which nearly 700 coal samples were collected, primarily for chemical analyses, but for which stratigraphic descriptions, coal thicknesses, and locations were also obtained. The compilation of coal data from gamma ray-neutron logs by R. M. DeLong between 1986 and 1988 and his preliminary work on the deep coals of Monroe and Noble Counties have helped speed the work on this project.

A number of nearly completed manuscripts with resource maps by D. L. Crowell (Washington and Waynesburg coals), C. L. Scheerens (Quakertown and Sharon coals, and deep coals of Belmont County), and by R. M. DeLong (Clarion coal) have added greatly to our knowledge of Ohio coals. The recent work and preliminary maps provided by G. E. Larsen, R. G. Rea, M. R. Caudill, and E. R. Slucher in Columbiana, Mahoning, and Jefferson Counties and by D. L. Crowell in Guernsey County have provided important information for this study.

Post-1960 published or open-file materials which were consulted include studies by Berryhill (1963), Couchot (1978), Couchot and others (1980), DeLong (1965a, 1965b, 1967, 1968, 1969, 1972), and White and Totten (1985), and OGS open-file geologic maps of the Alliance, East Palestine, Homeworth, New Middletown, and Salineville 7.5-minute quadrangles.

OBJECTIVES

The objectives of this project were to determine state-level totals of the estimated economic resource, minable reserve base, and recoverable coal in Ohio, allocated to specified ranges of sulfur and heat content. In addition, resources and reserves were to be categorized by mining methods (surface and underground). Land use and environmental restrictions, needed to determine remaining minable reserves, were

to be delineated and percentages of restricted coal calculated.

In context of a Phase I, one-year project, the objectives of this project were to update Ohio's coal reserves and resources for as many counties as time allowed, and to deplete production tonnages to January 1, 1991, on the remaining coal-producing counties. For the depleted counties, only estimated economic resources were required or possible with the data available.

LOCATION AND STRATIGRAPHY

Eastern Ohio lies on the northwest edge of the Appalachian bituminous coal basin, which trends northeast-southwest from Pennsylvania to Alabama. Coal beds containing significant coal resources are found in about 27 eastern Ohio counties (fig. 1). Nearly 60 coal beds in Pennsylvanian- and Permian- age rocks in Ohio (fig. 2) have been named, but many are thin and have no economic importance.

The total coal tonnages reported herein are based on 14 coal beds (fig. 3). Although production is reported from at least five or six additional beds, such as the Harlem coal, these beds have not been mapped in sufficient detail for accurate reserve calculations to be attempted. In 1990, production was reported from 13 of the 14 coal beds investi-

FIGURE 1.—Location map and 1990 coal production by county (data from Division of Geological Survey, 1991). Resources were determined for 27 counties. In those counties where the number 1 appears, the resources and reserves were determined by revised calculations; where the number 2 is present, the resources for certain seams were determined by revised calculations and the remaining seams depleted from the EIA's 1971 DRB. Where the number 3 is present, resources were depleted from the EIA's 1971 DRB.

FIGURE 2.—Generalized geologic map of the coal-bearing rocks of Ohio (after Couchot and others, 1980).

¹ New resource and reserve tonnages based on these coals.

FIGURE 3 —Geologic column of coal-bearing strata in Ohio, Lower Permian and Pennsylvanian Systems (after Brant and DeLong, 1960).

gated in this study and six additional beds--the Lower Mercer, Upper Mercer, Winters, Strasburg, Mahoning, and Harlem coals. These 6 beds make up 2.4 percent of the total production for 1990. No production was reported from the Quakertown coal bed in 1990, although this bed is one of the 14 beds discussed in this report.

COAL RESOURCE CLASSIFICATION

Since 1952 the OGS has used a resource classification similar to that used by the U.S. Geological Survey (USGS) (Brant and DeLong, 1960; Krumin and others, 1952; Crowell, 1985). This system was apparently adopted by the OGS on the advice of Gilbert Cady, who in 1952 was a consultant to the OGS (Krumin and others, 1952). The classification system used by the OGS differs from the USGS method in at least one important aspect. Rather than use 3/4 mile from a point of measurement for measured plus indicated resource determination, as recommended by the USGS, the OGS uses 2 miles.

In 1976 the USGS adopted clearly defined standards for resource and reserve calculations, and in 1983 expanded on this system. The USGS defines coal resources as "naturally occurring concentrations or deposits of coal in the Earth's crust, in such forms and amounts that economic extraction is currently or potentially feasible" (Wood and others, 1983).

Measured resources "refers to coal for which estimates of the rank, quality, and quantity have been computed to a high degree of geologic assurance, from sample analysis and measurements from closely spaced and geological well-known sample sites" (Decision Analysis Corporation, 1990). According to the USGS criteria, measured resources are computed by projection of thicknesses of coal and overburden, rank, and quality data for a distance of 1/4 mile from a point of measurement (Wood and others, 1983). Indicated resources refer to coal of a moderate degree of geologic assurance for which estimates of the rank, quality, and quantity have been computed by projection of thicknesses of coal and overburden, rank, and quality data from points of measurement and sampling on the basis of geologic evidence (Wood and others, 1983). Indicated resources are located in a belt 1/2 mile wide beginning 1/4 mile from the point of measurement and ending 3/4 mile from the point.

Demonstrated resources are the sum of measured and indicated resources. Demonstrated reserve base, or reserve base, refers to those parts of the measured and indicated resources that meet specified minimum physical and chemical criteria related to current mining and production practices (Decision Analysis Corporation, 1990).

The estimated economic resources determined for this project represent the measured and indicated categories of coal resources and include coal that is at least 14 inches thick with less than 100 feet of overburden, or coal that is

at least 28 inches thick with more than 100 feet of overburden.

The minable reserves, as used in this project, are equivalent to the estimated economic resources adjusted for inaccessibility due to land use and environmental restrictions. Recoverable coal represents that portion of the minable reserve after mine recovery factors have been taken into account. In 1985 the OGS adopted a recovery factor of 80 percent for surface coal (<100 feet of overburden) and a factor of 50 percent for coal deeper than 100 feet below the surface (Crowell, 1985). These figures were used consistently throughout this project.

Reliability arcs of 2 miles for measured plus indicated resources were retained only for the Pittsburgh, Middle Kittanning, and Lower Kittanning coals. These three coals are considered to have relatively uniform thicknesses over large areas of Ohio (R. M. DeLong, oral commun., 1991; Brant, 1956; Brant and DeLong, 1960). Resource tonnages for the remaining coals were obtained using 3/4 mile radii for the measured plus indicated reliability arcs. The reasons for making this relatively significant change are (1) to make Ohio's reserve estimates more representative of actual identified coal, (2) to enable Ohio's reserves to be more easily compared to coal reserves of other states, and (3) to reflect the most recent information available on Ohio's coal fields.

METHODS

Map Construction: Coal point locations, thicknesses, and elevations, if known, from a variety of sources were transferred by hand to mylar base maps, or more commonly were digitized and plotted on mylar base maps. Croplines and isopach lines were traced onto mylar from other sources or were drawn from the information on the mylar if no other sources of information existed. In instances where croplines were not available from previous mapping or were outdated, structure contour maps were drawn on the mylar and were used in conjunction with 7.5-minute topographic quadrangle maps to draw in croplines at the appropriate elevation (fig. 4). Each mylar map at a scale of 1:24,000 depicts a single coal bed and may show county, township, and quadrangle boundary lines, croplines, 100-foot overburden, isopach lines, structure contours, stripped areas, abandoned underground mines, restricted areas, and reliability arcs (fig. 5). Areas on 7.5-minute quadrangle maps identified as stripped areas and abandoned underground mines identified from OGS abandoned-underground-mine data were traced onto mylar, and the delineated area was removed from consideration for coal resource calculations.

Areas inaccessible to coal mining because of land use or environmental restrictions were identified on the mylar sheets. Land use and environmental restrictions were further subdivided into deep and surface restrictions. Surface and

Structure contour map on base of coal bed

Topographic contour map

Juxtaposition of coal-bed-structure and topographic contours, showing location of coal-bed cropline (black).

FIGURE 4.-Finding coal-bed cropline using structure contour and topographic maps.

- Surface minable coal (001S - 999S)
- Deep minable coal (001D - 999D)
- Inaccessible coal:
 - Land use, surface (01LS - 99LS)
 - Land use, deep (01LD - 99LD)
 - Environmental, surface (01ES - 99ES)
 - Environmental, deep (01ED - 99ED)
- Deep coal <28 inches thick:
 - Technologically restricted (XXTD)
 - Technologically restricted and inaccessible (XXLD)
- Areas outside reliability arcs or below coal cropline
- ▨ Strip mines
- ▨ Underground abandoned mines
- 28 Coal bed isopach, in inches
- ~ Coal bed cropline
- ~ 100-foot overburden line
- x Point of coal measurement

Figure 5.—Hypothetical example of a coal resources work map showing political boundaries, coal data points, isopach lines, coal cropline, 100-foot overburden line, coal mines, and various types of minable and restricted areas. XXTD, XXLD, and mined-out areas were excluded from resource calculations.

underground land-use restrictions included federal and state parks, natural areas and preserves, conservancy lands, U.S. Forest Service land, large reservoirs, small lakes greater than about four acres, incorporated towns, and densely populated urban areas outside of incorporated areas.

Surface environmental restrictions included large rivers and areas where slopes were approximately 30 degrees or greater. Alluvial valleys were not restricted if coal was known to be present, or was judged to be present on the basis of geologic assumptions, beneath the valley floor. Technological restrictions included coal less than 14 inches thick and coal less than 28 inches thick with greater than 100 feet of overburden. Blocks of coal of all sizes were included in our resource calculations. Barriers were identified and removed from resource calculations, and outlines of deep underground mines were generalized.

Calculations: Once the 1:24,000 mylar maps were completed, the different resource and restricted areas were coded (fig. 5). Individually coded areas did not extend across state, county, civil township, 7.5-minute quadrangle, isopach, or 100-foot overburden lines. A method for rapidly and accurately measuring acreage on a 7.5-minute quadrangle map was used for this project (Wells, 1972). This method is based on the point-count procedures commonly used in petrography and many other disciplines. In this method, 7.5-minute quadrangle-size mylar sheets with an array of approximately

10,000 equally spaced points are overlain on the mylar work map containing delineated and coded resources and restricted areas (fig. 6). The number of grid points within a coded area can be rapidly counted using this method. For example, a restricted area might contain 250 points within its boundaries. Therefore $250/10,000$ of the total quadrangle is represented by this restricted area. Because the total acreage of the quadrangle is easily calculated (Wells, 1972), it is a simple matter of multiplying 0.025 times the total acreage of the quadrangle to obtain the number of restricted acres. Coal tonnages for each coded area were calculated by multiplying 150 short tons per acre-inch of coal times acres times coal thickness. Coal thicknesses were contoured at 14, 28, 42, 54, 66, 78, and 90 inches. The coal thickness used to calculate tonnages was the average of the isopach lines that the particular area fell between.

The total tonnage of surface and underground coal adjusted for production and coal lost to mining represents the remaining estimated economic resource. Factors of 1.25 and 2 were used to determine surface and underground coal lost to mining, respectively. The remaining estimated economic resource minus inaccessible coal represents the remaining minable reserve base. Recoverable coal is considered to be 80 percent of the surface and 50 percent of the underground minable reserve base.

Base year adjustments: The USGS 7.5-minute topographic quadrangle maps on which stripped areas are delineated varied

FIGURE 6.-Hypothetical example of a coal resources work map (figure 5) with dot matrix overlay superimposed to show how area is measured using dot point count. Sample measurements:

01LD (Fox Co.) contains all or most of 16 dots.

006S (Raccoon Co.) contains 2 dots.

in age. Thus, the tons of surface coal determined by our point-count method represent the amount of coal in the ground at different times, depending on the age of the topographic map. A method was devised to adjust the surface coal tonnages to a base year. The base year was chosen as the most recent date of those quadrangles composing the county. Either the aerial photo date or photoinspected date indicated on the quadrangle map was chosen as the most representative date depicting the most recent strip-mined areas. In Ohio, coal production is reported by county and civil township (Annual reports, Ohio Division of Mines, 1970-1980, and Ohio Division of Geological Survey, 1981-1990). The production for a specific township had to be distributed to the quadrangles which fell within or partially within the township so that production could be adjusted to the base year on a quadrangle basis. The following procedure was used to adjust the surface coal in the ground to a base year. First, all quadrangles within or partially within a specified civil township were identified. For example, in figure 7, civil township Y occupies portions of four quadrangles, A, B, C, and D. Aerial photos for quadrangle A and D were flown in 1982. Quadrangle B was photoinspected in 1971, and aerial photos were flown in 1976 for quadrangle C. The most recent date for all quadrangles in the county is 1987. Therefore, in quadrangles A and D production must be adjusted from 1982 to 1987 (the base year), for B, from 1971 to 1987, and for C, from 1976 to 1987.

FIGURE 7.--Example of base year adjustment for Carroll County, Harrison Township (Y). Tonnages are hypothetical. See text for description of how adjustments were done.

The percentage of the production by civil township to be distributed to the three quadrangles is based on the relative amount of minable coal left in the ground in the four quadrangles. The minable reserves left in the ground in quadrangles A, B, C, and D are 50,000, zero, 700,000, and 250,000 tons, respectively, for a total of 1,000,000 tons. Civil township Y produced 200,000 tons of coal between 1971 and 1987, with 150,000 tons of this produced between 1976 and 1987. Between 1982 and 1987, 75,000 tons were produced in civil township Y. Therefore, $50,000/1,000,000$ or 5 percent of the 75,000 tons produced between 1982 and 1987 or 3,750 tons is assigned to quadrangle A to represent the production between 1982 and 1987 for this quadrangle. Because no coal is left in quadrangle B, no production is assigned to this quadrangle. For quadrangle C, $700,000/1,000,000$ or 70 percent of 150,000 tons produced between 1976 and 1982 equals 105,000 tons assigned to quadrangle C. For quadrangle D, $250,000/1,000,000$ or 25 percent of 75,000 tons equals 18,750 tons produced between 1982 and 1987 in civil township Y that will be assigned to quadrangle D.

The assumption is that the proportion of coal in the ground in the four quadrangles in township Y reflects the proportion of coal produced in the four quadrangles. This may not be necessarily true, but should be a good approximation. Once the production from the civil townships for a particular county and coal bed combination have been distributed to the appropriate 7.5-minute quadrangles, the total

distributed production is summed for the entire county and added to the total county production from one year after the base year to January 1, 1991.

Depletions: To determine the depletion of underground coal in the ground, active and abandoned underground mines were considered. The OGS has on file 7.5-minute maps outlining the location and extent of abandoned underground mines, updated through 1988. These mines were traced onto mylar maps and the areas were eliminated from consideration in the reserve calculation. Deep-coal production tonnages and coal lost to mining for 1989 and 1990 were calculated and depleted from the resource. Active underground mines were located and a reliability arc drawn so that the estimated maximum extent of the mine was within the arc, then the historical production plus coal lost to mining through December 31, 1990, was depleted from the in-ground, deep coal for that county/bed combination. Surface coals were depleted from either the base year or, if the resource information was taken from a previous study, the date the previous study was completed (fig. 7 and table 1).

Coal quality distribution: Movable reserve and recoverable coal tonnages allocated to sulfur and Btu categories were computed following the recommended procedures described in Development of a revised methodology to estimate the

TABLE 1.-Methods used in determining coal resources and reserves for each county and bed, by coal quality. Deep coals are depleted for 1989 and 1990, except for Pittsburgh resource data derived from Report of Investigations No. 105. Surface coals are depleted from January 1 of the date shown below.

GROUP 1 COUNTIES	Beds	Calculation by	Number of analyses	Surface coal depletion date
Belmont (Bt)	Washington (Wa)	County	177	1983
	Waynesburg (Wy)	Bed/County	31	1983
	Meigs Creek (MC)	Bed/County	44	1983
	Pittsburgh (Pb)	Bed/County	47	1974
	Anderson (An)	County	177	1983
	Upper Freeport (UF)	County	177	1983
	Lower Freeport (LF)	County	177	1983
	Middle Kittanning (MK)	Bed/County	10	1983
	Lower Kittanning (LK)	Bed/County	9	1983
	Clarion (Cl)	County	177	1983
	Brookville (Bkv)	County	177	1983
Carroll (Cl)	Upper Freeport (UF)	County	17	1983
	Lower Freeport (LF)	County	17	1983
	Middle Kittanning (MK)	County	17	1983
	Lower Kittanning (LK)	County	17	1983
	Brookville (Bkv)	County	17	1983
Columbiana (Ca)	Upper Freeport (UF)	Bed/County	16	1983
	Lower Freeport (LF)	County	41	1983
	Middle Kittanning (MK)	County	41	1983
	Lower Kittanning (LK)	Bed/County	7	1983
Guernsey (Gy)	Meigs Creek (MC)	County	83	1985
	Pittsburgh (Pb)	Bed/County	7	1974
	Anderson (An)	County	83	1985
	Upper Freeport (UF)	Bed/County	23	1985
	Lower Freeport (LF)	Bed/County	8	1985
	Middle Kittanning (MK)	Bed/County	19	1985
	Lower Kittanning (LK)	Bed/County	8	1985
Harrison (Hn)	Waynesburg (Wy)	County	85	1983
	Meigs Creek (MC)	Bed/County	11	1983
	Pittsburgh (Pb)	Bed/County	23	1974
	Upper Freeport (UF)	Bed/County	11	1983
	Lower Freeport (LF)	Bed/County	33	1983
	Middle Kittanning (MK)	County	85	1983
	Lower Kittanning (LK)	County	85	1983

Jackson (Jkn/Jk)	Upper Freeport (UF)	County	27	1989
	Middle Kittanning (MK)	County	27	1989
	Lower Kittanning (LK)	Bed/County	8	1989
	Clarion (Cl)	Bed/County	12	1989
	Brookville (Bkv)	County	27	1989
	Quakertown (Qkt)	County	10	1989
	Sharon (Sh)	Bed/County	7	1989
Jefferson (Jfn/Jf)	Waynesburg (Wy)	Bed/County	7	1983
	Meigs Creek (MC)	County	90	1983
	Pittsburgh (Pb)	Bed/County	51	1974
	Upper Freeport (UF)	County	90	1983
	Lower Freeport (LF)	County	90	1983
	Middle Kittanning (MK)	County	90	1983
	Lower Kittanning (LK)	Bed/County	15	1983
Mahoning (Mg)	Middle Kittanning (MK)	County	9	1983
	Lower Kittanning (LK)	County	9	1983
Meigs (Ms)	Redstone/Pomeroy (R/P)	Bed/County	7	1987
	Pittsburgh (Pb)	County	14	1987
	Clarion (Cl)	County	14	1987
Monroe (Me)	Washington (Wa)	County	50	1983
	Waynesburg (Wy)	County	50	1983
	Meigs Creek (MC)	County	50	1977
	Pittsburgh (Pb)	Bed/County	28	1974
	Upper Freeport (UF)	County	50	1977
	Lower Freeport (LF)	County	50	1977
	Middle Kittanning (MK)	County	50	1977
	Lower Kittanning (LK)	County	50	1977
	Brookville (Bkv)	County	50	1977
Noble (Ne)	Waynesburg (Wy)	County	65	1983
	Meigs Creek (MC)	Bed/County	28	1985
	Pittsburgh (Pb)	County	67	1974
	Upper Freeport (UF)	Bed/County	10	1985
	Lower Freeport (LF)	County	65	1985
	Middle Kittanning (MK)	Bed/County	12	1985
	Lower Kittanning (LK)	County	65	1985
	Brookville (Bkv)	County	65	1985
Pike (Pke/Pk)	Sharon (Sh)	Bed/Region	11	1985
Tuscarawas (Ts)	Upper Freeport (UF)	County	71	1983
	Lower Freeport (LF)	County	71	1983
	Middle Kittanning (MK)	Bed/County	40	1983
	Lower Kittanning (LK)	Bed/County	15	1983
	Brookville (Bkv)	County	71	1983

Vinton (Vn)	Upper Freeport (UF)	County	72	1984
	Middle Kittanning (MK)	Bed/County	15	1984
	Lower Kittanning (LK)	Bed/County	14	1984
	Clarion (Cl)	Bed/County	20	1984
	Brookville (Bkv)	Bed/County	8	1984
	Quakertown (Qkt)	Bed/Regional	13	1985

GROUP 2 COUNTIES

Gallia (Ga)	Redstone/Pomeroy (R/P)	County	28	1971
	Pittsburgh (Pb)	County	28	1971
	Upper Freeport (UF)	County	28	1971
	Middle Kittanning (MK)	County	28	1971
	Lower Kittanning (LK)	County	28	1971
	Clarion (Cl)	County	28	1984
Hocking (Hg)	Upper Freeport (UF)	County	23	1971
	Middle Kittanning (MK)	County	23	1971
	Lower Kittanning (LK)	County	23	1971
	Clarion (Cl)	County	23	1984
	Brookville (Bkv)	County	23	1971
	Quakertown (Qkt)	Bed/Region	13	1985
Lawrence (Le)	Redstone/Pomeroy (R/P)	County	43	1971
	Upper Freeport (UF)	County	43	1971
	Middle Kittanning (MK)	County	43	1971
	Lower Kittanning (LK)	County	43	1971
	Clarion (Cl)	County	43	1984
Scioto (So)	Middle Kittanning (MK)	County	63	1971
	Lower Kittanning (LK)	County	63	1971
	Clarion (Cl)	County	63	1984
	Sharon (Sh)	Bed/Region	11	1985

GROUP 3 COUNTIES

Athens (As)	Undifferentiated	County	19	1971
Coshocton (Cn)	Undifferentiated	County	56	1971
Holmes (Hs)	Undifferentiated	County	20	1971
Morgan (Mon/Mo)	Undifferentiated	County	14	1971
Muskingum (Mum/Mu)	Undifferentiated	County	70	1971
Perry (Py)	Undifferentiated	County	45	1971
Stark (Sk)	Undifferentiated	County	30	1971
Washington (Wn)	Undifferentiated	County	13	1971
Wayne (We)	Undifferentiated	County	22	1971

distribution of the Demonstrated Reserve Base (DRB) by quality, prepared by Science Applications International Corporation (1988) for the Energy Information Administration. According to this method, reserves are assigned at the bed/county level when there are eight or more samples available. If fewer than eight samples are available, the reserves are assigned to the county or bed/region level. For our study, the cut off was seven samples rather than eight in order to increase the number of distributions using the bed/county method. Table 1 lists the number of analyses and the method of calculation for each bed. For the county, bed/county, and bed/region methods, the areas of 7.5-minute quadrangles were considered cells (see Appendix I for an example of a bed/county calculation).

Chemical data were obtained from a database derived from information in OGS publications by Botoman and Stith (1978, 1981, 1986, and 1988) and from unpublished EIA coal chemical data. Only analyses which represented whole beds excluding partings greater than 3/8 inch, production benches, or run-of-mine were used.

RESULTS

This report contains three groups of data. The first group contains 14 counties (table 2) for which remaining

estimated economic resources, minable reserves, and recoverable coal have been calculated using nearly all post-1960 data readily available to us. These counties have coal production depleted from a base year or from the date that a particular study was completed. The estimated economic resource for Group 1 counties totals 17.627 billion short tons; 3.212 billion tons surface minable and 14.415 billion tons is deep minable (Table 2 and Appendix II). The minable reserve base, which is the estimated economic resource minus inaccessible (restricted) coal is 16.517 billion tons with 2.889 billion tons and 13.628 billion tons of surface and deep minable, respectively.

The second data group consists of four counties (table 1) for which specific coals have been updated using post-1960 information, and the remaining coals depleted from the 1971 EIA Coal Reserves Data Base using EIA production figures for 1971 through 1989, and 1990 OGS figures (S. L. Weisgarber, oral commun., 1991). For these four counties, minable reserve base and recoverable coal could not be calculated because inaccessible coals were not evaluated. The Group 2 counties account for an additional 1.969 billion short tons of estimated economic resource (Appendix III). Of this total, 0.909 billion tons are deep minable and 1.060 billion are surface minable.

The third group consists of nine counties (table 1) for which reserves have been depleted from the 1971 EIA Coal Reserves Data Base using EIA production figures for 1971

TABLE 2.-EIA Coal Reserve Data Base for Group 1 counties, by coal type and mining method.
Coal remaining as of January 1, 1991.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	>2.50	2047888519	1914772962	1003353476
Underground			1874763195	1761549647	880774824
Surface			173125324	153223315	122578652
TOTAL	>26	1.68 - 2.50	877433731	831343358	438933433
Underground			791540264	753804177	376902089
Surface			85893467	77539181	62031345
TOTAL	>26	0.84 - 1.67	384220988	360259760	206644641
Underground			287054513	271877225	135938613
Surface			97166475	88382535	70706028
TOTAL	>26	0.61 - 0.83	113378184	107956485	70930964
Underground			53653275	51447412	25723706
Surface			59724909	56509073	45207258
TOTAL	>26	0.41 - 0.60	83837285	78216195	50541232
Underground			42320426	40105748	20052874
Surface			41516859	38110447	30488358
TOTAL	23 - 25.99	>2.50	8504853176	8007449363	4418155479
Underground			6983203246	6626013371	3313006686
Surface			1521649930	1381435992	1105148794
TOTAL	23 - 25.99	1.68 - 2.50	2514095612	2348547394	1303400876
Underground			2023328090	1918123463	959061732
Surface			490767522	430423931	344339145
TOTAL	23 - 25.99	0.84 - 1.67	798575614	712754168	403174397
Underground			617170499	556763125	278381563
Surface			181405115	155991043	124792834
TOTAL	23 - 25.99	0.61 - 0.83	29410520	28686620	15893650
Underground			24162883	23518821	11759411
Surface			5247637	5167799	4134239
TOTAL	23 - 25.99	0.41 - 0.60	168142095	158903130	94685411
Underground			112635420	108123643	54061822
Surface			55506675	50779487	40623590

TOTAL	23 - 25.99	0.00 - 0.40	0	0	0
Underground			0	0	0
Surface			0	0	0
TOTAL	<23	>2.50	1444320255	1354525381	771463582
Underground			1100959561	1040522411	520261206
Surface			343360694	314002970	251202376
TOTAL	<23	1.68 - 2.50	413010115	381524713	203825242
Underground			357539109	337981761	168990881
Surface			55471006	43542952	34834362
TOTAL	<23	0.84 - 1.67	184435898	171523100	101576820
Underground			126598159	118805533	59402767
Surface			57837739	52717567	42174054
TOTAL	<23	0.61 - 0.83	37264743	35058159	24948216
Underground			10579573	10327703	5163852
Surface			26685170	24730456	19784365
TOTAL	<23	0.41 - 0.60	26011473	25037684	17402369
Underground			9174271	8759261	4379631
Surface			16837202	16278423	13022738
TOTAL	All Ranges	All Ranges	17626878208	16516558472	9124929787
Underground			14414682484	13627723301	6813861651
Surface			3212195724	2888835171	2311068137

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

Combined	6.3
Underground	5.5
Surface	9.9

through 1989 and 1990 OGS figures (S. L. Weisgarber, oral commun., 1991). For Group 3 counties, minable reserve base and recoverable coal were not calculated because inaccessible coals were not evaluated. The Group 3 counties contain 4.344 billion short tons of estimated economic resource (Appendix IV). Deep minable coal represents 2.620 billion tons and surface minable 1.724 billion tons of this total.

The results of this project indicate Ohio has 5.996 billion short tons of surface estimated economic coal resources and 17.943 billion short tons of underground estimated economic coal resources for a total of 23.932 billion short tons of coal resources. Table 3 contains the Ohio estimated economic resources distributed by sulfur and heat content. Approximately 64 percent of Ohio's estimated economic resources are in the highest sulfur category (>2.50 lbs sulfur/million Btu). Inaccessible coal which was determined for the 14 Group 1 counties represents 6.3 percent of the total estimated economic resource. For surface minable coals, 9.9 percent of the estimated economic resource is inaccessible, and for deep minable coal, 5.5 percent is inaccessible. Figure 8 compares the estimated economic resource and inaccessible coal for the group 1 counties.

CONCLUSIONS

The total estimated economic resource for Ohio determined from this study is 1.3 times larger than the 1991 EIA

TABLE 3.-Estimated Economic Resource for Ohio, by coal type and mining method. Coal remaining as of January 1, 1991.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	>26	>2.50	2229186062
Underground			1956917758
Surface			272268304
TOTAL	>26	1.68 - 2.50	924696001
Underground			816201746
Surface			108494255
TOTAL	>26	0.84 - 1.67	396518572
Underground			288421250
Surface			108097322
TOTAL	>26	0.61 - 0.83	163278566
Underground			79212275
Surface			84066291
TOTAL	>26	0.41 - 0.60	83837285
Underground			42320426
Surface			41516859
TOTAL	23 - 25.99	>2.50	10929960943
Underground			8293073697
Surface			2636887246
TOTAL	23 - 25.99	1.68 - 2.50	3541605949
Underground			2579128296
Surface			962477653
TOTAL	23 - 25.99	0.84 - 1.67	1478767487
Underground			1030761885
Surface			448005602
TOTAL	23 - 25.99	0.61 - 0.83	428388666
Underground			291271572
Surface			137117094
TOTAL	23 - 25.99	0.41 - 0.60	199029157
Underground			112681134
Surface			86348023

TOTAL	23 - 25.99	0.00 - 0.40	171831094
Underground			140711429
Surface			31119665
TOTAL	<23	>2.50	2136542126
Underground			1490461949
Surface			646080177
TOTAL	<23	1.68 - 2.50	931317034
Underground			644995603
Surface			286321431
TOTAL	<23	0.84 - 1.67	251792602
Underground			157348514
Surface			94444088
TOTAL	<23	0.61 - 0.83	45066942
Underground			10591002
Surface			34475940
TOTAL	<23	0.41 - 0.60	27653399
Underground			9174271
Surface			18479128
TOTAL	All Ranges	All Ranges	23939471885
Underground			17943272807
Surface			5996199078

* Million Btu/short ton

**Lbs sulfur/million Btu

COAL RESOURCES OF OHIO

Minable and Inaccessible

FIGURE 8.--Percentage of Estimated Economic Resource considered minable reserves or inaccessible (restricted) coal. See table 1 for key to county abbreviations.

Demonstrated Reserve Base. This increase is the direct result of new information incorporated into this study which was not available to EIA personnel. Figure 9 compares, by county, the 20-year-old 1971 EIA DRB with our data and indicates where the largest changes have occurred since 1971.

Inaccessible coal was determined in 14 counties. The percentage of inaccessible coal should be representative of the entire state. However, it should be kept in mind that certain categories of land-use restrictions such as highways and oil-and gas-well fields were not considered in this study. In some counties these unaccounted-for restrictions could be significant.

Approximately 64 percent of Ohio's estimated economic coal resources are in the high sulfur range (>2.50 lbs sulfur per million Btu), and 23 percent in the 1.68 - 2.50 sulfur range. Combined, these two ranges contain 87 percent of Ohio's coal resources.

1971 DRB AND 1991 EER

FIGURE 9.--Comparison of EIA's 1971 Demonstrated Reserve Base (DRB) and this report's 1991 Estimated Economic Resource (EER). See table 1 for key to county abbreviations.

REFERENCES

- Berryhill, Jr., H. L., 1963, Geology and coal resources of Belmont County, Ohio: U.S. Geological Survey Professional Paper 380, 113 p.
- Botoman, G., and Stith, D. A., 1978, Analyses of Ohio coals: Ohio Division of Geological Survey Information Circular No. 47, 148 P.
- Botoman, G., and Stith, D. A., 1981, Analyses of Ohio coals, 1977-1978: Ohio Division of Geological Survey Information Circular No. 50, 51 p.
- Botoman, G., and Stith, D. A., 1986, Analyses of Ohio coals, 1979-1980: Ohio Division of Geological Survey Information Circular No. 52, 26 p.
- Botoman, G., and Stith, D. A., 1988, Analyses of Ohio coals, 1982-1984: Ohio Division of Geological Survey Information Circular No. 55, 17 p.
- Brant, R. A., 1956, Coal resources of the upper part of the Allegheny formation in Ohio: Ohio Division of Geological Survey Report of Investigations No. 29, 68 p.
- Brant, R. A., and DeLong, R. M., 1960, Coal resources of Ohio: Ohio Division of Geological Survey Bulletin 58, 245 p.
- Couchot, M. L., 1978, Resources of the Pittsburgh (No. 8) coal in the Belmont field: Ohio Division of Geological Survey Report of Investigations No. 105, 12 p.
- Couchot, M. L., Crowell, D. L., Van Horn, R. G. and Struble, R. A., 1980, Investigation of the deep coal resources of portions of Belmont, Guernsey, Monroe, Noble, and Washington Counties, Ohio: Ohio Division of Geological Survey Report of Investigations No. 116, 49 p.
- Crowell, D. L., 1985, Coal-resource classification system as used by the Ohio Department of Natural Resources, Division of Geological Survey: Open File Report 85-1, 10 p.
- Decision Analysis Corporation of Virginia, 1990, Coal reserves assessment conference: Background, results and future: Prepared for U.S. Department of Energy, Energy Information Administration, 51 p.

- DeLong, R. M., 1965a, Geology of the Kensington quadrangle, Ohio: Ohio Division of Geological Survey Report of Investigation No. 55, map.
- DeLong, R. M., 1965b, Geology of the Malvern quadrangle, Ohio: Ohio Division of Geological Survey Report of Investigations No. 57, map with text.
- DeLong, R. M., 1967, Bedrock geology of the Minerva quadrangle, Stark, Columbiana, and Carroll Counties, Ohio: Ohio Division of Geological Survey Report of Investigations No. 65, map with text.
- DeLong, R. M., 1968, Bedrock geology of the Dellroy quadrangle, Carroll County, Ohio: Ohio Division of Geological Survey Report of Investigations No. 68, map with text.
- DeLong, R. M., 1969, Bedrock geology of the Carrollton quadrangle, Carroll County, Ohio: Ohio Division of Geological Survey Report of Investigations No. 71, map with text.
- DeLong, R. M., 1972, Bedrock geology of the Bergholz quadrangle, Carroll and Jefferson Counties, Ohio: Ohio Division of Geological Survey Report of Investigations No. 87, map with text.
- Krumin, P. O., Smith, W. H., Brant, R. A., and Amos, F., 1952, The Meigs Creek No. 9 coal bed in Ohio: Ohio Division of Geological Survey Report of Investigations No. 17, 163 p.
- Ohio Division of Geological Survey, 1980-1990, Report on Ohio mineral industries: Ohio Department of Natural Resources, Division of Geological Survey, Columbus, Ohio.
- Ohio Division of Mines, 1970-1979, Ohio Division of Mines Report: Ohio Department of Industrial Relations, Columbus, Ohio.
- Science Applications International Corporation, 1988, Development of a revised methodology to estimate the distribution of the Demonstrated Reserve Base (DRB) by quality: Final Report to the Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, U.S. Department of Energy, 5-15 p.
- Wells, R. B., 1972, Simplified method for calculation of mineral reserves or "The Pennsylvania planimeter eliminator": Pennsylvania Geology, Pennsylvania

Topographic and Geologic Survey, v. 3, no. 3, p. 2-5.

White, G. W., and Totten, S. M., 1985, Glacial geology of Columbiana County Ohio: Ohio Division of Geological Survey Report of Investigations No. 129, color map.

Wood, G. H., Jr., Kehn, T. M., Carter, M. D., and Culbertson, W. C., 1983, Coal resource classification system of the U.S. Geological Survey: U.S. Geological Survey Circular 891, 65 p.

APPENDIX I

Detailed example of calculation.

The following example explains the bed/county or bed/region method used in calculating the surface minable estimated economic resource, and distributing the tonnages to various sulfur and Btu categories. Similar calculations were used to obtain deep minable estimated economic resource, and surface and deep minable reserve base. The county method of computation is similar except coal thicknesses are not used. Much of the following example is only slightly modified from the explanation given in the Recommended Methodology section of the report by Decision Analysis Corporation of Virginia (1990). The Decision Analysis report explains the procedures in mathematically rigorous terms and presents the reasoning behind the methods used.

Example

There are seven coal chemical analyses available for the Lower Kittanning coal in Columbiana County (table 2). With seven or more analyses, the bed/county method of calculation can be used for distributing the coal resource tonnages to the appropriate sulfur and Btu categories. We determined that the Lower Kittanning coal in Columbiana County contains 77,444,725 tons of surface estimated economic resource. Each coal chemical analysis is assigned to the appropriate chemical category identical to the sulfur and Btu categories found in Appendices II, III, and IV. The seven chemical analyses (samples A,B,C,D,E,F, and G) belong to the following chemical categories:

23 to 25.99 Btu* and >2.50 sulfur**: Samples A and B.
>26 Btu* and 1.68 to 2.50 sulfur**: Samples C and D.
>26 Btu* and >2.50 sulfur**: Samples E, F, and G.

* = million Btu/short ton
** = lbs sulfur/million Btu

A cell represents the area-of-influence of the samples assigned to the chemical categories. In this report 7.5-minute quadrangles were chosen as cells. In this example there are four cells containing at least one sample. In this example there are four cells containing at least one sample. Thus, the 77,444,725 tons of resources are divided into four shares, and weighted according to seam thickness. The calculations are as follows:

R = share of resources to be assigned to each of the four cells.

Rk = total resources (i.e. 77,444,725 tons).

M = total number cells containing at least one sample.

Sk = average seam thickness for the seven samples (40.67 inches)

Sj = average seam thickness for the samples in each cell.

$$R = (Rk/M) (Sj/Sk)$$

Cell no. 1 contains sample A

Cell no. 2 contains samples B, C, and D.

Cell no. 3 contains sample E.

Cell no. 4 contains samples F and G.

tons

$$R(\text{cell 1}) = (77,444,725/4) (114/40.67) = 54,270,338$$

tons

$$R(\text{cell 2}) = (77,444,725/4) (26.3/40.67) = 12,520,262$$

tons

$$R(\text{cell 3}) = (77,444,725/4) (39.0/40.67) = 18,566,168$$

tons

$$R(\text{cell 4}) = (77,444,725/4) (26.4/40.67) = 12,567,868$$

Next, the resources assigned to each cell are subdivided into X shares, where X is the number of samples contained in each cell. The size of each share is found by the following equation:

Rs = share of resources to be assigned to each sample within a cell.

R = total share of resources assigned to each cell.

N = total number of samples in each cell.

Ss = seam thickness for each sample.

Sj = average seam thickness for all samples in each cell.

$$Rs = (R/N) (Ss/Sj)$$

$$\begin{aligned}Rs(\text{sample A}) &= (54,270,338/1) (114/114) = 54,270,338 \text{ tons} \\Rs(\text{sample B}) &= (12,520,262/3) (22.6/26.3) = 3,586,285 \text{ tons} \\Rs(\text{sample C}) &= (12,520,262/3) (28.3/26.3) = 4,490,791 \text{ tons} \\Rs(\text{sample D}) &= (12,520,262/3) (28.0/26.3) = 4,443,186 \text{ tons} \\Rs(\text{sample E}) &= (18,566,168/1) (39.0/39.0) = 18,566,168 \text{ tons} \\Rs(\text{sample F}) &= (12,567,868/2) (29.0/26.4) = 6,902,806 \text{ tons} \\Rs(\text{sample G}) &= (12,567,868/2) (23.8/26.4) = 5,665,062 \text{ tons}\end{aligned}$$

Now, the tonnages are added for each sample that is in the same chemical category.

Sample A+B = 57,856,623 tons
Sample C+D = 8,933,977 tons
Sample E+F+G = 31,134,036 tons
TOTAL = 97,924,636 distributed tons.

NOTE: The distributed tonnage is larger than the original raw 77,444,725 tons because the weighting factor of the coal thicknesses. In this report, percentages of inaccessible coal reported at the bottom of appendix II are based on 100 X the raw inaccessible tonnages divided by the distributed resources. These percentages are not directly comparable to the percent total inaccessible coal found by subtracting minable reserve base from the estimated economic resource.

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Belmont County.

	Std Btu Range [†]	Std Sulfur Range ^{**}	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	>2.50	451142400	432710789	223810886
Underground			424432904	407859150	203929575
Surface			26709496	24851639	19881311
TOTAL	>26	1.68 - 2.50	235657251	226689258	116210409
Underground			225081721	217136657	108568329
Surface			10575530	9552601	7642081
TOTAL	>26	0.84 - 1.67	182331095	174211567	87351784
Underground			181479585	173391565	86695783
Surface			851510	820002	656002
TOTAL	>26	0.61 - 0.83	2679788	2550964	1521483
Underground			1828278	1730962	865481
Surface			851510	820002	656002
TOTAL	23 - 25.99	>2.50	2026725119	1945213673	1046830803
Underground			1762639696	1697800453	848900227
Surface			264085423	247413220	197930576
TOTAL	23 - 25.99	1.68 - 2.50	687225696	659114163	367051429
Underground			555726557	534133005	267066503
Surface			131499139	124981158	99984926
TOTAL	23 - 25.99	0.84 - 1.67	15732988	15085559	9583434
Underground			8616937	8283376	4141688
Surface			7116051	6802183	5441746
TOTAL	23 - 25.99	0.61 - 0.83	2679788	2550964	1521483
Underground			1828278	1730962	865481
Surface			851510	820002	656002
TOTAL	<23	>2.50	376948145	361981334	208387562
Underground			281341914	270658350	135329175
Surface			95606231	91322984	73058387
TOTAL	<23	1.68 - 2.50	252701152	242069163	129969687
Underground			221566389	212285479	106142740
Surface			31134763	29783684	23826947

TOTAL	<23	0.84 - 1.67	6029524	5739668	3423335
Underground			4113626	3894664	1947332
Surface			1915898	1845004	1476003
TOTAL	<23	0.61 - 0.83	5473620	5258764	3571974
Underground			2186914	2116790	1058395
Surface			3286706	3141974	2513579
TOTAL	All Ranges	All Ranges	4245326566	4073175866	2199234269
Underground			3670842799	3531021413	1765510707
Surface			574483767	542154453	433723562

* Million Btu/short ton

**Lbs sulfur/ million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use)	3.8
Surface (Land use)	5.3
Underground (Environmental)	0.0
Surface (Environmental)	0.4

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Carroll County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	>2.50	114965385	108333639	63417592
Underground			80782700	77497732	38748866
Surface			34182685	30835907	24668726
TOTAL	>26	1.68 - 2.50	22993077	21666727	12683518
Underground			16156540	15499546	7749773
Surface			6836537	6167181	4933745
TOTAL	>26	0.84 - 1.67	38321794	36111214	21139198
Underground			26927566	25832578	12916289
Surface			11394228	10278636	8222909
TOTAL	23 - 25.99	>2.50	341063967	321389794	188138854
Underground			239655338	229909937	114954969
Surface			101408629	91479857	73183886
TOTAL	23 - 25.99	1.68 - 2.50	38321794	36111214	21139198
Underground			26927566	25832578	12916289
Surface			11394228	10278636	8222909
TOTAL	23 - 25.99	0.84 - 1.67	210769869	198611671	116265584
Underground			148101615	142079175	71039588
Surface			62668254	56532496	45225997
TOTAL	23 - 25.99	0.41 - 0.60	153287177	144444850	84556787
Underground			107710265	103330309	51665155
Surface			45576912	41114541	32891633
TOTAL	All Ranges	All Ranges	919723063	866669109	507340731
Underground			646261590	619981855	309990928
Surface			273461473	246687254	197349803

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use)	4.1
Surface (Land use)	9.8
Underground (Environmental)	0.0
Surface (Environmental)	0.0

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Columbiana County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	>2.50	147102003	129777346	74459104
Underground			110812518	97875909	48937955
Surface			36289485	31901437	25521150
TOTAL	>26	1.68 - 2.50	66752699	59473583	36418362
Underground			41926690	37201680	18600840
Surface			24826009	22271903	17817522
TOTAL	>26	0.84 - 1.67	106380467	96517472	65258418
Underground			44254540	39851866	19925933
Surface			62125927	56665606	45332485
TOTAL	23 - 25.99	>2.50	446646247	398475682	244676116
Underground			278234507	247014767	123507384
Surface			168411740	151460915	121168732
TOTAL	23 - 25.99	1.68 - 2.50	107560064	97457548	65971432
Underground			44422059	39982023	19991012
Surface			63138005	57475525	45980420
TOTAL	23 - 25.99	0.84 - 1.67	21502637	18917764	13142497
Underground			7476904	6639047	3319524
Surface			14025733	12278717	9822974
TOTAL	<23	>2.50	20568098	18725999	12622651
Underground			8717439	7860495	3930248
Surface			11850659	10865504	8692403
TOTAL	All Ranges	All Ranges	916512215	819345394	512548579
Underground			535844657	476425787	238212894
Surface			380667558	342919607	274335686

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use)	9.3
Surface (Land use)	7.8
Underground (Environmental)	0.0
Surface (Environmental)	1.0

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Guernsey County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	>2.50	13480617	12877241	6734358
Underground			12414750	11891448	5945724
Surface			1065867	985793	788634
TOTAL	>26	1.68 - 2.50	29849915	29065324	15035330
Underground			28077794	27389763	13694882
Surface			1772121	1675561	1340449
TOTAL	>26	0.41 - 0.60	2808529	2341965	1230656
Underground			2300759	2143053	1071527
Surface			507770	198912	159130
TOTAL	23 - 25.99	>2.50	799957707	761991208	406282948
Underground			710674990	677700062	338850031
Surface			89282717	84291146	67432917
TOTAL	23 - 25.99	1.68 - 2.50	195927533	185611207	99179381
Underground			173318727	164365281	82182641
Surface			22608806	21245926	16996741
TOTAL	23 - 25.99	0.84 - 1.67	42661732	39999615	22524442
Underground			33893133	31584166	15792083
Surface			8768599	8415449	6732359
TOTAL	23 - 25.99	0.61 - 0.83	2450672	2290628	1267470
Underground			2022254	1883441	941721
Surface			428418	407187	325750
TOTAL	23 - 25.99	0.41 - 0.60	226554	226554	172088
Underground			30518	30518	15259
Surface			196036	196036	156829
TOTAL	<23	>2.50	269817988	255460934	135747097
Underground			241217705	228738833	114369417
Surface			28600283	26722101	21377681

TOTAL	23	1.68 - 2.50	3904236	3645248	2004335
Underground			3264176	3039545	1519773
Surface			640060	605703	484562
TOTAL	All Ranges	All Ranges	1361085483	1293509924	690178106
Underground			1207214806	1148766110	574383055
Surface			153870677	144743814	115795051

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use) 4.8

Surface (Land use) 5.7

Underground (Environmental) 0.0

Surface (Environmental) 0.0

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Harrison County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	>2.50	138371921	133259478	68037708
Underground			132817387	128566247	64283124
Surface			5554534	4693231	3754585
TOTAL	>26	1.68 - 2.50	135068072	129931517	66326432
Underground			129655605	125395938	62697969
Surface			5412467	4535579	3628463
TOTAL	>26	0.84 - 1.67	10177994	9856377	4980495
Underground			9978482	9682023	4841012
Surface			199512	174354	139483
TOTAL	23 - 25.99	>2.50	607346537	582325715	298836242
Underground			576506760	556747767	278373884
Surface			30839777	25577948	20462358
TOTAL	23 - 25.99	1.68 - 2.50	403346062	386340912	199410079
Underground			378365865	365542170	182771085
Surface			24980197	20798742	16638994
TOTAL	23 - 25.99	0.84 - 1.67	295098171	247919726	128502510
Underground			276651664	232777570	116388785
Surface			18446507	15142156	12113725
TOTAL	23 - 25.99	0.61 - 0.83	5602649	5383079	2707198
Underground			5540110	5330883	2665442
Surface			62539	52196	41757
TOTAL	<23	>2.50	9078527	8673655	4450498
Underground			8612430	8294752	4147376
Surface			466097	378903	303122
TOTAL	<23	1.68 - 2.50	6236668	5973929	3095787
Underground			5800523	5611186	2805593
Surface			436145	362743	290194

TOTAL	: <23	0.84 - 1.67	:	29337213	28025802	14390065
Underground	:		:	27792882	26768590	13384295
Surface	:		:	1544331	1257212	1005770
TOTAL	: All Ranges	All Ranges	:	1639663814	1537690190	790737014
Underground	:		:	1551721708	1464717126	732358563
Surface	:		:	87942106	72973064	58378451

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use)	3.5
Surface (Land use)	18.8

Underground (Environmental)	0.0
Surface (Environmental)	0.0

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Jackson County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	23 - 25.99	>2.50	78052667	71947664	52188433
Underground			18297060	17898993	8949497
Surface			59755607	54048671	43238937
TOTAL	23 - 25.99	1.68 - 2.50	26378064	24364404	17637042
Underground			6259825	6181604	3090802
Surface			20118239	18182800	14546240
TOTAL	23 - 25.99	0.84 - 1.67	32142672	21608274	15640677
Underground			5599469	5486473	2743237
Surface			26543203	16121801	12897441
TOTAL	23 - 25.99	0.41 - 0.60	9807524	9412321	6574498
Underground			3316167	3184531	1592266
Surface			6491357	6227790	4982232
TOTAL	<23	>2.50	79363992	69929154	51322096
Underground			19110070	15404090	7702045
Surface			60253922	54525064	43620051
TOTAL	<23	1.68 - 2.50	6185301	5735126	4096161
Underground			1676127	1639798	819899
Surface			4509174	4095328	3276262
TOTAL	<23	0.84 - 1.67	48344367	45506775	32259721
Underground			14265767	13818996	6909498
Surface			34078600	31687779	25350223
TOTAL	<23	0.61 - 0.83	29933651	27941923	19984353
Underground			8079031	7897285	3948643
Surface			21854620	20044638	16035710
TOTAL	<23	0.41 - 0.60	25136106	24162317	16702966
Underground			9171301	8756291	4378146
Surface			15964805	15406026	12324821

TOTAL	: All Ranges	All Ranges	:	335344344	300607958	216405948
Underground	:		:	85774817	80268061	40134031
Surface	:		:	249569527	220339897	176271918

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (landuse) 2.6

Surface (Land use) 8.5

Underground (Environmental) 0.0

Surface (Environmental) 0.0

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Jefferson County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	>2.50	305734268	275827087	142029085
Underground			285162122	262108615	131054308
Surface			20572146	13718472	10974778
TOTAL	>26	1.68 - 2.50	159197560	145650616	75268770
Underground			148397850	137505744	68752872
Surface			10799710	8144872	6515898
TOTAL	>26	0.84 - 1.67	15776718	13696331	7390027
Underground			12754990	11890126	5945063
Surface			3021728	1806205	1444964
TOTAL	>26	0.61 - 0.83	11071673	10006215	5252142
Underground			9863222	9176100	4588050
Surface			1208451	830115	664092
TOTAL	>26	0.41 - 0.60	20694802	18271355	9744844
Underground			17437356	16240801	8120401
Surface			3257446	2030554	1624443
TOTAL	23 - 25.99	>2.50	448839681	402367924	209906022
Underground			406363525	373294390	186647195
Surface			42476156	29073534	23258827
TOTAL	23 - 25.99	1.68 - 2.50	212032805	189590158	99176983
Underground			190486644	174983810	87491905
Surface			21546161	14606348	11685078
TOTAL	23 - 25.99	0.84 - 1.67	53766419	48208207	27594811
Underground			48142878	44306129	22153065
Surface			5623541	3902078	5441746
TOTAL	<23	>2.50	40476662	36879499	19797451
Underground			35217801	32353827	16176914
Surface			5258861	4525672	3620538

TOTAL	<23	1.68 - 2.50	3146900	2867828	1485691
Underground			2933901	2695237	1347619
Surface			212999	172591	138073
TOTAL	<23	0.84 - 1.67	86642658	78941068	42526525
Underground			74840378	68754432	34377216
Surface			11802280	10186636	8149309
TOTAL	All Ranges	All Ranges	1357380146	1223306288	637852267
Underground			1231600667	1133309211	566654606
Surface			125779479	88997077	71197662

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use)	7.8
Surface (Land use)	28.9
Underground (Environmental)	0.0
Surface (Environmental)	0.7

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Mahoning County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	0.84 - 1.67	30166976	28801438	19782866
Underground			11291155	10860947	5430474
Surface			18875821	17940491	14352393
TOTAL	>26	0.61 - 0.83	90500930	86404313	59348598
Underground			33873466	32582841	16291421
Surface			56627464	53821472	43057178
TOTAL	>26	0.41 - 0.60	60333954	57602875	39565732
Underground			22582311	21721894	10860947
Surface			37751643	35880981	28704785
TOTAL	23 - 25.99	>2.50	45250465	43202157	29674299
Underground			16936733	16291421	8145711
Surface			28313732	26910736	21528589
TOTAL	<23	>2.50	15083489	14400720	9891434
Underground			5645578	5430474	2715237
Surface			9437911	8970246	7176197
TOTAL	All Ranges	All Ranges	241335814	230411503	158262929
Underground			90329243	86887577	43443789
Surface			151006571	143523926	114819141

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use) 3.8

Surface (Land use) 5.0

Underground (Environmental) 0.0

Surface (Environmental) 0.0

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Meigs County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	23 - 25.99	>2.50	197942568	190923882	109060556
Underground			150119326	145595165	72797583
Surface			47823242	45328717	36262974
TOTAL	23 - 25.99	1.68 - 2.50	145196327	139878585	79994721
Underground			109786834	106360491	53180246
Surface			35409493	33518094	26814475
TOTAL	23 - 25.99	0.84 - 1.67	53008686	50786656	29197737
Underground			39534736	38105294	19052647
Surface			13473950	12681362	10145090
TOTAL	<23	>2.50	84827354	84705853	46809004
Underground			69954618	69852261	34926131
Surface			14872736	14853592	11882874
TOTAL	<23	1.68 - 2.50	8482736	8470585	4680900
Underground			6995462	6985226	3492613
Surface			1487274	1485359	1188287
TOTAL	All Ranges	All Ranges	489457671	474765561	269742918
Underground			376390976	366898437	183449219
Surface			113066695	107867124	86293699

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use) 2.5

Surface (Land use) 4.3

Underground (Environmental) 0.0

Surface (Environmental) 0.2

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Monroe County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	>2.50	766724767	714674811	363535782
Underground			744063999	694013555	347006778
Surface			22660768	20661256	16529005
TOTAL	23 - 25.99	>2.50	1692596833	1576470388	802500579
Underground			1640673101	1528919106	764459553
Surface			51923732	47551282	38041026
TOTAL	23 - 25.99	1.68 - 2.50	184030783	170281282	87226494
Underground			176640771	163328438	81664219
Surface			7390012	6952844	5562275
TOTAL	23 - 25.99	0.84 - 1.67	18272560	16907363	8660788
Underground			17538799	16217009	8108505
Surface			733761	690354	552283
TOTAL	<23	>2.50	311938700	288632809	147851999
Underground			299412368	276847493	138423747
Surface			12526332	11785316	9428253
TOTAL	<23	1.68 - 2.50	54817682	50722084	25982360
Underground			52616401	48651025	24325513
Surface			2201281	2071059	1656847
TOTAL	All Ranges	All Ranges	3028381325	2817688737	1435758002
Underground			2930945439	2727976626	1363988313
Surface			97435886	89712111	71769689

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use)	7.0
Surface (Land use)	5.8

Underground (Environmental)	0.0
Surface (Environmental)	2.2

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Noble County.

	Std Btu Range ^a	Std Sulfur Range ^{a*}	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	>2.50	56193033	53756019	26994718
Underground			55804004	53366990	26683495
Surface			389029	389029	311223
TOTAL	>26	1.68 - 2.50	175665945	167191921	83749450
Underground			175154312	166680288	83340144
Surface			511633	511633	409306
TOTAL	>26	0.61 - 0.83	8333184	8202384	4175461
Underground			8085620	7954820	3977410
Surface			247564	247564	198051
TOTAL	23 - 25.99	>2.50	1021148988	995590929	550068904
Underground			846552020	821346130	410673065
Surface			174596968	174244799	139395839
TOTAL	23 - 25.99	1.68 - 2.50	250727507	242429215	121691699
Underground			249137203	240838911	120419456
Surface			1590304	1590304	1272243
TOTAL	23 - 25.99	0.84 - 1.67	10425658	10276607	5180743
Underground			10284193	10135142	5067571
Surface			141465	141465	113172
TOTAL	23 - 25.99	0.61 - 0.83	13866523	13670284	6884655
Underground			13701481	13505242	6752621
Surface			165042	165042	132034
TOTAL	<23	>2.50	141336661	140307293	83139997
Underground			97961937	97019459	48509730
Surface			43374724	43287834	34630267
TOTAL	<23	1.68 - 2.50	56561630	55787349	28005078
Underground			56190284	55416003	27708002
Surface			371346	371346	297077

TOTAL	:	All Ranges	All Ranges	:	1734259129	1687212001	909890705
Underground	:			:	1512871054	1466262985	733131493
Surface	:			:	221388075	220949016	176759213

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use)	3.3
Surface (Land use)	0.2

Underground (Environmental)	0.0
Surface (Environmental)	0.0

APPENDIX II

EIA Coal Reserve Data Base, by county, for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Pike County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	0.61 - 0.83	792609	792609	633281
Underground			2689	2689	1345
Surface			789920	789920	631936
TOTAL	23 - 25.99	0.61 - 0.83	1007080	1007080	804639
Underground			3417	3417	1709
Surface			1003663	1003663	802930
TOTAL	23 - 25.99	0.41 - 0.60	297228	297228	237480
Underground			1008	1008	504
Surface			296220	296220	236976
TOTAL	<23	0.84 - 1.67	1645829	1645829	1314988
Underground			5584	5584	2792
Surface			1640245	1640245	1312196
TOTAL	<23	0.61 - 0.83	979105	979105	782287
Underground			3322	3322	1661
Surface			975783	975783	780626
TOTAL	<23	0.41 - 0.60	875367	875367	699403
Underground			2970	2970	1485
Surface			872397	872397	697918
TOTAL	All Ranges	All Ranges	5597218	5597218	4472077
Underground			18990	18990	9495
Surface			5578228	5578228	4462582

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use)	0.0
Surface (Land use)	0.0

Underground (Environmental)	0.0
Surface (Environmental)	0.0

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Tuscarawas County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	>2.50	54174125	53556552	34334241
Underground			28472811	28370001	14185001
Surface			25701314	25186551	20149241
TOTAL	>26	1.68 - 2.50	50580315	50005515	32082918
Underground			26500171	26404980	13202490
Surface			24080144	23600535	18880428
TOTAL	23 - 25.99	>2.50	548400208	534686447	359633879
Underground			228407180	227050928	113525464
Surface			319993028	307635519	246108415
TOTAL	23 - 25.99	1.68 - 2.50	203731350	200798817	133338872
Underground			91450697	91000604	45500302
Surface			112280653	109798213	87838570
TOTAL	23 - 25.99	0.84 - 1.67	34568644	34198871	22263955
Underground			17038646	16983806	8491903
Surface			17529998	17215065	13772052
TOTAL	<23	>2.50	12730407	12451020	9045606
Underground			3088081	3050699	1525350
Surface			9642326	9400321	7520257
TOTAL	<23	1.68 - 2.50	1450370	1440051	1010045
Underground			473319	473319	236660
Surface			977051	966732	773386
TOTAL	<23	0.84 - 1.67	11725922	11605059	7618835
Underground			5567286	5550706	2775353
Surface			6158636	6054353	4843482
TOTAL	All Ranges	All Ranges	917361341	898742332	599328353
Underground			400998191	398885043	199442522
Surface			516363150	499857289	399885831

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use) 0.5
Surface (Land use) 2.3

Underground (Environmental) 0.0
Surface (Environmental) 0.0

APPENDIX II

EIA Coal Reserve Data Base, by county for Ohio: Group 1 counties. Coal remaining as of January 1, 1991. Vinton County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource	Minable Reserve Base	Recoverable Coal
TOTAL	>26	1.68 - 2.50	1668897	1668897	1158243
Underground			589581	589581	294791
Surface			1079316	1079316	863453
TOTAL	>26	0.84 - 1.67	1065944	1065361	741853
Underground			368195	368120	184060
Surface			697749	697241	557793
TOTAL	23 - 25.99	>2.50	250882189	182863900	120357844
Underground			108143010	86444252	43222126
Surface			142739179	96419648	77135718
TOTAL	23 - 25.99	1.68 - 2.50	59617627	16569889	11583547
Underground			20805342	5574548	2787274
Surface			38812285	10995341	8796273
TOTAL	23 - 25.99	0.84 - 1.67	10625578	10233855	6937303
Underground			4291525	4165938	2082969
Surface			6334053	6067917	4854334
TOTAL	23 - 25.99	0.61 - 0.83	3803808	3784585	2708205
Underground			1067343	1064876	532438
Surface			2736465	2719709	2175767
TOTAL	23 - 25.99	0.41 - 0.60	4523612	4522177	3144559
Underground			1577462	1577277	788639
Surface			2946150	2944900	2355920
TOTAL	<23	>2.50	82150232	62377111	42398185
Underground			30679620	25011678	12505839
Surface			51470612	37365433	29892346
TOTAL	<23	1.68 - 2.50	19523440	4813350	3495197
Underground			6022527	1184943	592472
Surface			13500913	3628407	2902726

TOTAL	<23	0.84 - 1.67	710385	58899	43351
Underground			12636	12561	6281
Surface			697749	46338	37070
TOTAL	<23	0.61 - 0.83	878367	878367	609602
Underground			310306	310306	155153
Surface			568061	568061	454449
TOTAL	All Ranges	All Ranges	435450079	288836391	193177889
Underground			173867547	126304080	63152040
Surface			261582532	162532311	130025849

* Million Btu/short ton

**Lbs sulfur/million Btu

INACCESSIBLE PERCENTAGE

(See note at bottom of Appendix I)

Underground (land use)	22.9
Surface (Land use)	29.3

Underground (Environmental)	0.0
Surface (Environmental)	0.4

APPENDIX III

EIA Estimated Economic Resource, by county for Ohio: Group 2 counties. Coal remaining as of January 1, 1991. Gallia County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	23 - 25.99	>2.50	239426029
Underground			127874468
Surface			111551561
TOTAL	23 - 25.99	1.68 - 2.50	10366901
Underground			5536833
Surface			4830068
TOTAL	23 - 25.99	0.84 - 1.67	180595181
Underground			166104978
Surface			14490203
TOTAL	<23	>2.50	161427447
Underground			86216394
Surface			75211053
TOTAL	<23	1.68 - 2.50	32105805
Underground			29529774
Surface			2576031
TOTAL	<23	0.84 - 1.67	41467601
Underground			22147331
Surface			19320270
TOTAL	All Ranges	All Ranges	665388964
Underground			437409778
Surface			227979186

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX III

EIA Estimated Economic Resource, by county for Ohio: Group 2 counties.
Coal remaining as of January 1, 1991. Hocking County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	23 - 25.99	>2.50	24303357
Underground			37143
Surface			24266214
TOTAL	23 - 25.99	1.68 - 2.50	25610436
Underground			39048
Surface			25571388
TOTAL	23 - 25.99	0.84 - 1.67	20185499
Underground			30476
Surface			20155023
TOTAL	23 - 25.99	0.61 - 0.83	3797074
Underground			5714
Surface			3791360
TOTAL	23 - 25.99	0.41 - 0.60	30013772
Underground			45714
Surface			29968058
TOTAL	<23	>2.50	19048
Underground			19048
Surface			0
TOTAL	<23	1.68 - 2.50	122496880
Underground			0
Surface			122496880
TOTAL	<23	0.84 - 1.67	7509719
Underground			11429
Surface			7498290
TOTAL	<23	0.61 - 0.83	7505676
Underground			11429
Surface			7494247
TOTAL	All Ranges	All Ranges	241441461
Underground			200001
Surface			241241460

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX III

EIA Estimated Economic Resource, by county for Ohio: Group 2 counties.
Coal remaining as of January 1, 1991. Lawrence County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	23 - 25.99	>2.50	267559197
Underground			88753643
Surface			178805554
TOTAL	23 - 25.99	1.68 - 2.50	88716997
Underground			29428840
Surface			59288157
TOTAL	23 - 25.99	0.84 - 1.67	241272679
Underground			80033987
Surface			161238692
TOTAL	23 - 25.99	0.61 - 0.83	65716295
Underground			21799141
Surface			43917154
TOTAL	<23	>2.50	143637043
Underground			47646693
Surface			95990350
TOTAL	<23	1.68 - 2.50	241329971
Underground			200863451
Surface			40466520
TOTAL	All Ranges	All Ranges	1048232182
Underground			468525755
Surface			579706427

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX III

EIA Estimated Economic Resource, by county for Ohio: Group 2 counties.
Coal remaining as of January 1, 1991. Scioto County.

	Std Btu Range [†]	Std Sulfur Range ^{†*}	Est Econ Resource
TOTAL	>26	0.61 - 0.83	790729
Underground			
Surface			790729
TOTAL	23 - 25.99	>2.50	2620211
Underground			843057
Surface			1777154
TOTAL	23 - 25.99	1.68 - 2.50	834265
Underground			268426
Surface			565839
TOTAL	23 - 25.99	0.84 - 1.67	2237067
Underground			719780
Surface			1517287
TOTAL	23 - 25.99	0.61 - 0.83	1668914
Underground			222694
Surface			1446220
TOTAL	23 - 25.99	0.41 - 0.60	873290
Underground			
Surface			873290
TOTAL	<23	>2.50	1223589
Underground			393692
Surface			829897
TOTAL	<23	1.68 - 2.50	475840
Underground			153102
Surface			322738
TOTAL	<23	0.84 - 1.67	1078848
Underground			23860
Surface			1054988
TOTAL	<23	0.61 - 0.83	296523
Underground			
Surface			296523

TOTAL	<23	0.41 - 0.60	1641926
Underground			
Surface			1641926
TOTAL	All Ranges	All Ranges	13741202
Underground			2624611
Surface			11116591

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX IV

EIA Estimated Economic Resource, by county for Ohio: Group 3 counties.
Coal remaining as of January 1, 1991. Athens County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	23 - 25.99	>2.50	257746641
Underground			211067143
Surface			46679498
TOTAL	23 - 25.99	1.68 - 2.50	315023672
Underground			257970952
Surface			57052720
TOTAL	23 - 25.99	0.84 - 1.67	85915547
Underground			70355714
Surface			15559833
TOTAL	23 - 25.99	0.61 - 0.83	257746641
Underground			211067143
Surface			46679498
TOTAL	23 - 25.99	0.00 - 0.40	171831094
Underground			140711429
Surface			31119665
TOTAL	<23	>2.50	114554063
Underground			93807619
Surface			20746444
TOTAL	All Ranges	All Ranges	1202817658
Underground			984980000
Surface			217837658

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX IV

EIA Estimated Economic Resource, by county for Ohio: Group 3 counties.
Coal remaining as of January 1, 1991. Coshocton County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	>26	>2.50	19687293
Underground			2088876
Surface			17598417
TOTAL	>26	1.68 - 2.50	12826569
Underground			1360934
Surface			11465635
TOTAL	>26	0.84 - 1.67	10937385
Underground			1160487
Surface			9776898
TOTAL	23 - 25.99	>2.50	179025102
Underground			18995055
Surface			160030047
TOTAL	23 - 25.99	1.68 - 2.50	55407795
Underground			5878919
Surface			49528876
TOTAL	23 - 25.99	0.84 - 1.67	13920308
Underground			1476983
Surface			12443325
TOTAL	<23	>2.50	19389000
Underground			2057226
Surface			17331774
TOTAL	<23	1.68 - 2.50	13945165
Underground			1479620
Surface			12465545
TOTAL	<23	0.84 - 1.67	2982923
Underground			316496
Surface			2666427
TOTAL	All Ranges	All Ranges	328121540
Underground			34814596
Surface			293306944

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX IV

EIA Estimated Economic Resource, by county for Ohio: Group 3 counties.
Coal remaining as of January 1, 1991. Holmes County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	126	12.50	2520596
Underground			412500
Surface			2108096
TOTAL	126	0.84 - 1.67	1260298
Underground			206250
Surface			1054048
TOTAL	23 - 25.99	12.50	55453121
Underground			9075000
Surface			46378121
TOTAL	23 - 25.99	1.68 - 2.50	30247157
Underground			4950000
Surface			25297157
TOTAL	23 - 25.99	0.61 - 0.83	1260298
Underground			206250
Surface			1054048
TOTAL	All Ranges	All Ranges	90741470
Underground			14850000
Surface			75891470

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX IV

EIA Estimated Economic Resource, by county for Ohio: Group 3 counties.
Coal remaining as of January 1, 1991. Morgan County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	23 - 25.99	>2.50	455720188
Underground			319438500
Surface			136281688
TOTAL	<23	>2.50	80421210
Underground			56371500
Surface			24049710
TOTAL	All Ranges	All Ranges	536141398
Underground			375810000
Surface			160331398

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX IV

EIA Estimated Economic Resource, by county for Ohio: Group 3 counties.
Coal remaining as of January 1, 1991. Muskingum County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	>26	>2.50	8558975
Underground			5825137
Surface			2733838
TOTAL	>26	1.68 - 2.50	34235899
Underground			23300548
Surface			10935351
TOTAL	23 - 25.99	>2.50	481595173
Underground			327767982
Surface			153827191
TOTAL	23 - 25.99	1.68 - 2.50	98428211
Underground			66989077
Surface			31439134
TOTAL	23 - 25.99	0.84 - 1.67	70458704
Underground			47953361
Surface			22505343
TOTAL	<23	>2.50	106987186
Underground			72814214
Surface			34172972
TOTAL	<23	1.68 - 2.50	12838463
Underground			8737706
Surface			4100757
TOTAL	<23	0.84 - 1.67	8558975
Underground			5825137
Surface			2733838
TOTAL	All Ranges	All Ranges	821661586
Underground			559213162
Surface			262448424

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX IV

EIA Estimated Economic Resource, by county for Ohio: Group 3 counties.
Coal remaining as of January 1, 1991. Perry County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	23 - 25.99	>2.50	229193802
Underground			96558866
Surface			132634936
TOTAL	23 - 25.99	1.68 - 2.50	218252389
Underground			91949272
Surface			126303117
TOTAL	23 - 25.99	0.84 - 1.67	35595433
Underground			31296718
Surface			4298715
TOTAL	23 - 25.99	0.61 - 0.83	19579370
Underground			8248747
Surface			11330623
TOTAL	<23	>2.50	34551830
Underground			14556613
Surface			19995217
TOTAL	<23	1.68 - 2.50	5798638
Underground			2466102
Surface			3332536
TOTAL	<23	0.84 - 1.67	5758638
Underground			2426102
Surface			3332536
TOTAL	All Ranges	All Ranges	548730100
Underground			247502420
Surface			301227680

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX IV

EIA Estimated Economic Resource, by county for Ohio: Group 3 counties.
Coal remaining as of January 1, 1991. Stark County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	>26	>2.50	71208997
Underground			37060550
Surface			34148447
TOTAL	>26	0.61 - 0.83	49109653
Underground			25559000
Surface			23550653
TOTAL	23 - 25.99	>2.50	69026346
Underground			35924594
Surface			33101752
TOTAL	23 - 25.99	1.68 - 2.50	142963658
Underground			74405089
Surface			68558569
TOTAL	23 - 25.99	0.84 - 1.67	30011455
Underground			15619389
Surface			14392066
TOTAL	23 - 25.99	0.61 - 0.83	49109653
Underground			25559000
Surface			23550653
TOTAL	<23	>2.50	30011455
Underground			15619389
Surface			14392066
TOTAL	<23	1.68 - 2.50	49655316
Underground			25842989
Surface			23812327
TOTAL	All Ranges	All Ranges	491096533
Underground			255590000
Surface			235506533

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX IV

EIA Estimated Economic Resource, by county for Ohio: Group 3 counties.
Coal remaining as of January 1, 1991. Washington County.

	Std Btu Range [*]	Std Sulfur Range ^{**}	Est Econ Resource
TOTAL	>26	>2.50	79321682
Underground			36767500
Surface			42554182
TOTAL	23 - 25.99	>2.50	158643363
Underground			73535000
Surface			85108363
TOTAL	23 - 25.99	1.68 - 2.50	39660841
Underground			18383750
Surface			21277091
TOTAL	<23	1.68 - 2.50	39660841
Underground			18383750
Surface			21277091
TOTAL	All Ranges	All Ranges	317286727
Underground			147070000
Surface			170216727

* Million Btu/short ton

**Lbs sulfur/million Btu

APPENDIX IV

EIA Estimated Economic Resource, by county for Ohio: Group 3 counties.
Coal remaining as of January 1, 1991. Wayne County.

	Std Btu Range*	Std Sulfur Range**	Est Econ Resource
TOTAL	>26	1.68 - 2.50	199802
Underground			0
Surface			199802
TOTAL	>26	0.84 - 1.67	99901
Underground			0
Surface			99901
TOTAL	23 - 25.99	>2.50	4795237
Underground			0
Surface			4795237
TOTAL	23 - 25.99	1.68 - 2.50	1998015
Underground			0
Surface			1998015
TOTAL	23 - 25.99	0.61 - 0.83	99901
Underground			0
Surface			99901
TOTAL	All Ranges	All Ranges	7192856
Underground			0
Surface			7192856

* Million Btu/short ton

**Lbs sulfur/millon Btu

END

**DATE
FILMED**

12/18/91