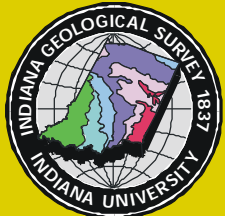
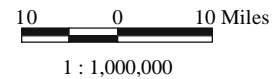
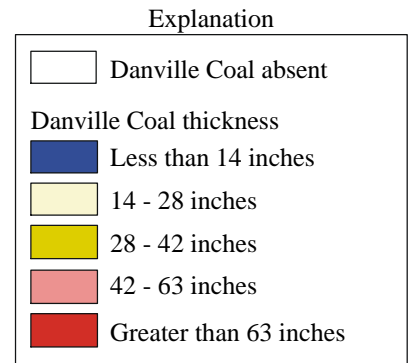
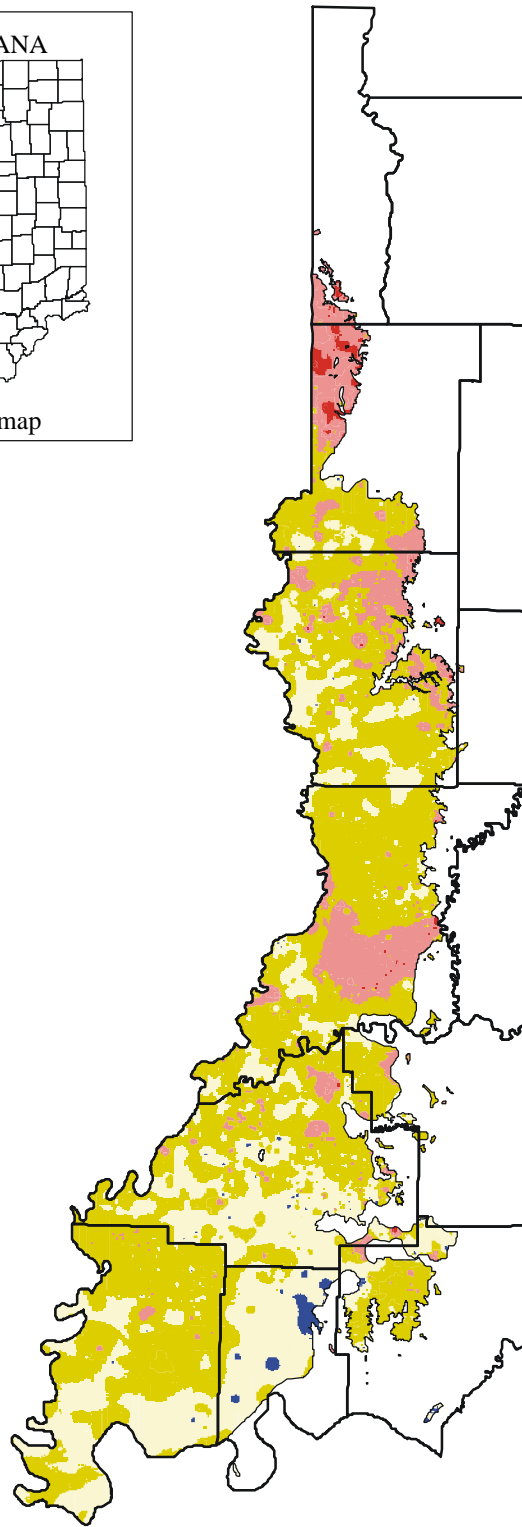
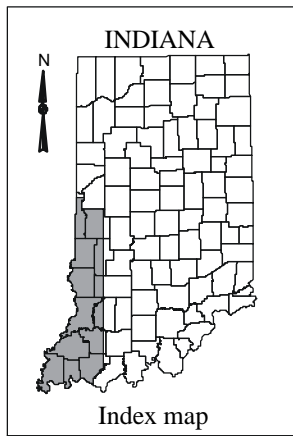


The Availability of the Danville Coal Member for Mining in Indiana

by
Carol L. Conolly
Alex Zlotin



Indiana Geological Survey Open-File Study 2000-1
June 2000

Indiana Geological Survey
611 North Walnut Grove
Bloomington, IN 47405



Final Report to the United States Geological Survey
Agreement No. 99HQAG0083

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THE AVAILABILITY OF THE DANVILLE COAL MEMBER FOR MINING IN INDIANA

Carol L. Conolly and Alex Zlotin

ABSTRACT

This study assesses the resources of the Danville Coal Member in Indiana and identifies those resources that have the most favorable geologic and land use characteristics for mining. The tonnage of original coal in place, remaining coal after mining, coal unlikely to be mined due to geologic and land use factors, and available coal resources were calculated for the Danville Coal in Indiana. The geologic and land use factors which restrict the mining of the Danville Coal were identified through interviews with geologists and mining engineers mining the Danville Coal in Indiana and Illinois. These restrictions were applied to the tonnage of remaining Danville Coal resources in order to calculate the tonnage of available resources.

The original, remaining, and available coal resources are reported in terms of potential method of mining, surface or underground, coal thickness, 14-28 inches, 28-42 inches, or greater than 42 inches, and overburden thickness, 0-200 feet, and greater than 100 feet. Coal that lies between depths of 100 and 200 feet is considered minable by both surface and underground methods. Additionally, the resources are categorized by three levels of geologic assurance or reliability. The reliability categories express the degree of reliability of the resource estimate based on the density of coal thickness data points that are used to derive the resource estimate. The three reliability categories are: measured (0-0.5 miles from the data point), indicated (0.5-2.0 miles), and inferred (2.0-4.0 miles).

The total volume of original Danville Coal resources in Indiana is calculated to be 6.55 billion short tons. Of the 6.55 billion short tons, 0.36 billion short tons have been removed by mining or lost in the mining process, thus leaving 6.19 billion short tons of remaining Danville resources. Technological and land use restrictions remove 5.36 billion short tons from potential mining, leaving 0.83 billion short tons (13% of the original resources or 13% of the remaining resources) available for mining in Indiana. Of the 0.83 billion short tons of total available resources, 0.52 billion tons (8% of the original resources or 63% of the total available resources) are available for underground mining, while 0.31 billion short tons (5% of the original resources or 37% of the total available resources) are available for surface mining.

INTRODUCTION

The Coal Availability Study Program

The accuracy of previous estimates of coal resources in the United States and particularly the portion available for future development has been challenged in recent years (Damberger, 1993). The National Coal Council (NCC) released a report in 1987 expressing concerns about the reliability of the U.S. Department of Energy's (DOE) database on coal resources. The NCC found that this database included non-minable coal, lacked provisions for losses due to mining and preparation, and did not account for coal sterilized by competing land uses. Based upon these findings, the NCC concluded that the DOE's database significantly overstated the amount of coal resources available for future development. The need to develop a more reliable database provided the incentive for the coal availability study program.

In 1986, a pilot study was undertaken by the Kentucky Geological Survey (KGS) and the U.S. Geological Survey (USGS) to develop and test a methodology for determining the quantity of coal resources available for mining under current mining conditions (Eggleston and others, 1990). In a coal availability study, the land-use and technological restrictions affecting the mining of coal are specifically defined, and their impact on the amount of minable coal is measured. This method of calculating available coal resources is more accurate than traditional methods which do not specifically define the restrictions to mining, but rather incorporate the restrictions into a recovery factor (a percentage) which is then applied to the amount of minable coal to derive available coal resources.

In a coal availability study, available coal resources are defined as:

$$\begin{array}{r} \text{ORIGINAL COAL RESOURCES} \\ \text{minus} \\ \text{COAL MINED AND LOST IN MINING} \\ \text{equals} \\ \text{REMAINING COAL RESOURCES} \\ \text{minus} \\ \text{COAL RESTRICTED BY LAND-USE} \\ \text{minus} \\ \text{COAL RESTRICTED BY TECHNOLOGICAL FACTORS} \end{array}$$

7.5-Minute Quadrangle Coal Availability Studies in Indiana

The concern with previous estimates of coal resources in the United States has manifested itself as a collaborative program between the USGS and state geological surveys to conduct coal availability studies to estimate the amount and character of coal resources available for mining within selected 7.5-minute quadrangles. Since 1993, the Indiana Geological Survey (IGS) has completed ten quadrangle-based coal availability studies (fig 1). An additional coal availability study of the Vincennes Quadrangle was conducted by the Illinois State Geological Survey (ISGS) with the cooperation of the IGS. Five of these eleven quadrangle studies included an assessment of the Danville Coal (fig 1).

Statewide Coal Availability Studies in Indiana and Illinois

This assessment of the availability of the Danville Coal for mining in Indiana is the second statewide coal availability study conducted by the IGS. In 1999, the IGS and the ISGS completed statewide assessments of the available coal resources of the Springfield Coal in Indiana and Illinois, respectively. The ISGS expects to conduct a statewide availability study of the Danville Coal in the year 2000. The eventual comparison of both Danville studies is facilitated by the fact that this study has used the same (or very similar) criteria for available coal that the ISGS expects to use for their statewide Danville study. Prior to beginning this study, the IGS and ISGS compiled a list of the criteria to define available Danville Coal (Tables 2a and 2b). These criteria were derived from interviews conducted by the ISGS and IGS with coal companies mining the Danville Coal in Illinois and Indiana, and from the knowledge obtained from the IGS and ISGS quadrangle-based coal availability studies.

Coal Resource Classification System

In this study, as in all previous coal availability studies, the IGS uses the terms and definitions of the USGS coal resource classification system, (Wood and others, 1983). The USGS classification system uses the terms measured (0-0.25 miles from data point), indicated (0.25-0.75 miles from data point) and inferred (0.75-3.0 miles from data point) to indicate the reliability of resource estimates based on the density of coal thickness data points (Wood and others, 1983). Collectively, the resources in the measured, indicated, and inferred categories are termed identified resources to distinguish them from resources based on less reliable estimates. The term resources refers to coal that is greater than or equal to 14 inches thick, and within the measured, indicated, and inferred reliability categories.

The Illinois State Geological Survey uses reliability categories that are similar to the USGS categories measured, indicated, and inferred, namely, Class Ia (0-0.5 miles from data point), Class Ib (0.5-2.0 miles from data point), and Class IIa (2.0-4.0 miles from data point). These categories were used by the ISGS in their statewide Springfield Coal availability study, and will likely be used in their statewide Danville study. In order to be compatible with the ISGS Danville study, the IGS has used the ISGS reliability categories for this report. Because the ISGS classes are essentially equivalent to the USGS categories, the USGS terminology is used in this report. In this report, the term resources refers to coal that is greater than or equal to 14 inches thick, and within the measured (Class Ia), indicated (Class Ib), and inferred (Class IIa) reliability categories of the I

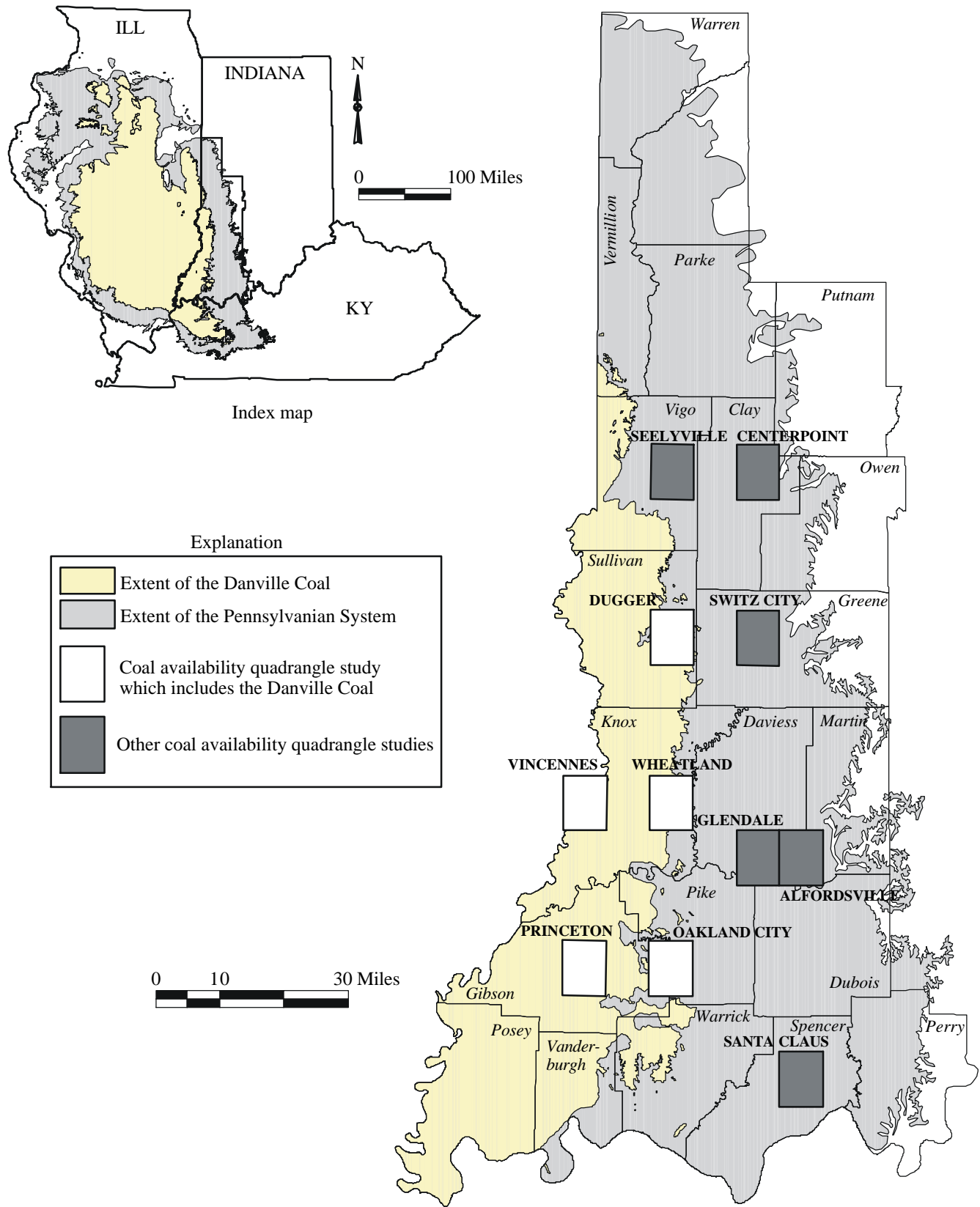


Figure 1. Map of southwestern Indiana showing the ten coal availability quadrangle studies that have been completed by the Indiana Geological Survey (IGS) since 1993. A coal availability study of the Vincennes Quadrangle was conducted by the Illinois State Geological Survey, with cooperation of the IGS. Also shown are the extent of the Danville Coal Member and the Pennsylvanian System in Indiana and in the Illinois Basin (Index map).

GEOLOGY AND MINING OF THE DANVILLE COAL IN INDIANA

Coal Production in Indiana

Coal production in Indiana comes from the coal beds within the Pennsylvanian System. The Indiana coal field constitutes the eastern edge of the Illinois Basin, a basin that covers parts of a three-state area, including Illinois and western Kentucky (fig. 1). The maximum thickness of the Pennsylvanian System in Indiana is about 1,500 feet (475 m). Pennsylvanian rocks in the Illinois Basin are composed of cyclic sequences of dominantly shale, siltstone, and sandstone interstratified with lesser amounts of coal, limestone, and black shale. Coal is found in at least 45 different stratigraphic positions in Indiana, but constitutes only about 3 percent of Pennsylvanian rocks (fig. 2). All coals in Indiana are ranked as high-volatile, bituminous coal.

Danville Coal Production

The importance of the Danville Coal to Indiana's economy is evidenced by the fact that as recently as January 1999, the Danville Coal was being mined at 14 surface mines (11 of which are also mining the Hymera Coal) and 2 underground mines. The production from these mines accounted for roughly half of Indiana's total coal production during January - September 1999 (Indiana Division of Reclamation, unpublished data). Figure 3 shows the distribution of surface and underground mines (active and abandoned) of the Danville Coal in Indiana. The thickest resources of the Danville Coal in Indiana occur in southern Vermillion County and northwest Vigo County (fig. 4). Available data on mined thickness range from 1.0 to 8.3 feet. The maximum depth of the Danville Coal in Indiana is 910 feet, in northwest Posey County (fig. 5).

METHOD

Sources of Data

Several steps were completed before calculating the resources, including: collection and compilation of point source coal thickness and structure data; construction of cross sections for correlation of coal beds; digitization of outcrop, land use in the area, and the extent of mined-out area maps. The Danville Coal thickness and structure maps in this study were created from public and confidential point source stratigraphic data which includes data points in Illinois that lie within five kilometers of the Indiana state border. This data set includes data collected as recently as September 1999 (fig. 6). Table 1 provides a summary of the point source data used in this study, exclusive of the data points in Illinois. Detailed information regarding other data used in this study is available upon request to the IGS.

Table 1. Point source Danville Coal stratigraphic data used to make the structure and thickness maps in this study, exclusive of data points in Illinois.

#of data points	Data source	Data type	Comment
1,493	IGS files	cores and rotary drill holes	
700	Confidential data collected by IGS post-June 1998	cores and rotary drill holes	Data are located in 9 of the 11 counties in which Danville occurs.
534	Public data collected by IGS post-January 1998	cores and rotary drill holes	Mine permit data located in areas of recent (post-1995) or active mining.
1,958	Geophysical logs	resistivity and spontaneous potential logs	These data are used to provide coal structure and thickness data in areas with few core or rotary drill data.
Total = 4,685			

PENNSYLVANIAN SYSTEM				ILLINOIS	INDIANA	W. KENTUCKY										
Raccoon Creek Group	Caseyville Fm.	Tradewater Fm.	Willis	Reynoldsburg	Pinnick St. Meinrad French Lick	Ice House Foster Amos Bell										
							Mansfield Fm.	Brazil Fm.	Upper Block	Maring Hill Blue Creek	Mariah Hill Blue Creek	Battery Rock Nolin				
													Staubton Fm.	Minshall/Bufaloville	Mining City Empire	Lead Creek
	Carbondale Group	Carbondale Fm.	Linton Fm.	Survant	Colchester	Colchester Dekoven Davis										
							Petersburgh Fm.	Springfield	Houchin Creek	Houchin Creek						
											Dugger Fm.	Herrin	Herrin	Herrin		
	McLeansboro Gp.	Shelburn Fm.	DANVILLE Hymera Herrin	DANVILLE Jamestown	DANVILLE Baker Paradise	DANVILLE Baker Paradise										
							McLeansboro Gp.	Shelburn Fm.	Shelburn Fm.	Patoka Fm.	Patoka Fm.	Patoka Fm.				
	Bond Fm.	Bond Fm.	Bond Fm.	Bond Fm.												
					Mattoon Fm.	Mattoon Fm.							Mattoon Fm.	Mattoon Fm.		

Figure 2. Lithostratigraphy of the Pennsylvanian System in the Illinois Basin, showing major coalbeds; modified from Mastalerz and Harper (1998).

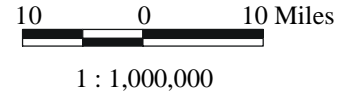
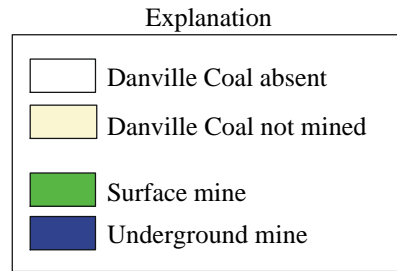
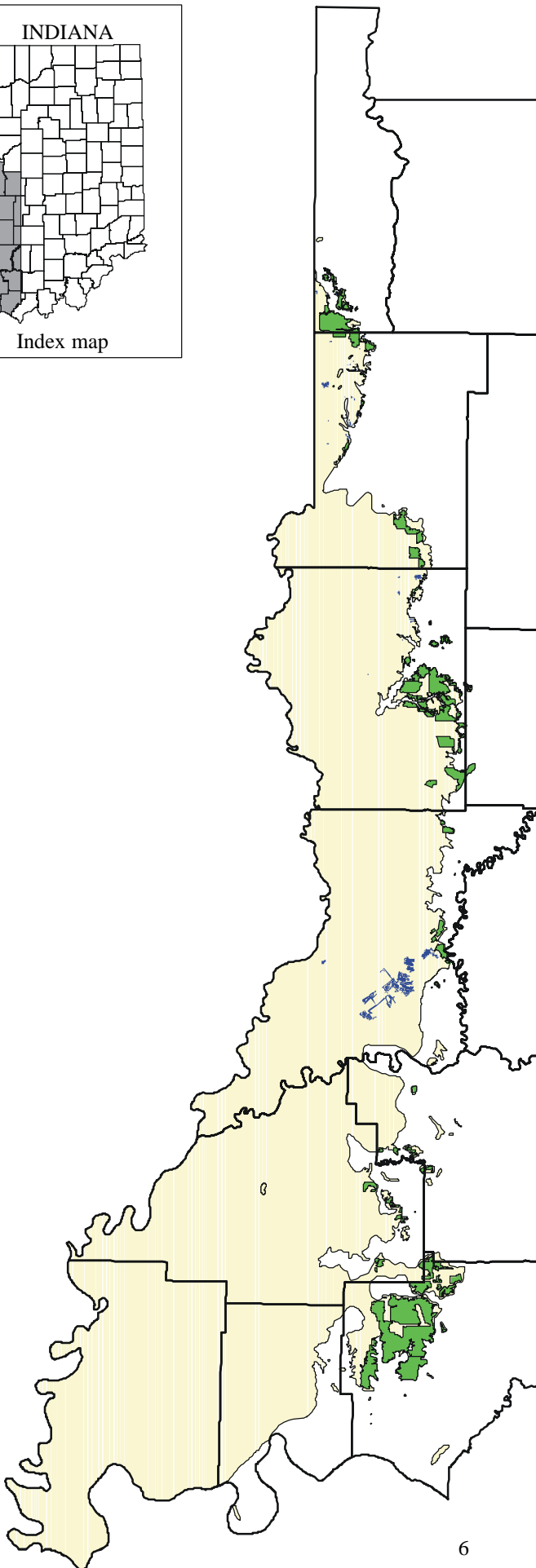
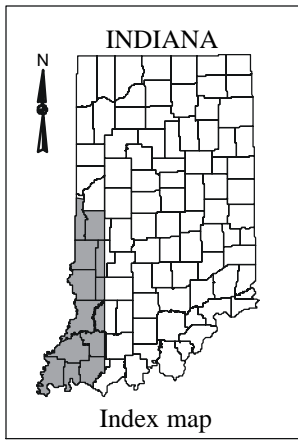


Figure 3. Map showing the distribution of surface and underground mines (active and abandoned) of the Danville Coal in Indiana.

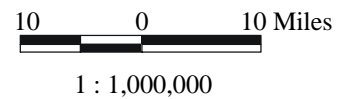
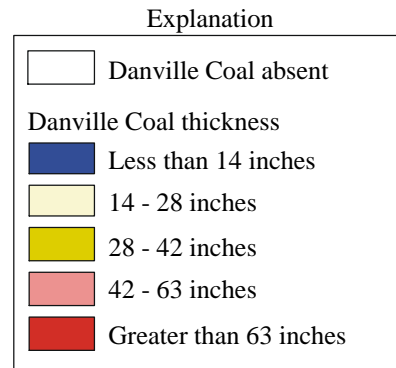
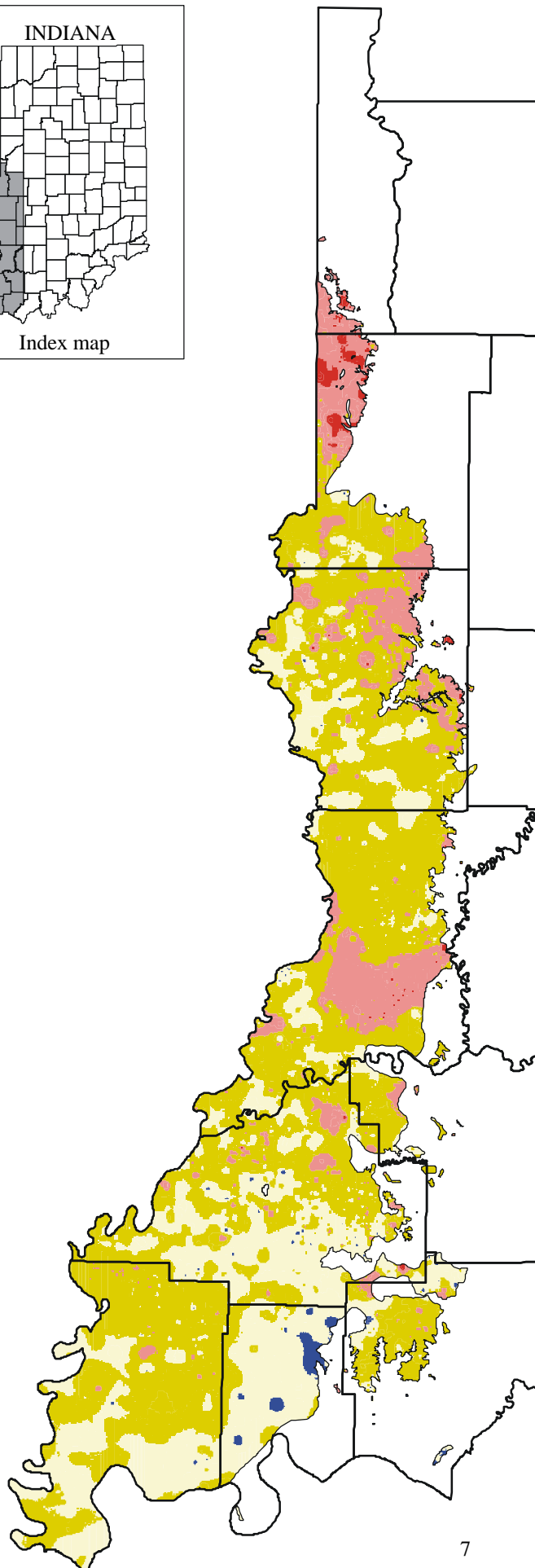
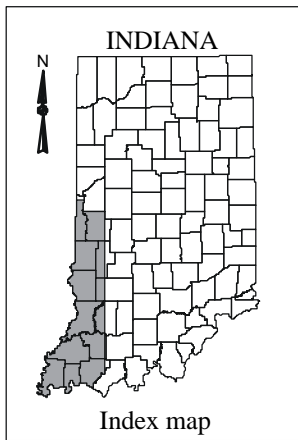


Figure 4. Map showing the thickness of the Danville Coal. For this study, Danville Coal less than 14 inches thick is considered too thin for surface mining and Danville Coal less than 42 inches thick is considered too thin for underground mining.

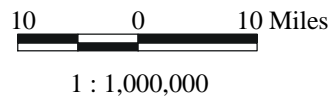
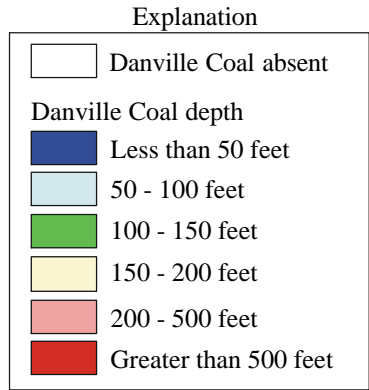
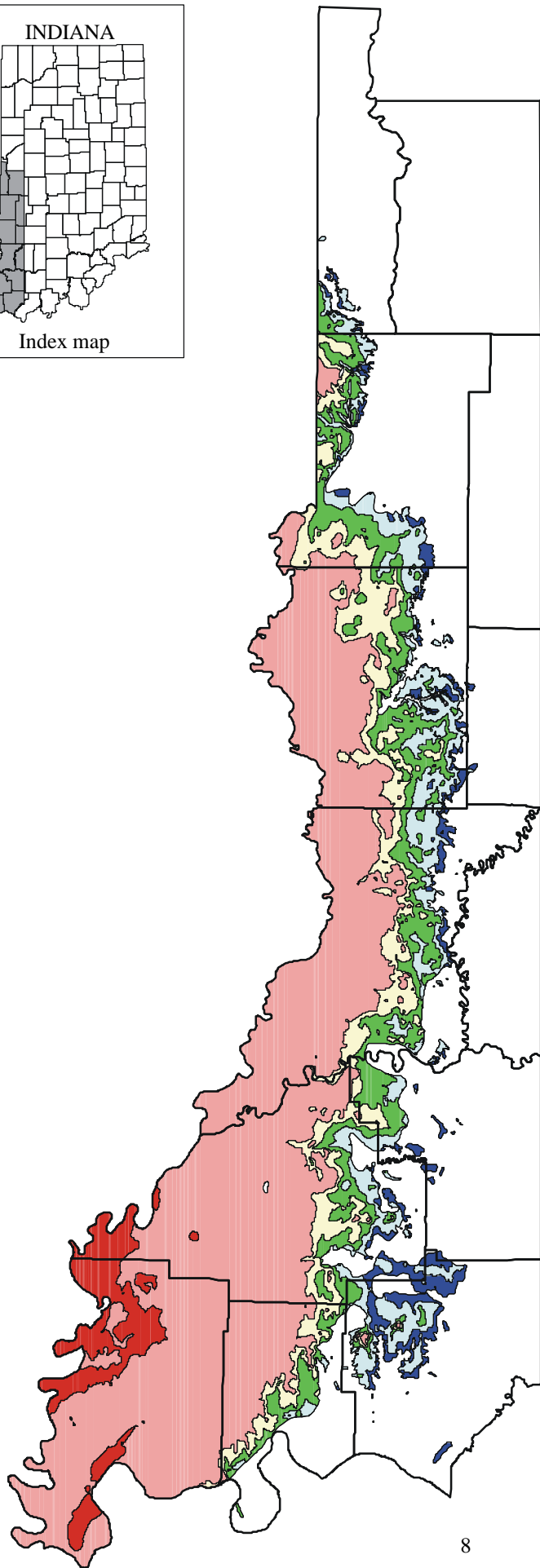
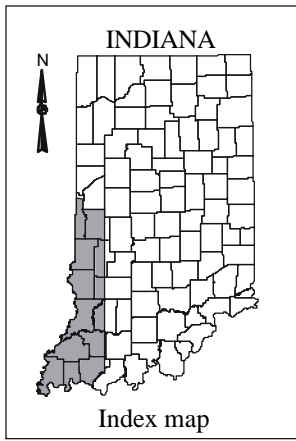


Figure 5. Map showing the depth of the Danville Coal in Indiana. For this study, the maximum depth for surface mining is 200 feet, and the minimum depth for underground mining is 100 feet.

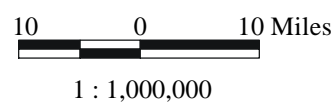
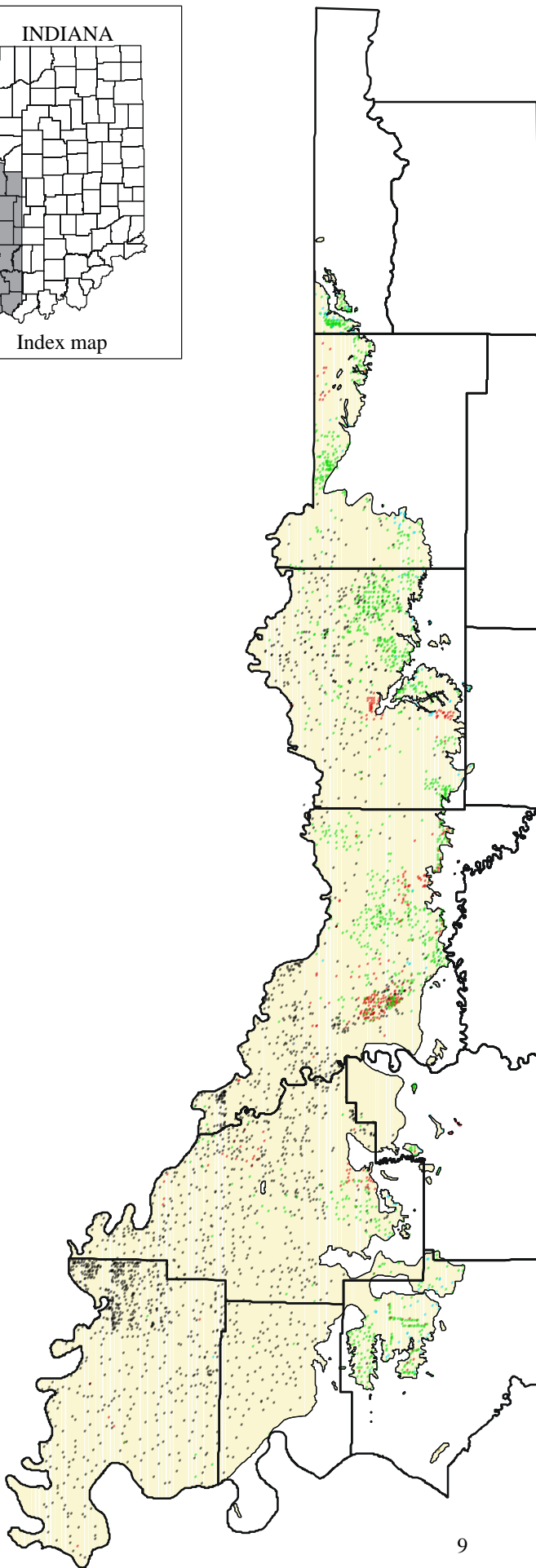
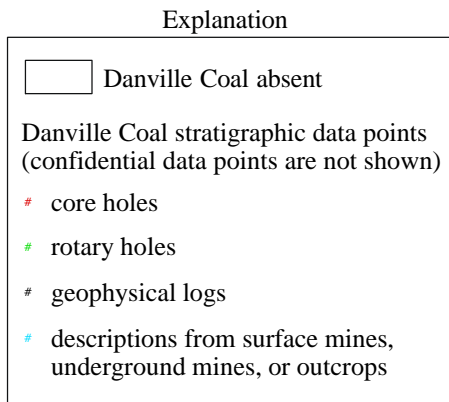
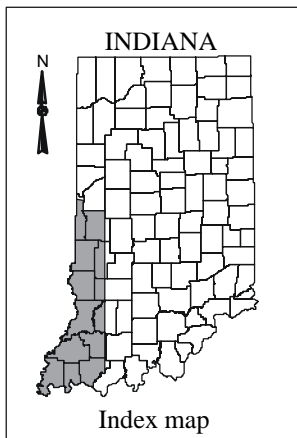


Figure 6. Map showing a subset of the Danville Coal stratigraphic data points that were used to create the Danville Coal thickness and structure maps for this study. A total of 3,985 non-confidential data points are shown. Not shown are 700 confidential data points, and data points in Illinois.

Resource Calculations

The original, remaining, and available Danville Coal resources were calculated using the Geographic Information System (GIS) software Arc/Info. The projection system used for this study was the Universal Transverse Mercator (UTM) System, zone 16, Clarke 1866 spheroid, North American Datum 27, with x-y coordinates in meters. Calculations took into account the amount of original coal in place, mined coal, coal lost during mining, and restrictions to mining. The coal resources were calculated in short tons using an average value of 1 acre/foot of coal = 1,800 short tons.

The original, remaining, and available coal resources are reported in terms of potential method of mining, surface or underground, coal thickness, 14-28 inches, 28-42 inches, or greater than 42 inches, and overburden thickness, 0-200 feet, and greater than 100 feet. Coal that lies between depths of 100 and 200 feet is considered minable by both surface and underground methods. Additionally, the resources are categorized by three levels of geologic assurance or reliability. The reliability categories express the degree of reliability of the resource estimate based on the density of coal thickness data points that are used to derive the resource estimate. The three reliability categories are: measured (0-0.5 miles from the data point), indicated (0.5-2.0 miles), and inferred (2.0-4.0 miles).

TECHNOLOGICAL AND LAND USE FACTORS THAT AFFECT THE AVAILABILITY OF THE DANVILLE COAL FOR MINING

Through interviews with geologists and mining engineers mining the Danville Coal, the technological and land use factors that restrict the mining of the Danville Coal were identified. These restrictions were applied to the volume of remaining resources in order to calculate the volume of available resources. Technological restrictions refer to geologic conditions of the coals and of the surrounding rock which make underground mining uneconomic or unsafe. Land-use restrictions refer to surface features which restrict mining. Coal mining companies often leave a buffer zone around these features rather than mine directly adjacent to them. Thus, to delineate more accurately the amount of coal that is restricted from mining, a buffer zone is placed around each land use feature based upon current mining practices.

Tables 2a and 2b list the technological and land use restrictions that were used in this study to define Danville Coal available for surface mining and underground mining, respectively. Figures 4 through 13 illustrate these restrictions.

The restrictions which had the greatest impact on the availability of the Danville Coal for both underground and surface mining were those related to coal thickness. For this study, 42 inches is the minimum coal thickness for available underground-minable coal. Although it is technologically possible to mine coal thinner than 42 inches in underground mines, most coal companies in Indiana currently find that it is not economical to do so. An examination of Figure 4 reveals that a significant portion of the Danville Coal is thinner than 42 inches. This restriction accounts for 4,529 million tons, or 82 percent of the total original underground-minable Danville Coal resources (Table 4, fig.15).

The restriction which had the greatest impact on the availability of the Danville Coal for surface mining was the maximum stripping ratio. Stripping ratio is the number of cubic yards of overburden that must be removed to recover one ton of coal. For this study, the maximum stripping ratio for available surface-minable coal is 25:1. Figure 8 shows those areas where surface mining of the Danville Coal is affected by this restriction. Stripping ratio accounts for 1,614 million tons, or 61 percent of the total original surface-minable Danville Coal resources (Table 6, fig.17).

The interburden between adjacent coal seams must contain competent strata of sufficient thickness so that underground mining of one seam will not disrupt the stability of the roof or floor of another seam (Chekan et al., 1986). Mining experts interviewed for this study recommended 40 feet as the minimum thickness of interburden. In Indiana, the Hymera Coal generally lies within 40 feet beneath the Danville Coal; therefore, where both the Danville and Hymera Coals are of suitable depth, thickness, and quality for underground mining, only one coal may be safely mined. Based upon a comparison of the thickness and quality of the Danville and Hymera Coals in those areas where both coals would be available for underground mining, it was assumed that coal companies would likely mine the Danville Coal rather than the Hymera Coal; therefore, for the purpose of this study, this restriction was not applied to the Danville Coal, but rather to the Hymera Coal (Table 2b).

Table 2a. Criteria used to define Danville Coal available for surface mining in this study.

TECHNOLOGICAL RESTRICTIONS		
Minimum seam thickness	14 inches	Figure 4, page 7
Maximum depth	200 feet	Figure 5, page 8
Maximum unconsolidated overburden	60 feet	Figure 7, page 12
Maximum stripping ratio (cubic yds. of overburden / ton of raw coal)	25 : 1	Figure 8, page 13
Minimum size of mine reserve Less than 50 feet of overburden More than 50 feet of overburden	175,000 tons of raw coal 590,000 tons of raw coal	no figure
LAND USE RESTRICTIONS		
Towns	no mining within 2,640 feet	Figure 9, page 14
Public lands (Federal and State Parks)	no mining within 100 feet	Figure 9, page 14
Paved roads	no mining within 100 feet	Figure 9, page 14
Railroads	no mining within 100 feet	Figure 9, page 14
Pipelines	no mining within 100 feet	Figure 9, page 14
Underground mines	no mining within 200 feet	Figure 9, page 14
Closely-spaced oil wells	no mining in areas where there are more than 7 oil wells per 40 acres	Figure 9, page 14

Table 2b. Criteria used to define Danville Coal available for underground mining in this study.

TECHNOLOGICAL RESTRICTIONS		
Minimum seam thickness	42 inches	Figure 4, page 7
Minimum bedrock cover	75 feet	Figure 10, page 15
Minimum ratio of bedrock to unconsolidated overburden	1 : 1	Figure 11, page 16
Minimum size of mine reserve	80 million tons of raw coal	no figure
Faults	no mining within 800 feet of fault	Figure 12, page 17
Minimum interburden between minable seams	40 feet	no figure; applied to Hymera Coal
LAND USE RESTRICTIONS		
Towns	no mining within 100 feet	Figure 13, page 18
Public lands (Federal and State Parks)	no mining within 100 feet	Figure 13, page 18
Interstate highways	no mining within 100 feet	Figure 13, page 18
Underground mines	no mining within 200 feet	Figure 13, page 18
Closely-spaced oil wells	no mining in areas where there are more than 7 oil wells per 40 acres	Figure 13, page 18

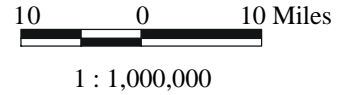
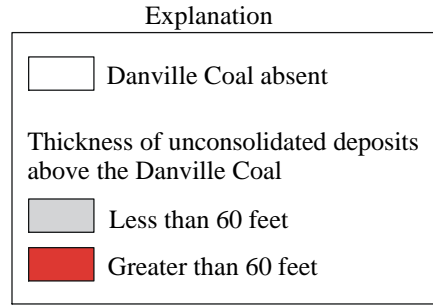
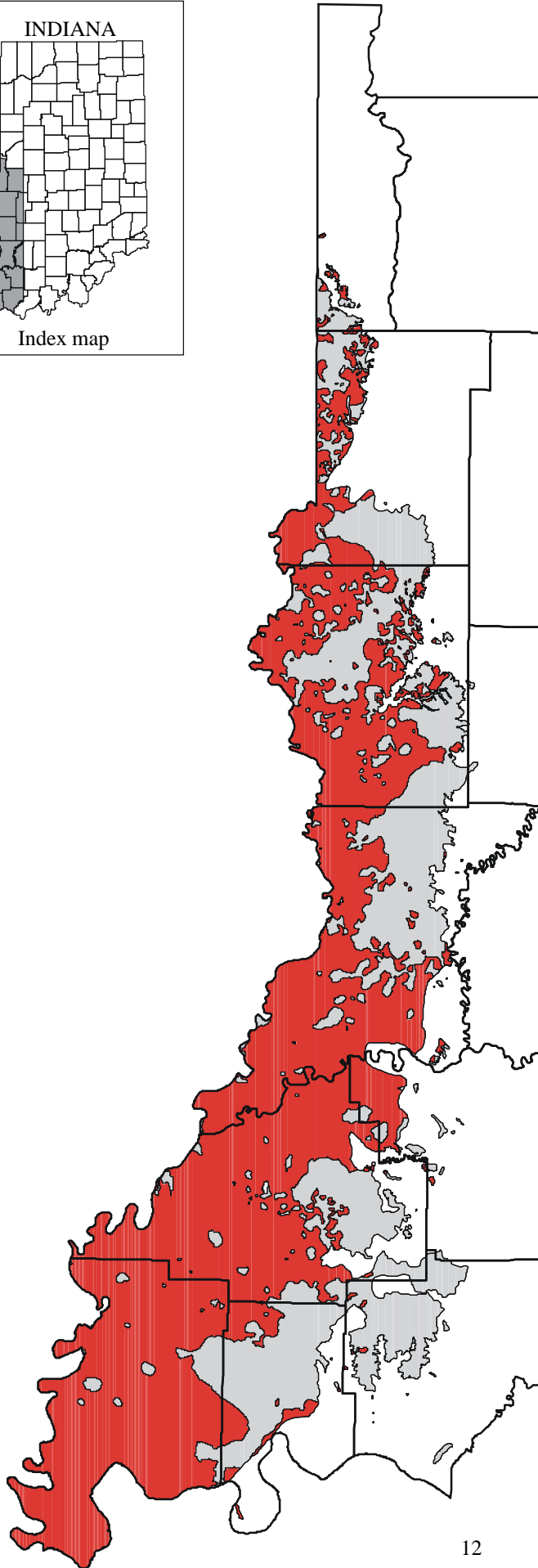
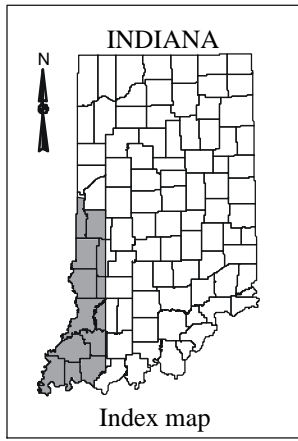


Figure 7. Map showing the thickness of unconsolidated deposits above the Danville Coal in Indiana. For this study, the Danville Coal is considered unavailable for surface mining in areas where the overlying unconsolidated deposits are greater than 60 feet thick.

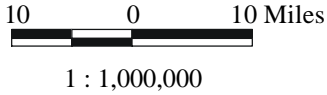
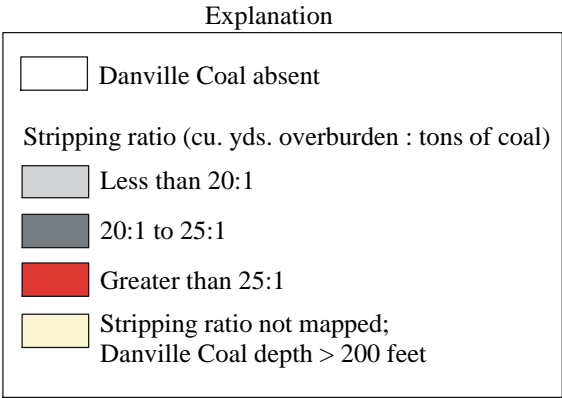
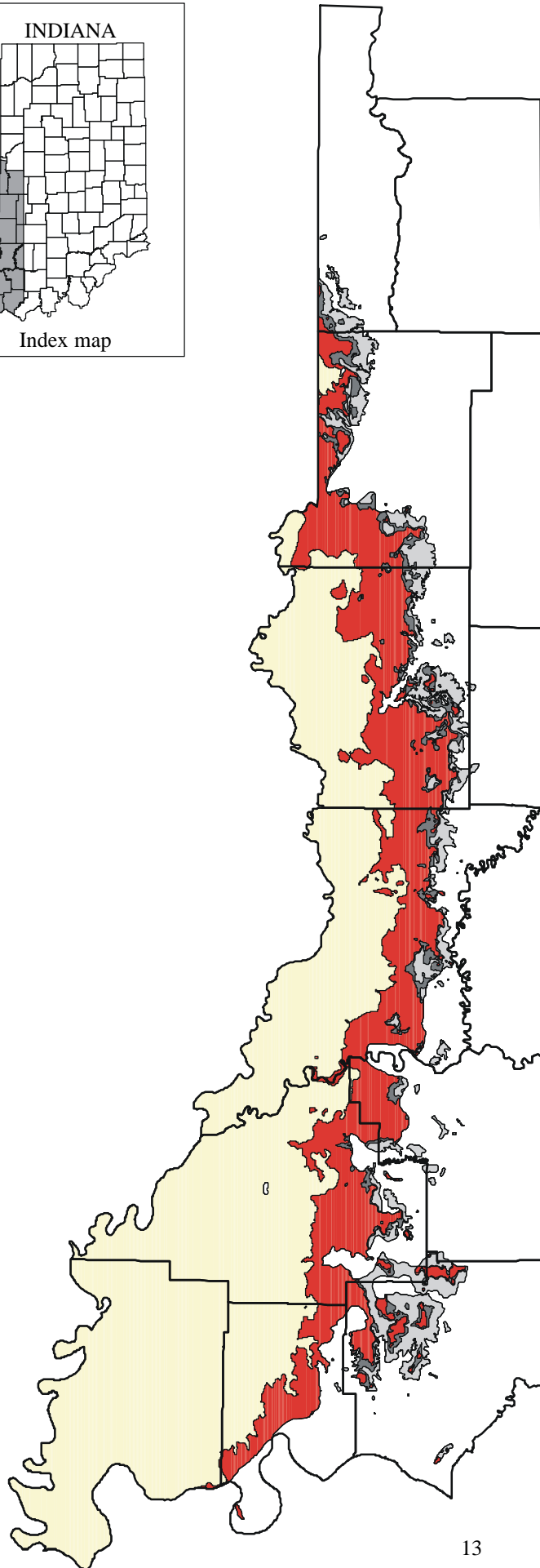
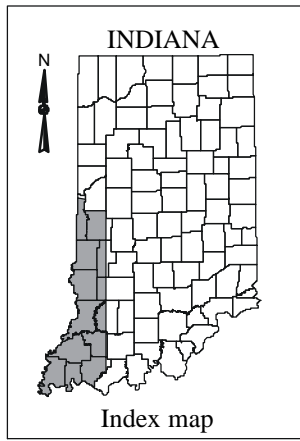


Figure 8. Map showing the stripping ratio of the Danville Coal in areas where the depth to the Danville Coal is less than 200 feet. Stripping ratio is the number of cubic yards of overburden that must be removed to recover 1 ton of coal. For this study, the Danville Coal is considered unavailable for surface mining in areas where the stripping ratio is greater than 25:1.

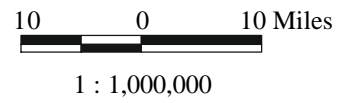
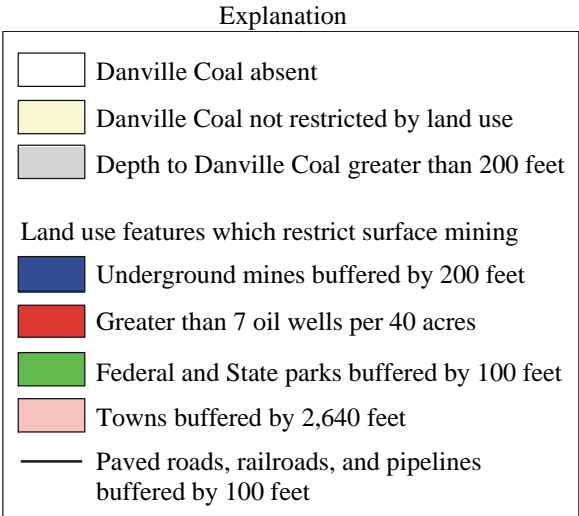
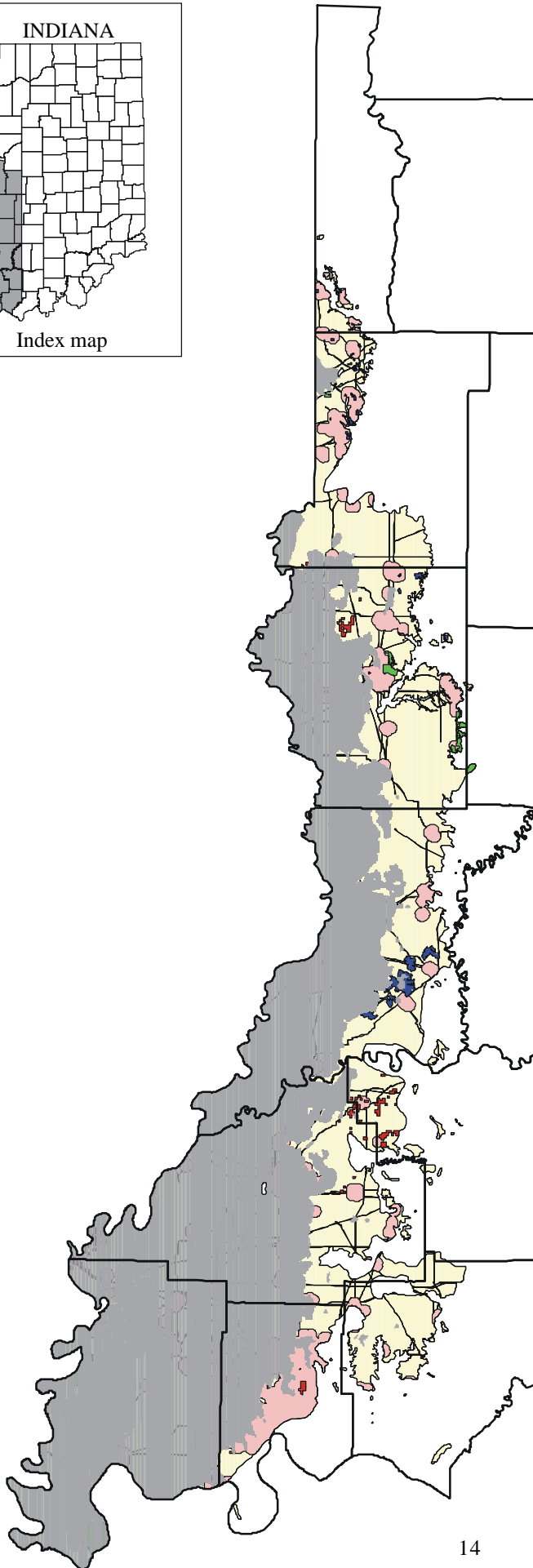
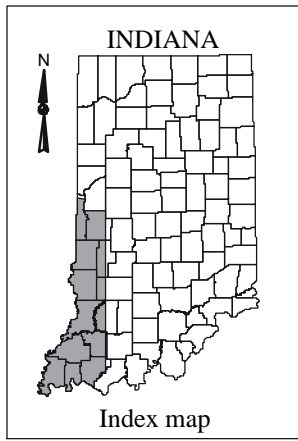


Figure 9. Map showing the land use features that restrict the Danville Coal from surface mining.

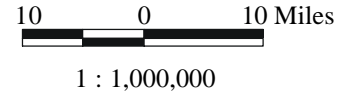
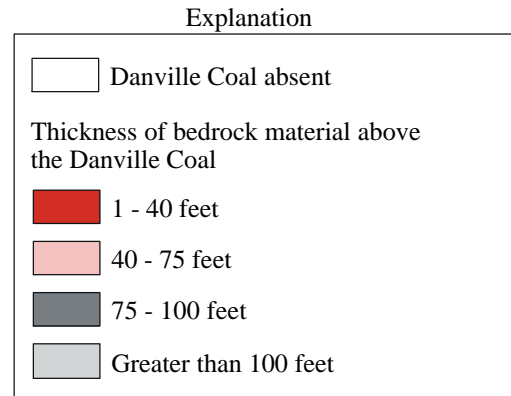
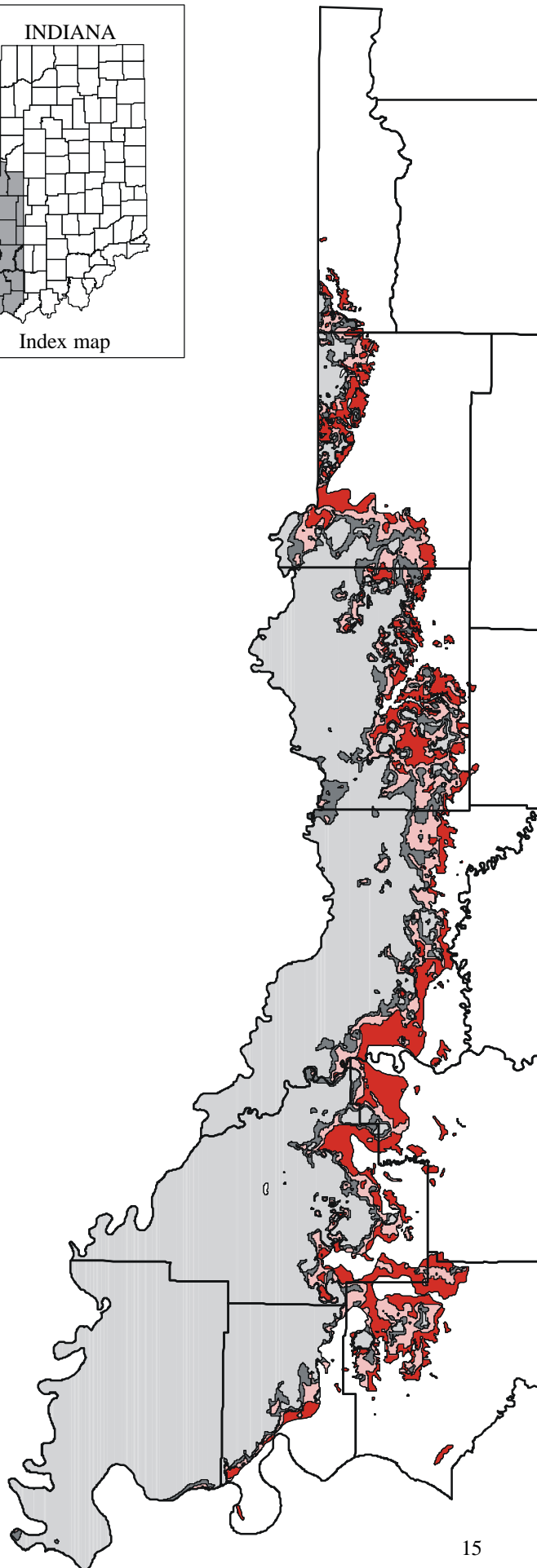
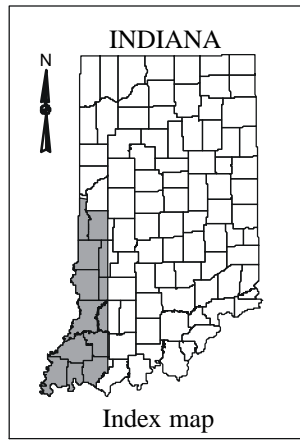


Figure 10. Map showing the thickness of bedrock material above the Danville Coal. For this study, the Danville Coal is considered unavailable for underground mining in areas where the overlying bedrock is less than 75 feet thick.

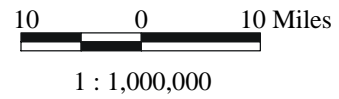
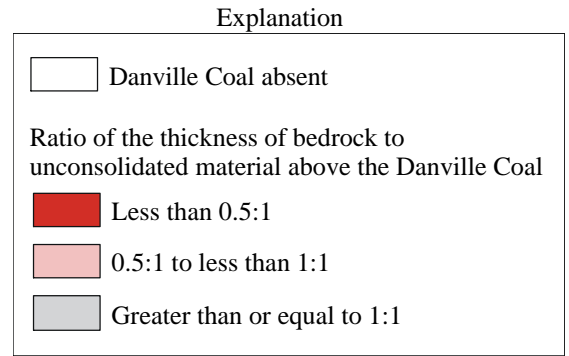
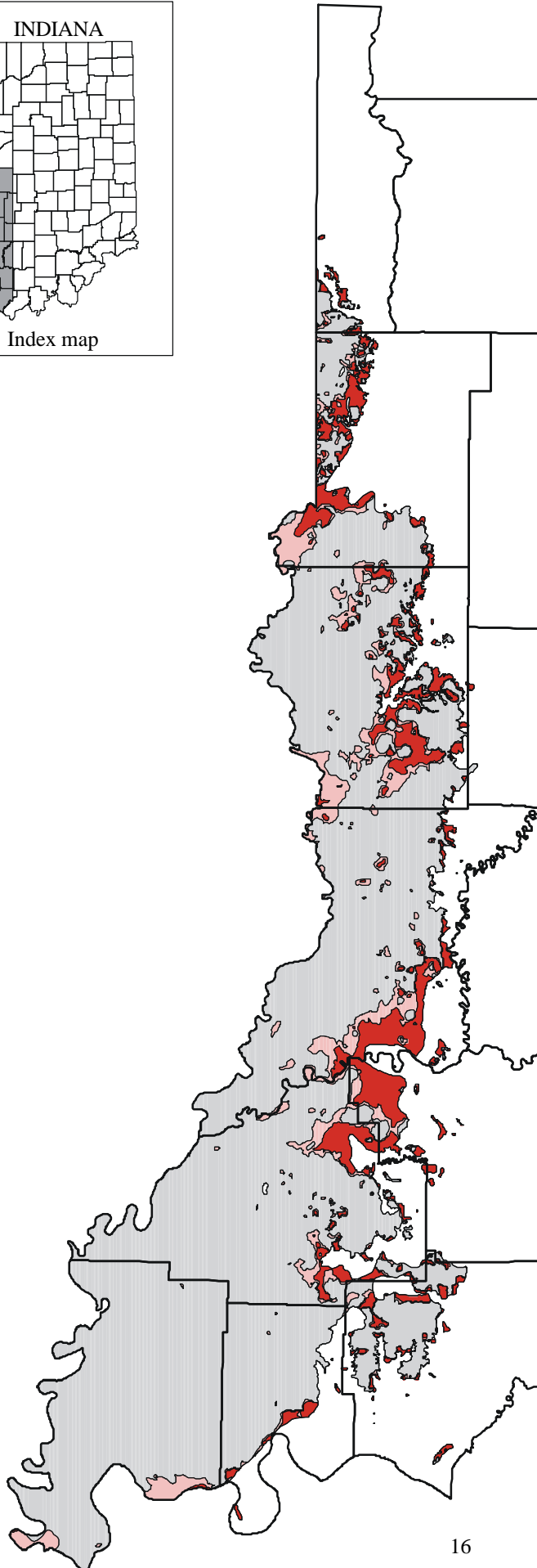
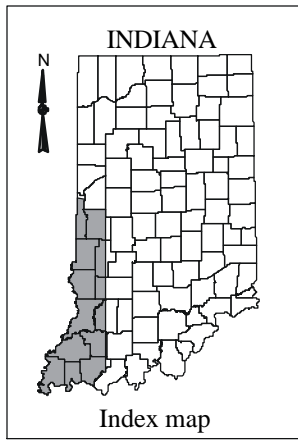


Figure 11. Map showing the ratio of the thickness of bedrock to unconsolidated material above the Danville Coal. For this study, the Danville Coal is considered unavailable for underground mining in areas where this ratio is less than 1:1.

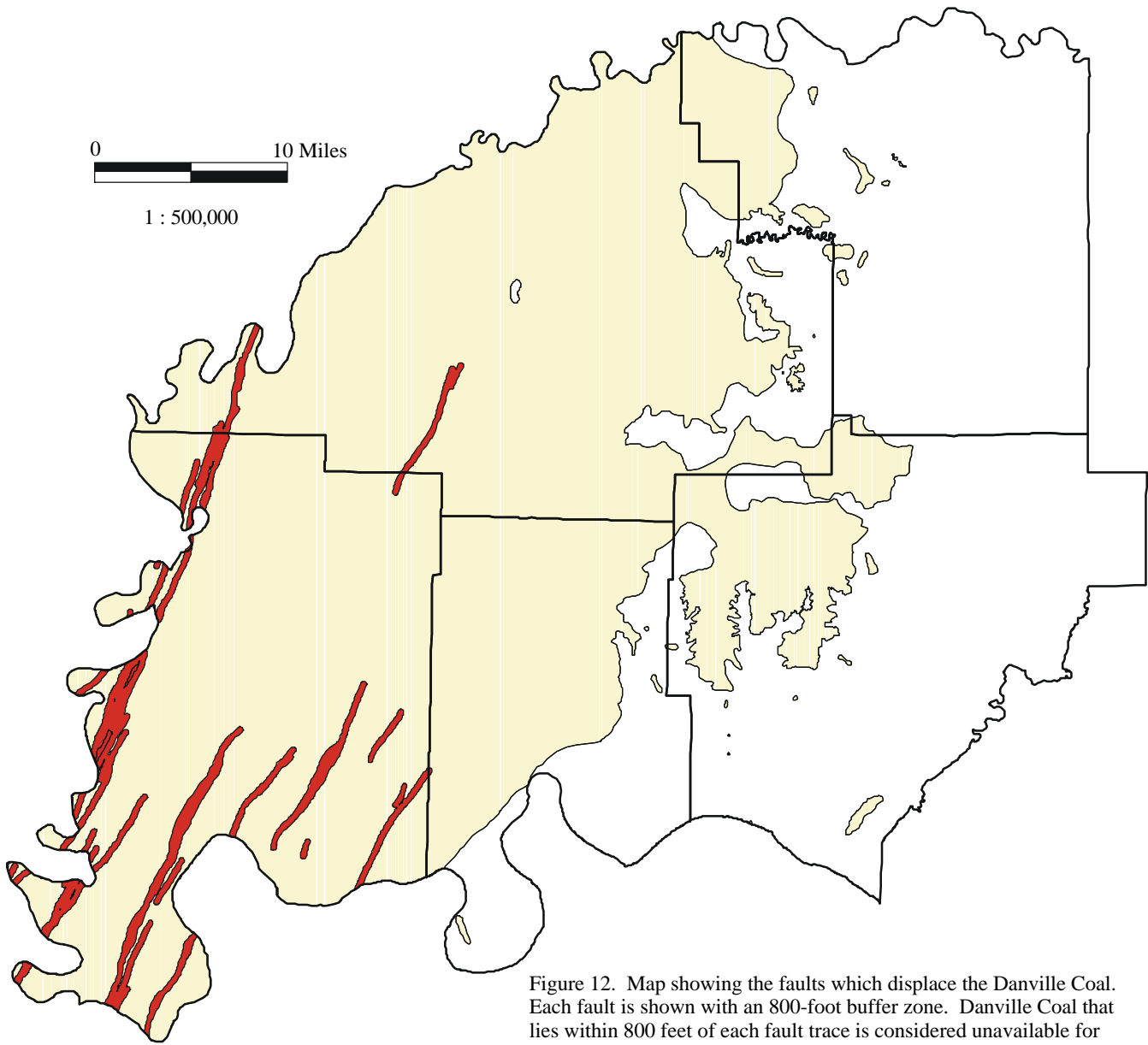
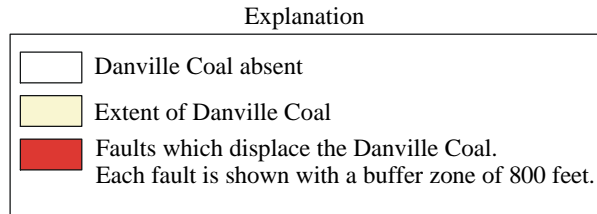
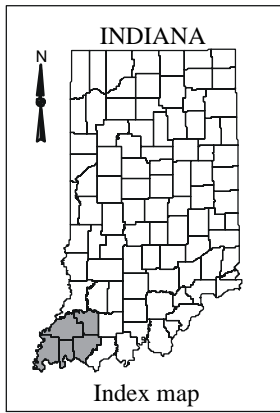


Figure 12. Map showing the faults which displace the Danville Coal. Each fault is shown with an 800-foot buffer zone. Danville Coal that lies within 800 feet of each fault trace is considered unavailable for underground mining.

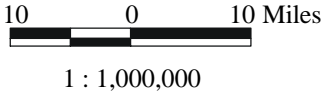
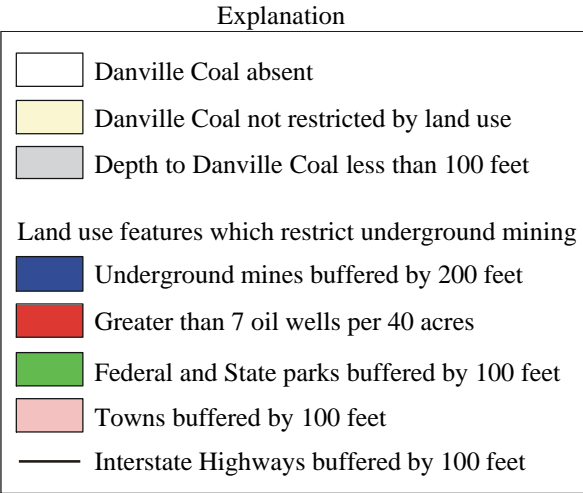
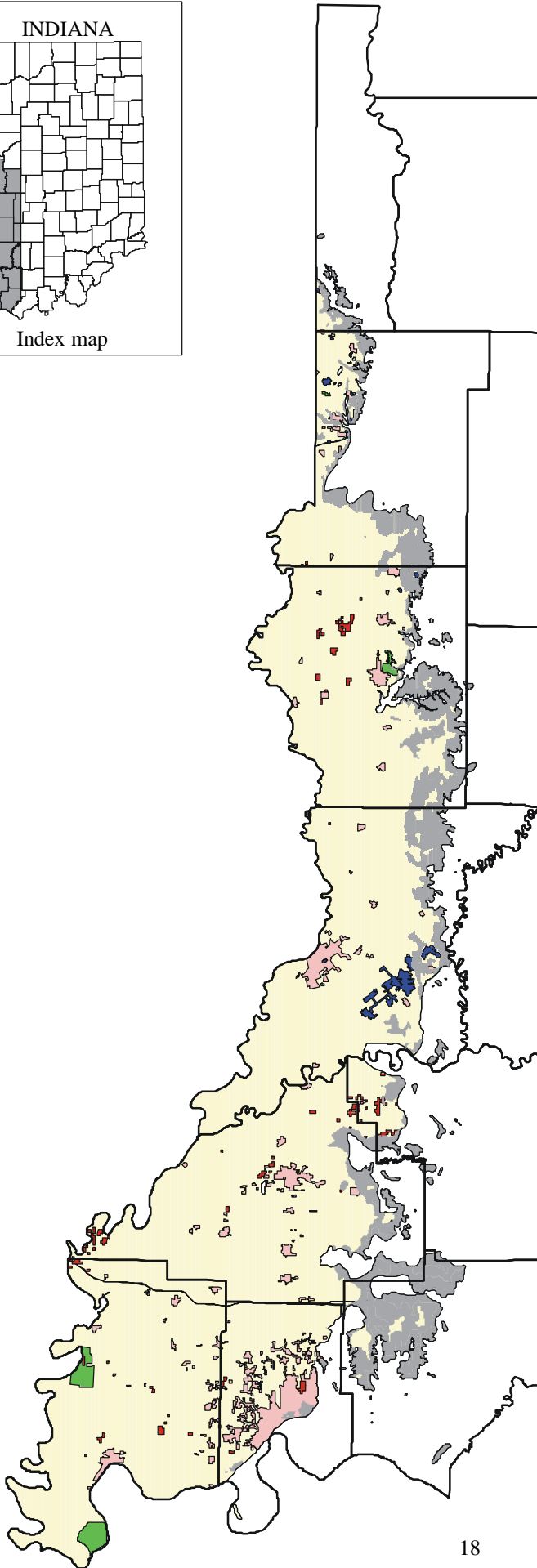
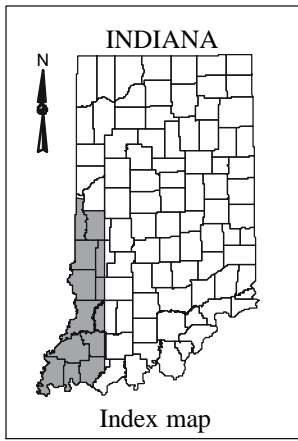


Figure 13. Map showing the land use features that restrict the Danville Coal from underground mining.

TOTAL AVAILABLE DANVILLE COAL RESOURCES IN INDIANA

The total volume of original Danville Coal resources in Indiana is calculated to be 6.55 billion short tons. Of the 6.55 billion short tons, 0.36 billion short tons have been removed by mining or lost in the mining process, thus leaving 6.19 billion short tons of remaining Danville resources. Technological and land use restrictions remove 5.36 billion short tons from potential mining, leaving 0.83 billion short tons (13% of the original resources or 13% of the remaining resources) available for mining in Indiana. Of the 0.83 billion short tons of total available resources, 0.52 billion tons (8% of the original resources or 63% of the total available resources) are available for underground mining, while only 0.31 billion short tons (5% of the original resources or 37% of the total available resources) are available for surface mining (fig. 14, Table 3). Tables 8 through 30 provide a detailed reporting of surface minable and underground minable Danville Coal resources by county.

Figure 14. Danville Coal resources in Indiana, billions of tons (bt.)

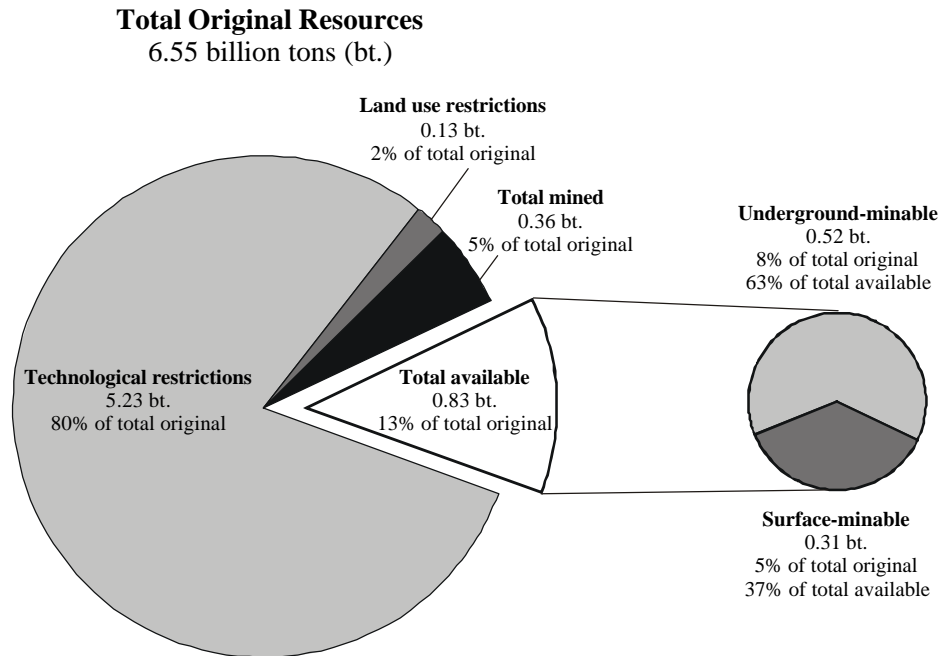


Table 3. Resources of the Danville Coal in Indiana, billions of tons. Numbers in parentheses are percent of original resources in the category. Resources include Danville Coal greater than or equal to 14 inches thick and within the measured, indicated, and inferred reliability categories. Surface and underground resources do not add to the total because coal that lies between depths of 100 to 200 feet is included in both categories. Total resources are reported without overlap by calculating surface resources for overburden thickness of 0-100 feet and underground resources for overburden thickness greater than 100 feet and then summing the result of these two calculations.

	Total	Potential Mining Method	
		Surface ¹	Underground ²
Original	6.55	2.64	5.53
Mined	0.36 (5%)	0.35 (13%)	0.07 (1%)
Remaining	6.19 (95%)	2.29 (87%)	5.46 (99%)
Available	0.83 (13%)	0.35 (13%)	0.52 (10%)
Technological restrictions	5.23 (80%)	1.83 (70%)	4.89 (88%)
Land use restrictions	0.13 (2%)	0.11 (4%)	0.05 (1%)

¹ Tonnages are reported for Danville Coal with 0-200 feet of overburden.

² Tonnages are reported for Danville Coal with greater than 100 feet of overburden.

DANVILLE COAL RESOURCES AVAILABLE FOR UNDERGROUND MINING

Table 4. A summary of the underground minable resources of the Danville Coal in Indiana, millions of tons and percent of total original underground minable resources. A more detailed report of the underground minable resources is provided in Table 5.

	million tons	% of original
Original	5,531.7	100.0
Mined	68.6	1.2
Remaining	5,463.1	98.8
Available	522.3	9.4
Technological restrictions		
Seam < 42 inches thick	4,529.7	81.9
Thin bedrock cover	243.3	4.4
Faulted	0.2	<0.1
Block size / configuration	120.1	2.2
Total	4,893.4	88.5
Land use restrictions		
Towns	30.6	0.6
Public lands	1.2	<0.1
Interstate highways	0.5	<0.1
Oil wells	1.9	<0.1
Underground mines	13.2	0.2
Total	47.4	0.9
Total restricted	4,940.8	89.3

Figure 15. Underground minable resources of the Danville Coal in Indiana, millions of tons and percent of total original underground minable resources. Resources that are restricted by faults do not appear in the pie diagram because they comprise only 0.2 million tons or <0.1% of the total original underground minable resources.

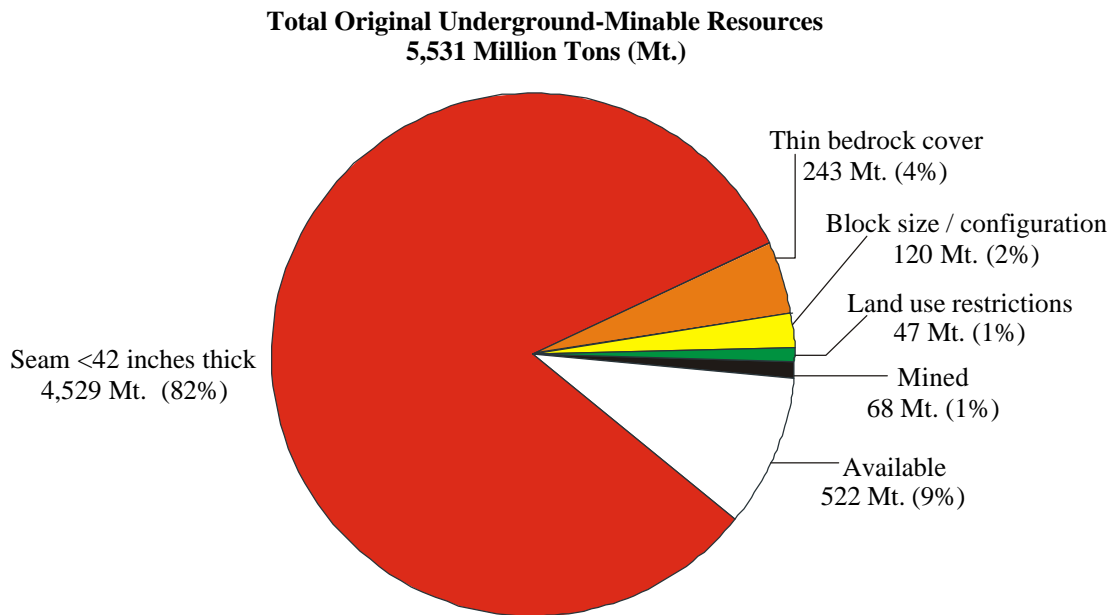
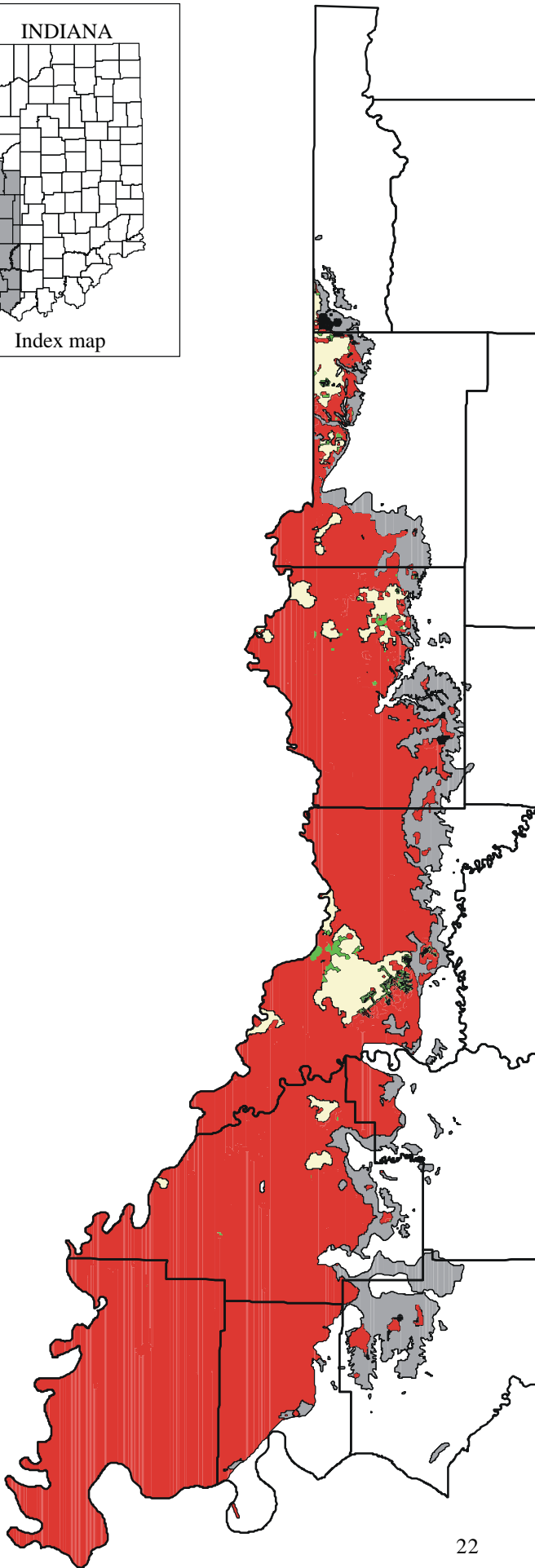
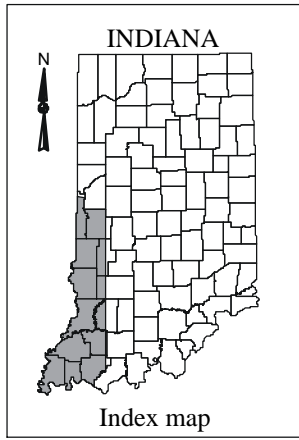


Table 5. Estimated original, remaining, restricted, and available underground minable resources (thousands of short tons) of the Danville Coal Member in Indiana. Resources are reported for overburden greater than 100 feet and are subdivided by coal thickness (>14"-28", >28"-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Danville Coal in Indiana													
>100 ft overburden													
reliability category	Measured				Indicated				Inferred				
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"
Original resources (pre-mining resources)													
Total	584,488	1,693,304	643,309	2,921,102	664,288	1,475,982	346,674	2,486,945	57,100	63,349	3,225	123,674	1,305,877
Remaining resources (post-mining resources)													
Total	584,466	1,684,569	587,620	2,856,654	664,288	1,475,931	342,521	2,482,740	57,100	63,349	3,225	123,674	1,305,854
Technological restrictions													
Seam <42 inches thick	584,466	1,684,569	0	2,269,035	664,288	1,475,931	0	2,140,219	57,100	63,349	0	120,449	1,305,854
Thin bedrock cover	0	0	152,202	152,202	0	0	88,162	88,162	0	0	2,923	2,923	0
Faulted	0	0	244	244	0	0	0	0	0	0	0	0	0
Block size / configuration	0	0	103,704	103,704	0	0	16,345	16,345	0	0	81	81	0
Total	584,466	1,684,569	256,150	2,525,185	664,288	1,475,931	104,507	2,244,726	57,100	63,349	3,004	123,454	1,305,854
Land use restrictions													
Towns	0	0	12,894	12,894	0	0	17,440	17,440	0	0	216	216	0
Public lands	0	0	863	863	0	0	290	290	0	0	0	0	0
Interstate Highways	0	0	444	444	0	0	83	83	0	0	0	0	0
Oil wells	0	0	1,897	1,897	0	0	51	51	0	0	0	0	0
Underground mines	0	0	12,315	12,315	0	0	895	895	0	0	0	0	0
Total	0	0	28,412	28,412	0	0	18,759	18,759	0	0	216	216	0
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]													
Total	0	0	303,057	303,057	0	0	219,255	219,255	0	0	4	4	0



Explanation

- Danville Coal available for underground mining
- Danville Coal absent
- Danville Coal mined out
- Depth to Danville Coal less than 100 feet
- Underground mining restricted by technologic factors
- Underground mining restricted by land use features

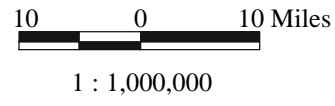


Figure 16. Map showing the areas where the Danville Coal is available for underground mining in Indiana and where underground mining is restricted.

DANVILLE COAL RESOURCES AVAILABLE FOR SURFACE MINING

Table 6. A summary of the surface minable resources of the Danville Coal in Indiana, millions of tons and percent of total original surface minable resources. A more detailed report of the surface minable resources is provided in Table 7.

	million tons	% of original
Original	2,636.3	100.0
Mined	348.0	13.2
Remaining	2,288.3	86.7
Available	349.7	13.2
Technological restrictions		
Stripping ratio	1,614.3	61.2
Thick unconsolidated material	205.7	7.8
Block size / configuration	10.2	0.4
Total	1,830.2	69.4
Land use restrictions		
Towns	89.5	3.4
Public lands	2.8	0.1
Roads	5.4	0.2
Railroads	3.4	0.1
Pipelines	2.6	0.1
Oil wells	0.5	0.0
Underground mines	4.1	0.2
Total	108.4	4.1
Total restricted	1,938.6	73.5

Figure 17. Surface minable resources of the Danville Coal in Indiana, millions of tons and percent of total original surface minable resources.

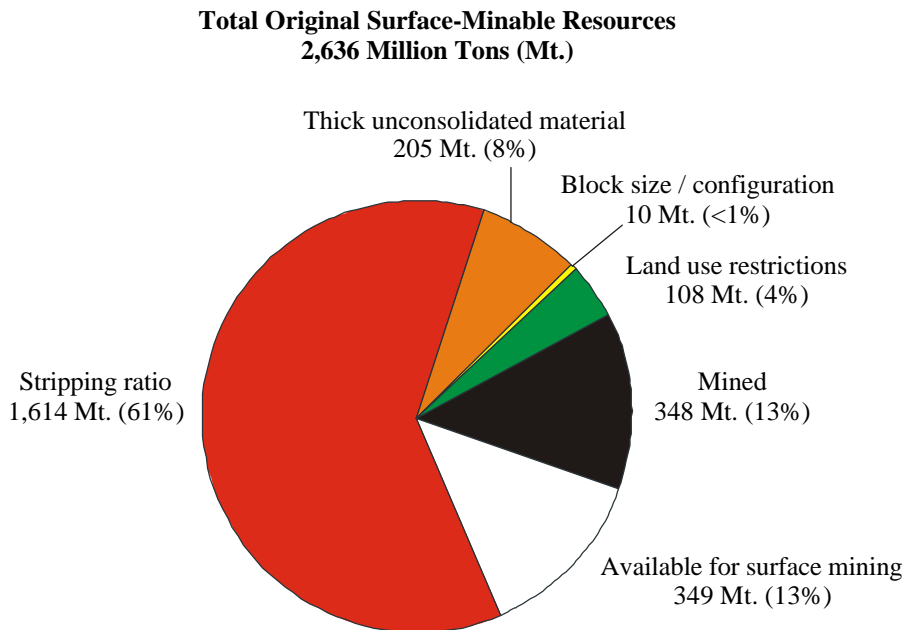


Table 7. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Indiana. Resources are reported for overburden 0 - 200 feet, and are subdivided by coal thickness (>14"-28", >28"-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Danville Coal in Indiana													
0 - 200 ft overburden													
reliability category	Measured				Indicated				Inferred				
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"
Original resources (pre-mining resources)													
Total	198,116	766,834	618,552	1,583,501	160,058	536,038	282,474	978,570	19,255	47,438	7,506	74,199	377,428
Remaining resources (post-mining resources)													
Total	181,864	612,481	493,187	1,287,532	156,528	504,893	265,177	926,597	19,255	47,438	7,506	74,199	357,646
Technological restrictions													
Stripping ratio	149,879	451,090	239,835	840,804	150,086	434,435	126,290	710,811	19,255	40,721	2,700	62,676	319,220
Thick unconsolidated	1,051	16,038	96,107	113,196	1,588	19,538	61,511	82,636	0	5,160	4,699	9,859	2,639
Block size / configuration	716	2,968	3,611	7,295	314	950	1,553	2,817	0	77	0	77	1,030
Total	151,646	470,095	339,554	961,295	151,987	454,923	189,354	796,264	19,255	45,958	7,399	72,612	322,889
Land use restrictions													
Towns	3,548	18,656	35,841	58,046	424	10,264	20,767	31,455	0	0	0	0	3,972
Public lands	1	939	662	1,601	0	527	641	1,167	0	0	0	0	1
Roads	662	1,162	2,143	3,967	229	432	783	1,444	0	24	0	24	891
Railroads	164	670	1,041	1,875	49	356	1,128	1,534	0	0	0	0	213
Pipelines	79	1,090	785	1,954	5	219	471	694	0	0	0	0	84
Oil wells	0	261	119	381	0	106	49	156	0	0	0	0	0
Underground mines	0	59	3,303	3,362	0	0	753	753	0	0	0	0	0
Total	4,454	22,837	43,893	71,184	707	11,904	24,592	37,203	0	24	0	24	5,160
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]													
Total	25,764	119,549	109,740	255,053	3,834	38,066	51,230	93,130	0	1,456	107	1,563	29,597

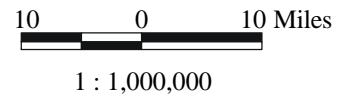
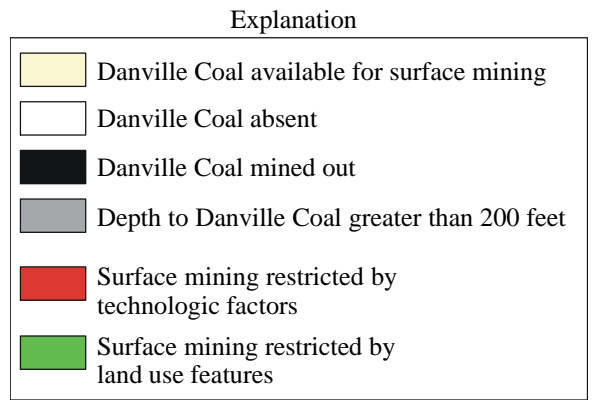
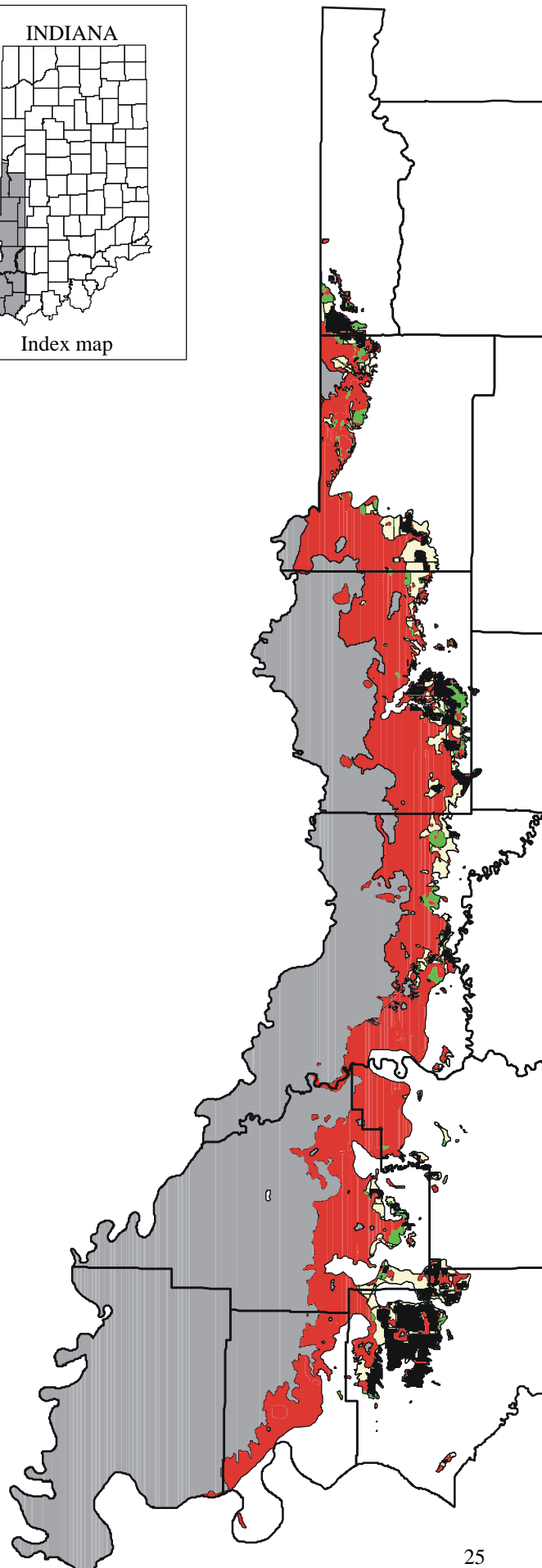
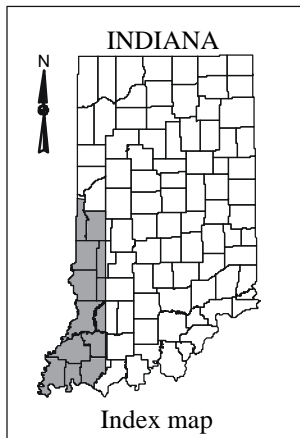


Figure 18. Map showing the areas where the Danville Coal is available for surface mining in Indiana and where surface mining is restricted.

CONCLUSIONS

The total volume of original Danville Coal resources in Indiana is calculated to be 6.55 billion short tons. Of the 6.55 billion short tons, 0.36 billion short tons have been removed by mining or lost in the mining process, thus leaving 6.19 billion short tons of remaining Danville resources. Technological and land use restrictions remove 5.36 billion short tons from potential mining, leaving 0.83 billion short tons (13% of the original resources or 13% of the remaining resources) available for mining in Indiana. Of the 0.83 billion short tons of total available resources, 0.52 billion tons (8% of the original resources or 63% of the total available resources) are available for underground mining, while 0.31 billion short tons (5% of the original resources or 37% of the total available resources) are available for surface mining.

The restrictions which had the greatest impact on the availability of the Danville Coal for both underground and surface mining were those related to seam thickness. For this study, 42 inches is the minimum seam thickness for available underground-minable coal. Although it is technologically possible to mine seams thinner than 42 inches in underground mines, most coal companies in Indiana currently find that it is not economical to do so. An examination of Figure 4 reveals that a significant portion of the Danville Coal is thinner than 42 inches. This restriction accounts for 4,529 million tons, or 82 percent of the total original underground-minable Danville Coal resources.

The restriction which had the greatest impact on the availability of the Danville Coal for surface mining was the maximum stripping ratio. Stripping ratio is the number of cubic yards of overburden that must be removed to recover one ton of coal. For this study, the maximum stripping ratio for available surface-minable coal is 25:1. Figure 8 shows those areas where surface mining of the Danville Coal is affected by this restriction. Stripping ratio accounts for 1,614 million tons, or 61 percent of the total original surface-minable Danville Coal resources.

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REFERENCES

- Chekan, G.J., Matetic, R.J. and Galek, J.A., 1986, Strata interactions in multiple-seam mining - two case studies in Pennsylvania: United States Department of the Interior, Bureau of Mines, Report of Investigations 9056, 17 p.
- Damberger, H. H., 1993, Coal: how much is really there?: Geotimes, March 1993, p. 16-18.
- Eggleston, J. R., Carter, M. D., and Cobb, J. C., 1990, Coal resources available for development - a methodology and pilot study: U.S. Geological Survey Circular 1055, 15 p.
- Mastalerz, M., and Harper, D., 1998, Coal in Indiana: A geologic overview: Indiana Geological Survey Special Report 60, 45 p.
- Wood, G. H., 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.

Daviess County, Indiana															
0 - 200 ft overburden															
reliability category	Measured				Indicated				Inferred				To		
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	
Original resources (pre-mining resources)															
Total	4	66	48	118	0	0	50	50	0	0	0	0	4	66	
Remaining resources (post-mining resources)															
Total	4	66	48	118	0	0	50	50	0	0	0	0	4	66	
Technological restrictions															
Stripping ratio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Thick unconsolidated	4	66	48	118	0	0	50	50	0	0	0	0	4	66	
Block size / configuration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	4	66	48	118	0	0	50	50	0	0	0	0	4	66	
Land use restrictions															
Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pipelines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]															
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 8. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Daviess County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Gibson County, Indiana															
0 - 200 ft overburden															
reliability category	Measured				Indicated				Inferred				To		
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	
Original resources (pre-mining resources)															
Total	87,201	133,450	27,176	247,827	25,918	49,904	18,006	93,828	0	0	0	0	113,119	183,354	
Remaining resources (post-mining resources)															
Total	86,205	128,963	25,749	240,917	25,280	48,431	18,006	91,717	0	0	0	0	111,485	177,394	
Technological restrictions															
Stripping ratio	77,009	101,410	12,596	191,015	23,185	37,706	12,405	73,296	0	0	0	0	100,195	139,116	
Thick unconsolidated	72	2,615	2,606	5,293	627	4,459	1,378	6,464	0	0	0	0	699	7,073	
Block size / configuration	170	288	299	757	152	7	3	162	0	0	0	0	322	295	
Total	77,251	104,313	15,501	197,065	23,964	42,171	13,786	79,921	0	0	0	0	101,215	146,484	
Land use restrictions															
Towns	686	5,222	2,976	8,884	110	1,264	44	1,418	0	0	0	0	796	6,486	
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Roads	65	197	0	262	57	19	0	76	0	0	0	0	122	216	
Railroads	0	90	143	233	37	69	98	204	0	0	0	0	37	159	
Pipelines	0	289	64	353	0	38	79	117	0	0	0	0	0	327	
Oil wells	0	197	0	197	0	0	0	0	0	0	0	0	0	197	
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	751	5,994	3,184	9,928	203	1,390	222	1,815	0	0	0	0	954	7,384	
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]															
Total	8,204	18,656	7,064	33,923	1,113	4,870	3,999	9,981	0	0	0	0	9,316	23,526	

Table 9. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Gibson County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Gibson County, Indiana													
>100 ft overburden													
reliability category	Measured				Indicated				Inferred				
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"
Original resources (pre-mining resources)													
Total	249,698	418,895	60,895	729,488	138,150	221,048	21,206	380,404	2	0	0	2	387,849
Remaining resources (post-mining resources)													
Total	249,698	418,825	60,895	729,418	138,150	221,048	21,206	380,404	2	0	0	2	387,849
Technological restrictions													
Seam <42 inches thick	249,698	418,825	0	668,523	138,150	221,048	0	359,198	2	0	0	2	387,849
Thin bedrock cover	0	0	3,259	3,259	0	0	12,633	12,633	0	0	0	0	0
Faulted	0	0	0	0	0	0	0	0	0	0	0	0	0
Block size / configuration	0	0	28,979	28,979	0	0	158	158	0	0	0	0	0
Total	249,698	418,825	32,238	700,761	138,150	221,048	12,791	371,989	2	0	0	2	387,849
Land use restrictions													
Towns	0	0	672	672	0	0	0	0	0	0	0	0	0
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0
Interstate Highways	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil wells	0	0	4	4	0	0	51	51	0	0	0	0	0
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	677	677	0	0	51	51	0	0	0	0	0
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]													
Total	0	0	27,981	27,981	0	0	8,365	8,365	0	0	0	0	0

Table 10 . Estimated original, remaining, restricted, and available underground minable resources (thousands of short tons) of the Danville Coal Member in Gibson County, Indiana. Resources are reported for overburden greater than 100 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of e (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Greene County, Indiana															
0 - 200 ft overburden															
reliability category	Measured				Indicated				Inferred				To		
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	
Original resources (pre-mining resources)															
Total	327	1,443	846	2,617	0	535	55	589	0	0	0	0	327	1,978	
Remaining resources (post-mining resources)															
Total	0	320	430	750	0	7	50	57	0	0	0	0	0	327	
Technological restrictions															
Stripping ratio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Thick unconsolidated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Block size / configuration	0	0	0	0	0	0	27	27	0	0	0	0	0	0	
Total	0	0	0	0	0	0	27	27	0	0	0	0	0	0	
Land use restrictions															
Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Public lands	0	0	0	0	0	7	22	30	0	0	0	0	0	7	
Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroads	0	5	55	60	0	0	0	0	0	0	0	0	0	5	
Pipelines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	5	55	60	0	7	22	30	0	0	0	0	0	12	
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]															
Total	0	315	375	690	0	0	0	0	0	0	0	0	0	315	

Table 11. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Greene County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Knox County, Indiana															
0 - 200 ft overburden															
reliability category	Measured				Indicated				Inferred				To		
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	
Original resources (pre-mining resources)															
Total	19,717	136,414	145,123	301,253	12,500	134,893	37,792	185,185	0	16,826	125	16,952	32,217	288,133	
Remaining resources (post-mining resources)															
Total	19,239	131,017	116,268	266,523	12,500	134,472	35,867	182,839	0	16,826	125	16,952	31,738	282,316	
Technological restrictions															
Stripping ratio	16,784	104,261	68,610	189,656	12,179	115,113	18,317	145,610	0	12,067	0	12,067	28,964	231,441	
Thick unconsolidated	110	1,108	27,233	28,451	0	2,999	10,213	13,212	0	3,238	25	3,262	110	7,345	
Block size / configuration	28	458	363	849	9	189	49	246	0	41	0	41	36	687	
Total	16,922	105,827	96,206	218,955	12,188	118,301	28,579	159,067	0	15,346	25	15,370	29,110	239,473	
Land use restrictions															
Towns	1,469	5,787	4,256	11,512	312	4,907	1,670	6,889	0	0	0	0	1,781	10,694	
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Roads	0	289	140	429	0	142	174	316	0	24	0	24	0	455	
Railroads	0	0	30	30	0	20	75	95	0	0	0	0	0	20	
Pipelines	20	371	163	554	0	23	0	23	0	0	0	0	20	394	
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Underground mines	0	0	1,188	1,188	0	0	233	233	0	0	0	0	0	0	
Total	1,489	6,448	5,776	13,712	312	5,092	2,152	7,557	0	24	0	24	1,801	11,564	
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]															
Total	828	18,743	14,285	33,856	0	11,079	5,136	16,215	0	1,456	101	1,557	828	31,278	

Table 12. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Knox County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Knox County, Indiana													
>100 ft overburden													
reliability category	Measured				Indicated				Inferred				
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"
Original resources (pre-mining resources)													
Total	81,026	419,369	262,861	763,256	38,626	335,829	131,360	505,814	0	15,343	221	15,563	119,651
Remaining resources (post-mining resources)													
Total	81,007	418,682	229,525	729,213	38,626	335,829	129,588	504,043	0	15,343	221	15,563	119,632
Technological restrictions													
Seam <42 inches thick	81,007	418,682	0	499,689	38,626	335,829	0	374,454	0	15,343	0	15,343	119,632
Thin bedrock cover	0	0	65,601	65,601	0	0	16,591	16,591	0	0	0	0	0
Faulted	0	0	0	0	0	0	0	0	0	0	0	0	0
Block size / configuration	0	0	18,296	18,296	0	0	701	701	0	0	0	0	0
Total	81,007	418,682	83,896	583,585	38,626	335,829	17,292	391,747	0	15,343	0	15,343	119,632
Land use restrictions													
Towns	0	0	3,826	3,826	0	0	15,016	15,016	0	0	216	216	0
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0
Interstate Highways	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0
Underground mines	0	0	10,103	10,103	0	0	634	634	0	0	0	0	0
Total	0	0	13,928	13,928	0	0	15,650	15,650	0	0	216	216	0
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]													
Total	0	0	131,700	131,700	0	0	96,647	96,647	0	0	5	5	0

Table 13 . Estimated original, remaining, restricted, and available underground minable resources (thousands of short tons) of the Danville Coal Member in Knox County, Indiana. Resources are reported for overburden greater than 100 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Pike County, Indiana															
0 - 200 ft overburden															
reliability category	Measured				Indicated				Inferred				To		
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	
Original resources (pre-mining resources)															
Total	4,819	11,256	1,151	17,226	6,476	54,053	6,342	66,872	4,668	26,462	6,872	38,002	15,963	91,771	
Remaining resources (post-mining resources)															
Total	4,320	10,658	610	15,589	5,810	52,575	6,342	64,726	4,668	26,462	6,872	38,002	14,799	89,695	
Technological restrictions															
Stripping ratio	634	6,365	0	6,998	4,854	43,870	88	48,812	4,668	24,649	2,700	32,017	10,156	74,883	
Thick unconsolidated	0	107	34	141	732	6,376	5,659	12,766	0	1,777	4,172	5,949	732	8,260	
Block size / configuration	2	72	102	176	0	12	0	12	0	36	0	36	2	120	
Total	636	6,543	136	7,315	5,585	50,258	5,747	61,590	4,668	26,462	6,872	38,002	10,890	83,263	
Land use restrictions															
Towns	17	576	0	593	0	666	0	666	0	0	0	0	17	1,242	
Public lands	1	27	0	28	0	0	0	0	0	0	0	0	1	27	
Roads	70	2	0	73	0	0	0	0	0	0	0	0	70	2	
Railroads	7	12	0	18	0	0	0	0	0	0	0	0	7	12	
Pipelines	0	0	18	18	0	0	0	0	0	0	0	0	0	0	
Oil wells	0	65	42	107	0	106	49	155	0	0	0	0	0	171	
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	95	682	60	836	0	771	49	821	0	0	0	0	95	1,453	
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]															
Total	3,590	3,433	414	7,437	225	1,546	545	2,315	0	0	0	0	3,814	4,979	

Table 14. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Pike County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Pike County, Indiana >100 ft overburden														
reliability category	Measured				Indicated				Inferred					
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	
Original resources (pre-mining resources)														
Total	913	6,961	0	7,874	4,789	44,682	165	49,636	3,867	22,153	2,923	28,943	9,570	
Remaining resources (post-mining resources)														
Total	913	6,961	0	7,874	4,789	44,682	165	49,636	3,867	22,153	2,923	28,943	9,570	
Technological restrictions														
Seam <42 inches thick	913	6,961	0	7,874	4,789	44,682	0	49,471	3,867	22,153	0	26,020	9,570	
Thin bedrock cover	0	0	0	0	0	0	165	165	0	0	2,923	2,923	0	
Faulted	0	0	0	0	0	0	0	0	0	0	0	0	0	
Block size / configuration	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	913	6,961	0	7,874	4,789	44,682	165	49,636	3,867	22,153	2,923	28,943	9,570	
Land use restrictions														
Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0	
Interstate Highways	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0	
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]														
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 15 . Estimated original, remaining, restricted, and available underground minable resources (thousands of short tons) of the Danville Coal Member in Pike County, Inc Resources are reported for overburden greater than 100 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Posey County, Indiana															
0 - 200 ft overburden															
reliability category	Measured				Indicated				Inferred				To		
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	
Original resources (pre-mining resources)															
Total	18	969	0	987	481	1,356	0	1,837	0	0	0	0	500	2,325	
Remaining resources (post-mining resources)															
Total	18	969	0	987	481	1,356	0	1,837	0	0	0	0	500	2,325	
Technological restrictions															
Stripping ratio	18	969	0	987	481	1,356	0	1,837	0	0	0	0	500	2,325	
Thick unconsolidated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Block size / configuration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	18	969	0	987	481	1,356	0	1,837	0	0	0	0	500	2,325	
Land use restrictions															
Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pipelines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]															
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 16. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Posey County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Posey County, Indiana														
>100 ft overburden														
reliability category	Measured				Indicated				Inferred					
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	
Original resources (pre-mining resources)														
Total	90,854	452,500	11,374	554,728	215,483	386,823	2,132	604,438	35,892	22,279	0	58,172	342,229	
Remaining resources (post-mining resources)														
Total	90,854	452,500	11,374	554,728	215,483	386,823	2,132	604,438	35,892	22,279	0	58,172	342,229	
Technological restrictions														
Seam <42 inches thick	90,854	452,500	0	543,354	215,483	386,823	0	602,306	35,892	22,279	0	58,172	342,229	
Thin bedrock cover	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Faulted	0	0	244	244	0	0	0	0	0	0	0	0	0	0
Block size / configuration	0	0	11,086	11,086	0	0	2,132	2,132	0	0	0	0	0	0
Total	90,854	452,500	11,330	554,684	215,483	386,823	2,132	604,438	35,892	22,279	0	58,172	342,229	
Land use restrictions														
Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interstate Highways	0	0	44	44	0	0	0	0	0	0	0	0	0	0
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	44	44	0	0	0	0	0	0	0	0	0	0
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]														
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 17 . Estimated original, remaining, restricted, and available underground minable resources (thousands of short tons) of the Danville Coal Member in Posey County, Indiana. Resources are reported for overburden greater than 100 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Sullivan County, Indiana															
0 - 200 ft overburden															
reliability category	Measured				Indicated				Inferred				To		
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	
Original resources (pre-mining resources)															
Total	27,777	238,949	185,506	452,231	29,631	139,105	42,513	211,249	0	26	0	26	57,408	378,080	
Remaining resources (post-mining resources)															
Total	26,965	206,238	160,534	393,737	29,631	125,891	33,833	189,355	0	26	0	26	56,596	332,155	
Technological restrictions															
Stripping ratio	26,159	166,153	97,297	289,609	29,627	111,772	16,531	157,930	0	26	0	26	55,786	277,951	
Thick unconsolidated	131	6,746	15,639	22,515	0	3,946	4,058	8,005	0	0	0	0	0	131	
Block size / configuration	1	834	997	1,832	0	183	1,008	1,191	0	0	0	0	0	1	
Total	26,291	173,733	113,932	313,956	29,627	115,901	21,597	167,125	0	26	0	26	55,918	289,660	
Land use restrictions															
Towns	4	3,214	8,039	11,258	0	857	5,522	6,379	0	0	0	0	0	4	
Public lands	0	912	662	1,574	0	519	619	1,138	0	0	0	0	0	0	
Roads	0	269	285	554	0	18	116	134	0	0	0	0	0	0	
Railroads	0	55	235	290	0	23	39	62	0	0	0	0	0	0	
Pipelines	0	123	133	256	0	119	192	311	0	0	0	0	0	0	
Oil wells	0	0	77	77	0	0	0	0	0	0	0	0	0	0	
Underground mines	0	56	821	877	0	0	149	149	0	0	0	0	0	0	
Total	4	4,629	10,253	14,886	0	1,536	6,636	8,172	0	0	0	0	0	4	
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]															
Total	670	27,876	36,349	64,896	4	8,454	5,600	14,057	0	0	0	0	0	674	

Table 18. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Sullivan County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Sullivan County, Indiana >100 ft overburden													
reliability category	Measured				Indicated				Inferred				
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"
Original resources (pre-mining resources)													
Total	97,378	310,157	162,868	570,403	94,480	301,484	47,226	443,190	14	856	81	951	191,872
Remaining resources (post-mining resources)													
Total	97,374	305,779	159,789	562,942	94,480	301,435	47,106	443,021	14	856	81	951	191,869
Technological restrictions													
Seam <42 inches thick	97,374	305,779	0	403,153	94,480	301,435	0	395,915	14	856	0	870	191,869
Thin bedrock cover	0	0	32,748	32,748	0	0	10,628	10,628	0	0	0	0	0
Faulted	0	0	0	0	0	0	0	0	0	0	0	0	0
Block size / configuration	0	0	39,155	39,155	0	0	7,838	7,838	0	0	81	81	0
Total	97,374	305,779	71,903	475,056	94,480	301,435	18,466	414,381	14	856	81	951	191,869
Land use restrictions													
Towns	0	0	4,814	4,814	0	0	846	846	0	0	0	0	0
Public lands	0	0	122	122	0	0	0	0	0	0	0	0	0
Interstate Highways	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil wells	0	0	1,893	1,893	0	0	0	0	0	0	0	0	0
Underground mines	0	0	744	744	0	0	0	0	0	0	0	0	0
Total	0	0	7,573	7,573	0	0	846	846	0	0	0	0	0
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]													
Total	0	0	80,313	80,313	0	0	27,794	27,794	0	0	0	0	0

Table 19 . Estimated original, remaining, restricted, and available underground minable resources (thousands of short tons) of the Danville Coal Member in Sullivan County Resources are reported for overburden greater than 100 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Vanderburgh County, Indiana															
0 - 200 ft overburden															
reliability category	Measured				Indicated				Inferred				To		
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	
Original resources (pre-mining resources)															
Total	10,167	2,055	839	13,060	61,542	7,783	415	69,740	13,348	3,359	0	16,707	85,056	13,197	
Remaining resources (post-mining resources)															
Total	10,167	2,055	839	13,060	61,542	7,783	415	69,740	13,348	3,359	0	16,707	85,056	13,197	
Technological restrictions															
Stripping ratio	10,167	1,988	0	12,154	61,542	7,783	0	69,325	13,348	3,215	0	16,563	85,056	12,985	
Thick unconsolidated	0	0	464	464	0	0	0	0	0	145	0	145	0	145	
Block size / configuration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	10,167	1,988	464	12,618	61,542	7,783	0	69,325	13,348	3,359	0	16,707	85,056	13,130	
Land use restrictions															
Towns	0	0	375	375	0	0	415	415	0	0	0	0	0	0	
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pipelines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	375	375	0	0	415	415	0	0	0	0	0	0	
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]															
Total	0	67	0	67	0	0	0	0	0	0	0	0	0	67	

Table 20. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Vanderburgh County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Vanderburgh County, Indiana													
>100 ft overburden													
reliability category	Measured				Indicated				Inferred				
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"
Original resources (pre-mining resources)													
Total	47,663	19,551	0	67,214	155,717	45,958	0	201,675	16,064	1,699	0	17,763	219,444
Remaining resources (post-mining resources)													
Total	47,663	19,551	0	67,214	155,717	45,958	0	201,675	16,064	1,699	0	17,763	219,444
Technological restrictions													
Seam <42 inches thick	47,663	19,551	0	67,214	155,717	45,958	0	201,675	16,064	1,699	0	17,763	219,444
Thin bedrock cover	0	0	0	0	0	0	0	0	0	0	0	0	0
Faulted	0	0	0	0	0	0	0	0	0	0	0	0	0
Block size / configuration	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	47,663	19,551	0	67,214	155,717	45,958	0	201,675	16,064	1,699	0	17,763	219,444
Land use restrictions													
Towns	0	0	0	0	0	0	0	0	0	0	0	0	0
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0
Interstate Highways	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]													
Total	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 21 . Estimated original, remaining, restricted, and available underground minable resources (thousands of short tons) of the Danville Coal Member in Vanderburgh County, Indiana. Resources are reported for overburden greater than 100 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Vermillion County, Indiana															
0 - 200 ft overburden															
reliability category	Measured				Indicated				Inferred				To		
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	
Original resources (pre-mining resources)															
Total	0	580	69,495	70,075	0	0	13,129	13,129	0	0	509	509	0	580	
Remaining resources (post-mining resources)															
Total	0	526	27,455	27,981	0	0	10,237	10,237	0	0	509	509	0	526	
Technological restrictions															
Stripping ratio	0	369	1,844	2,213	0	0	3,082	3,082	0	0	0	0	0	369	
Thick unconsolidated	0	137	5,025	5,162	0	0	2,512	2,512	0	0	503	503	0	137	
Block size / configuration	0	0	777	777	0	0	147	147	0	0	0	0	0	0	
Total	0	506	7,646	8,152	0	0	5,741	5,741	0	0	503	503	0	506	
Land use restrictions															
Towns	0	20	9,489	9,509	0	0	2,031	2,031	0	0	0	0	0	20	
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroads	0	0	326	326	0	0	130	130	0	0	0	0	0	0	
Pipelines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Underground mines	0	0	304	304	0	0	0	0	0	0	0	0	0	0	
Total	0	20	10,119	10,139	0	0	2,161	2,161	0	0	0	0	0	20	
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]															
Total	0	0	9,690	9,690	0	0	2,335	2,335	0	0	6	6	0	0	

Table 22. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Vermillion County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Vermillion County, Indiana													
>100 ft overburden													
reliability category	Measured				Indicated				Inferred				
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"
Original resources (pre-mining resources)													
Total	0	423	19,633	20,056	0	0	6,930	6,930	0	0	0	0	0
Remaining resources (post-mining resources)													
Total	0	369	8,793	9,162	0	0	6,033	6,033	0	0	0	0	0
Technological restrictions													
Seam <42 inches thick	0	369	0	369	0	0	0	0	0	0	0	0	0
Thin bedrock cover	0	0	1,208	1,208	0	0	1,428	1,428	0	0	0	0	0
Faulted	0	0	0	0	0	0	0	0	0	0	0	0	0
Block size / configuration	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	369	1,208	1,577	0	0	1,428	1,428	0	0	0	0	0
Land use restrictions													
Towns	0	0	347	347	0	0	0	0	0	0	0	0	0
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0
Interstate Highways	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0
Underground mines	0	0	148	148	0	0	0	0	0	0	0	0	0
Total	0	0	495	495	0	0	0	0	0	0	0	0	0
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]													
Total	0	0	7,090	7,090	0	0	4,604	4,604	0	0	0	0	0

Table 23 . Estimated original, remaining, restricted, and available underground minable resources (thousands of short tons) of the Danville Coal Member in Vermillion County, Indiana. Resources are reported for overburden greater than 100 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Vigo County, Indiana														
0 - 200 ft overburden														
reliability category	Measured				Indicated				Inferred				To	
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"
Original resources (pre-mining resources)														
Total	9,566	97,116	180,611	287,293	13,182	118,090	159,584	290,856	449	235	0	684	23,197	215,442
Remaining resources (post-mining resources)														
Total	9,521	86,251	156,411	252,183	13,182	117,833	155,936	286,951	449	235	0	684	23,152	204,319
Technological restrictions														
Stripping ratio	7,864	52,863	59,067	119,794	12,953	108,254	75,785	196,992	449	235	0	684	21,266	161,353
Thick unconsolidated	730	4,864	44,697	50,291	229	1,739	37,641	39,609	0	0	0	0	959	6,603
Block size / configuration	0	465	1,064	1,529	0	100	318	418	0	0	0	0	0	565
Total	8,594	58,192	104,828	171,614	13,182	110,093	113,745	237,020	449	235	0	684	22,225	168,520
Land use restrictions														
Towns	308	2,413	10,706	13,428	0	1,630	11,086	12,715	0	0	0	0	308	4,043
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Roads	3	92	1,589	1,684	0	148	312	460	0	0	0	0	3	240
Railroads	0	294	252	545	0	132	644	776	0	0	0	0	0	425
Pipelines	0	176	406	582	0	0	200	200	0	0	0	0	0	176
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underground mines	0	3	990	994	0	0	371	371	0	0	0	0	0	3
Total	312	2,978	13,943	17,233	0	1,909	12,611	14,521	0	0	0	0	312	4,887
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]														
Total	616	25,081	37,640	63,336	0	5,831	29,580	35,410	0	0	0	0	616	30,911

Table 24. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Vigo County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Vigo County, Indiana >100 ft overburden													
reliability category	Measured				Indicated				Inferred				
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"
Original resources (pre-mining resources)													
Total	12,195	51,512	124,787	188,494	15,544	132,898	137,606	286,048	687	490	0	1,176	28,425
Remaining resources (post-mining resources)													
Total	12,195	50,871	116,497	179,563	15,544	132,898	136,240	284,682	687	490	0	1,176	28,425
Technological restrictions													
Seam <42 inches thick	12,195	50,871	0	63,066	15,544	132,898	0	148,442	687	490	0	1,176	28,425
Thin bedrock cover	0	0	49,387	49,387	0	0	46,717	46,717	0	0	0	0	0
Faulted	0	0	0	0	0	0	0	0	0	0	0	0	0
Block size / configuration	0	0	5,442	5,442	0	0	5,466	5,466	0	0	0	0	0
Total	12,195	50,871	54,829	117,895	15,544	132,898	52,183	200,625	687	490	0	1,176	28,425
Land use restrictions													
Towns	0	0	3,235	3,235	0	0	1,578	1,578	0	0	0	0	0
Public lands	0	0	741	741	0	0	290	290	0	0	0	0	0
Interstate Highways	0	0	400	400	0	0	83	83	0	0	0	0	0
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0
Underground mines	0	0	1,320	1,320	0	0	261	261	0	0	0	0	0
Total	0	0	5,695	5,695	0	0	2,213	2,213	0	0	0	0	0
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]													
Total	0	0	55,973	55,973	0	0	81,845	81,845	0	0	0	0	0

Table 25 . Estimated original, remaining, restricted, and available underground minable resources (thousands of short tons) of the Danville Coal Member in Vigo County, In Resources are reported for overburden greater than 100 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Warrick County, Indiana														
0 - 200 ft overburden														
reliability category	Measured				Indicated				Inferred				To	
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"
Original resources (pre-mining resources)														
Total	38,520	144,537	7,759	190,815	10,328	30,318	4,588	45,234	789	530	0	1,319	49,637	175,385
Remaining resources (post-mining resources)														
Total	25,424	45,420	4,844	75,687	8,102	16,545	4,441	29,088	789	530	0	1,319	34,315	62,494
Technological restrictions														
Stripping ratio	11,244	16,713	421	28,378	5,265	8,581	82	13,928	789	530	0	1,319	17,298	25,824
Thick unconsolidated	5	396	361	761	0	18	0	18	0	0	0	0	0	414
Block size / configuration	515	850	10	1,375	154	460	0	614	0	0	0	0	668	1,311
Total	11,763	17,959	792	30,515	5,419	9,059	82	14,560	789	530	0	1,319	17,971	27,548
Land use restrictions														
Towns	1,064	1,424	0	2,488	1	940	0	942	0	0	0	0	1,066	2,364
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Roads	523	312	129	965	172	106	181	459	0	0	0	0	696	418
Railroads	157	215	0	372	13	112	142	267	0	0	0	0	170	327
Pipelines	59	132	0	191	5	39	0	44	0	0	0	0	64	171
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,804	2,083	129	4,016	191	1,197	323	1,711	0	0	0	0	1,995	3,280
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]														
Total	11,857	25,378	3,922	41,157	2,492	6,288	4,036	12,817	0	0	0	0	14,349	31,666

Table 26. Estimated original, remaining, restricted, and available surface minable resources (thousands of short tons) of the Danville Coal Member in Warrick County, Indiana. Resources are reported for overburden 0-200 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).

Warrick County, Indiana													
>100 ft overburden													
reliability category	Measured				Indicated				Inferred				
coal thickness (inches)	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"	28 - 42"	>42"	Subtotal	14-28"
Original resources (pre-mining resources)													
Total	4,762	13,937	891	19,589	1,499	7,261	50	8,810	574	530	0	1,104	6,835
Remaining resources (post-mining resources)													
Total	4,762	11,031	746	16,540	1,499	7,259	50	8,808	574	530	0	1,104	6,835
Technological restrictions													
Seam <42 inches thick	4,762	11,031	0	15,793	1,499	7,259	0	8,758	574	530	0	1,104	6,835
Thin bedrock cover	0	0	0	0	0	0	0	0	0	0	0	0	0
Faulted	0	0	0	0	0	0	0	0	0	0	0	0	0
Block size / configuration	0	0	746	746	0	0	50	50	0	0	0	0	0
Total	4,762	11,031	746	16,540	1,499	7,259	50	8,808	574	530	0	1,104	6,835
Land use restrictions													
Towns	0	0	0	0	0	0	0	0	0	0	0	0	0
Public lands	0	0	0	0	0	0	0	0	0	0	0	0	0
Interstate Highways	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil wells	0	0	0	0	0	0	0	0	0	0	0	0	0
Underground mines	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0
Available resources = [Remaining resources - (Technological restrictions + Land use restrictions)]													
Total	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 27 . Estimated original, remaining, restricted, and available underground minable resources (thousands of short tons) of the Danville Coal Member in Warrick County Resources are reported for overburden greater than 100 feet, and are subdivided by coal thickness (14-28", 28-42", and >42"), and reliability of estimate (Measured = 0-0.5 miles from data points; Indicated = 0.5-2 miles from data points; and Inferred = 2-4 miles from data points).