DEPARTMENT OF NATURAL RESOURCES
ILLINOIS STATE GEOLOGICAL SURVEY
Morris Nickell
Director

For further information about this map contact:
Coal Section
Illinois State Geological Survey
615 East Peabody Drive
Champaign, IL 61820
(217) 244-2414

Availability of the Springfield Coal for Mining in Illinois

Map Summary of Illinois Minerals 118

Colin G. Treworgy, Christopher P. Korose, Cheri A. Chenoweth, and Daniel L. North

2000

Introduction

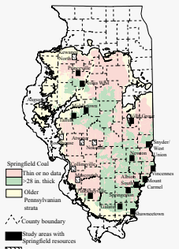
The 63 billion tons of Springfield Coal remaining in Illinois are the second largest coal resource in the state. They represent 97% of the 65 billion tons of original resources of Springfield Coal, the other 2 billion tons having been mined or lost in mining during the more than 100 years of mining Illinois coal. The degree to which this remaining resource is a viable fuel for the future depends on the availability of deposits that can be mined at a cost that is competitive with other coals and alternative fuels.

This is a map summary of Illinois State Geological Survey publication *Illinois Minerals 118*. This map sheet identifies those resources that have the most favorable geologic and land use characteristics for mining, shows the probable trend of future mining of these resources, and alerts mining companies to geologic conditions that have a potentially negative impact on mining costs.

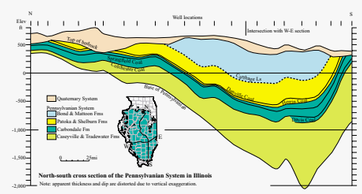
Geology and Minability

The Springfield Coal can be traced throughout the Illinois Basin. The coal crops out along the margins of the basin, but in much of the central and eastern part of the state, the overburden is buried by tens to hundreds of feet of glacial and alluvial deposits. The coal dips toward the center of the basin, reaching depths of more than 1,000 feet. More than 11,000 square miles of Springfield Coal resources have been mapped in Illinois. Surface minable resources are at least 18 inches thick and less than 150 feet deep, and underground minable resources are at least 28 inches thick. The resources occur mostly in two regions: southeastern and central Illinois. The thickest resources (up to 10 feet thick) in southeastern Illinois commonly occur along and within several miles of the Galatia Channel, a river system that was contemporaneous with the ancient peat swamp in which the coal formed (Hopkins 1968, Hopkins et al. 1977). In addition to apparently influencing the coal thickness, the Galatia Channel affected the sulfur content and mining conditions of the coal. In central Illinois, the thickest deposits (up to 7 feet thick) are north and east of the city of Springfield.

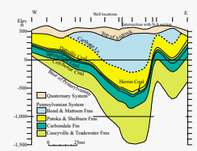
This map is based on a series of studies that examined the availability of coal in Illinois for future mining. These studies assessed the availability of coal in 2.7-7.5-minute quadrangles that were representative of mining conditions found in various parts of the state. Factors that restrict availability of coal were identified through interviews with more than 40 mining engineers, geologists, and other mining specialists representing 17 mining companies, consulting firms, and government agencies active in the Illinois mining industry. The major geologic and land use factors that were found to limit surface and underground mining of the Springfield Coal are listed in the tables to the right and depicted in this statewide assessment of the availability of the Springfield Coal. The factors that are considered to restrict mining are divided into two categories: land use and technological. Other conditions that are unfavorable for mining, but don't necessarily limit it are listed in a third category: potential restrictions. The land use factors consist of various land uses that are in some cases specifically protected from mining, but in most cases are simply uneconomical to mine. The technological factors consist of geologic conditions that are likely to raise mining costs to uneconomical levels. A few of these factors are illustrated. A complete explanation of all factors is given in *Illinois Minerals 118*.



Location of quadrangles studied for available coal



North-south cross section of the Pennsylvanian System in Illinois
Note: apparent thickness and dip are distorted due to vertical exaggeration.



East-west cross section of the Pennsylvanian System in Illinois
Note: thickness and dip are distorted due to vertical exaggeration.

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Chou, C.-L., 1991, Distribution and Forms of Chlorine in Illinois Basin Coals, *in* Chlorine in Coal, J. Stringer and D. D. Banerjee, eds., Elsevier Science Publishers, Amsterdam, p. 11-29.

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Treworgy, C.G., E.L. Prussen, M.A. Jenton, C.A. Chenoweth, M.H. Barph, R.J. Jacobson, and H.H. Damberger, 1997, Illinois Coal Reserve Assessment and Database Development: Final Report, Illinois State Geological Survey Open File Series 1997-4, 105 p.

See also the list of reports on available coal resources.

Criteria used to define resources available for underground mining

Technological restrictions	
Minimum seam thickness	42 in.
Maximum depth	75 ft
Maximum ratio of bedrock to unconsolidated overburden	1:1
Minimum interburden between minable seams	40 ft
Minimum size of mining block (clean coal)	40 million tons
Faults - width of zone of no mining on each side of fault	
Cottage Grove Fault System	
Master fault	500 to 1000 ft
Other faults	200 ft
Rend Lake Fault Zone	200 ft
Centralia Fault Zone	300 ft
Wabash Valley Fault System	800 ft
Galatia Channel	no mining within 0.5 mi
Land use restrictions (width of unminable coal around feature)	
Surface and underground mines	200 ft
Towns	0 ft*
Public lands	100 ft
Interstate highways	100 ft
Major airports	100 ft
Cemeteries	100 ft
Closely spaced oil wells (>7 wells per 40 acres)	**
Potential restrictions	
Closely spaced oil wells	4-7 wells per 40 acres
Bedrock cover	75-100 ft
Dykerohmy Shale	Transition zone at edge of deposit
Potential land use conflicts	Areas where land use patterns are incompatible with mining.

*Actual setback depends on depth, coal thickness, and mining method. Because the municipal boundaries used are commonly larger than the actual developed area, we did not use any buffer around towns. Resources underlying towns are unminable.
**Actual setback is dependent on site-specific factors including depth of coal and age and operational status of the oil well. We have delineated the approximate areas that will be restricted from mining.

Criteria used to define resources available for surface mining

Technological restrictions	
Minimum seam thickness	18 in.
Maximum depth	200 ft
Maximum unconsolidated overburden	60 ft
Stripping ratio (cubic yards of overburden/ton of raw coal; volumes and weights not adjusted for swell factors or cleaning losses)	
Minimum	25:1
Maximum average	20:1
Minimum size of mine reserve (clean coal)	
Cumulative tonnage needed to support mine development and operation	10 million tons
Individual block size (thousands of tons)	
Less than 50 ft of overburden	150
More than 50 ft of overburden	500
Land use restrictions (width of unminable coal around feature)	
Underground mines	200 ft
Towns	0.5 mi
Public lands	100 ft
Railroads	100 ft
Major state highways	100 ft
Major airports	100 ft
Cemeteries	100 ft
Potential restrictions	
Potential land use conflicts	All otherwise available surface minable coal in areas where land use is incompatible with mining.

Individual Quadrangle Reports on Available Coal Resources

Jacobson, R.J., C.G. Treworgy, and C. Chenoweth, 1996, Availability of Coal Resources for Mining in Illinois, Mt. Carmel Quadrangle, Southeastern Illinois: Illinois State Geological Survey Minerals 114, 39 p.

Treworgy, C. G., 1999, Coal Resources Map and Availability of Coal for Mining, Villa Grove Quadrangle, Douglas County, IL: Illinois State Geological Survey IGQ Villa Grove-CR.

Treworgy, C.G., C.A. Chenoweth, and M.H. Barph, 1995, Availability of Coal Resources for Mining in Illinois: Galatia Quadrangle, Saline and Hamilton Counties, Southern Illinois: Illinois State Geological Survey Illinois Minerals 113, 38 p.

Treworgy, C.G., C.A. Chenoweth, and R.J. Jacobson, 1996, Availability of Coal Resources for Mining in Illinois, Newton and Princeville Quadrangles, Jasper, Perrin, and Stark Counties: Illinois State Geological Survey Open File Series 1996-5, 47 p.

Treworgy, C.G., C.A. Chenoweth, and M.A. Jenton, 1996, Availability of Coal Resources for Mining in Illinois, Atwater, Carlinville, and Nokomis Quadrangles, Christian, Macoupin, Madison, Montgomery, and St. Clair Counties: Illinois State Geological Survey Open File Series 1996-2, 33 p.

Treworgy, C.G., C.A. Chenoweth, J.L. McBeth, and C.P. Korose, 1997, Availability of Coal Resources for Mining in Illinois, Augusta, Kewanee North, Muscatuna, Pittsburgville, and Rossville East Quadrangles, Adams, Brown, Greene, Henry, Perry, Schuyler, and St. Clair Counties: Illinois State Geological Survey Open File Series 1997-10, 72 p.

Treworgy, C.G., G.K. Coats, and M.H. Barph, 1994, Availability of Coal Resources for Mining in Illinois, Middletown Quadrangle, Central Illinois: Illinois State Geological Survey Circular 554, 48 p.

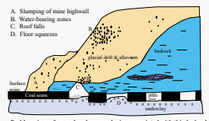
Treworgy, C.G., J.L. McBeth, C.A. Chenoweth, C.P. Korose, and D.L. North, 1998, Availability of Coal Resources for Mining in Illinois, Albion South, Peoria West, Snyder-West Union, Springerton, and Tallula Quadrangles, Edwards, Gallatin, Hamilton, Pope, Wabash, Wayne, and White Counties: Illinois State Geological Survey Open File Series 1998-4, 82 p.

Treworgy, C.G. and D.L. North, 1999, Availability of Coal Resources for Mining in Illinois, Shawneetown Quadrangle, Gallatin County, Illinois and Union County, Kentucky: Illinois State Geological Survey Open File Series 1999-7, 35 p.

Treworgy, C.G., D.L. North, C.L. Conedy, and L.C. Furer, 1999, Resources Maps and Availability for Mining of the Danville, Jamestown/Hymera, Springfield, Sawyer, and Sadorville Coals: Illinois State Geological Survey IGQ Vincennes-CR.

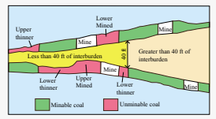
Report on the Availability of the Springfield Coal

Treworgy, C.G., C.P. Korose, C.A. Chenoweth, and D.L. North, 1999, Availability of the Springfield Coal for Mining in Illinois: Illinois State Geological Survey, Illinois Minerals 118, 41 p.



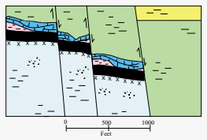
Problems in surface and underground mines associated with thin bedrock cover overlain by thick unconsolidated sediments

Slumping of the highwall and excess inflows of water may be encountered in surface mines with more than about 60 feet of unconsolidated overburden. Roof falls, floor squeezes, and water inflows may be experienced in underground mines with less than 100 feet of bedrock cover or a bedrock to unconsolidated overburden ratio of less than 1:1.



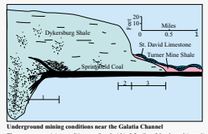
Effect of interburden thickness on underground mining

In areas where the interburden between two seams is less than 40 feet thick, only one of the two seams can be mined. The thinner of the two seams is considered unminable.



Cross section illustrating multiple, parallel faults displacing a coal seam

Many fault zones consist of multiple parallel faults with varying amounts of displacement. Although mines can mine through the zones, most companies find it uneconomical to mine past the first or second displacement encountered.

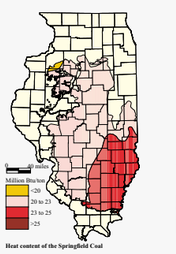


Underground mining conditions near the Galatia Channel

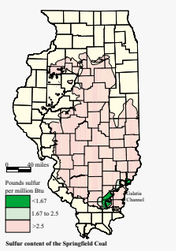
The most severe mining conditions are found within 0.5 miles of the channel (zone 1). These conditions include (A) local washouts and pinch-outs of coal and abrupt changes in coal elevation, (B) thick partings, and (C) weak facies of roof rock. Mining problems are also encountered in areas where there are abrupt changes in the thickness of the Dykerohmy Shale (zone 2) and in the transition zone at the edge of the Dykerohmy Shale (zone 3).

Quality

The Springfield Coal is a high volatile bituminous coal that ranges from rank A in the southeastern corner of the state to rank C in the northwestern two-thirds of the state. Heat content ranges over the same area from more than 25 million Btu per ton to less than 20 million Btu per ton, which is equivalent to more than 12,500 Btu per pound to less than 10,000 Btu per pound (as-received basis, ar). Ash is commonly in the range of 9 to 12% (ar), slightly lower ash content is reported in the southeastern part of the state. The sulfur content of the coal is commonly more than 3 pounds of sulfur per million Btu in the northwestern two-thirds of the state. In the southeastern third, the coal associated with the Galatia Channel. In these areas, the sulfur content of the coal is as low as less than 1 pound of sulfur per million Btu (about 1% sulfur). Chlorine content of the coal is loosely correlated to depth and increases from less than 0.1% (dry basis) at shallow depths along the margins of the basin to greater than 0.6% in the central part of the basin (Chou 1991).



Heat content of the Springfield Coal



Sulfur content of the Springfield Coal

Resources

Approximately 41% of the original Springfield resources (27 billion tons) are available for mining. Available means that the geologic, land use and geologic conditions related to mining are not likely to result in extraordinary mining difficulties. Resources with thin (<42 inches) overburden are comparable to those for other coals currently mined in the state. Of these resources, 23 billion tons are 42 to 66 inches thick, and 4 billion tons are greater than 66 inches thick. An additional 2.6 billion tons of the Springfield resources are available but have geologic or land use conditions that may make them less favorable for mining. Technological factors (geologic conditions and engineering parameters such as size of reserve block) restrict mining of 47% of the resources, and land use (e.g., towns, highways) restricts mining of 5% of the resources.

Most of the Springfield Coal resources have greater than 2.5 pounds of sulfur per million Btu and are only suited for the high-sulfur coal market. Only 1.4 billion tons of the remaining Springfield resources have a sulfur content of 0.6 to 1.7 pounds of sulfur per million Btu. However, the majority of these medium to low sulfur resources (1 billion tons) are classified as available or available with potential restrictions. Technological factors, such as geologic conditions associated with faults and channels, are the primary restrictions on mining these lower sulfur deposits.

Only about 8 billion tons of the original Springfield resources are less than 200 feet deep and potentially minable by surface methods. Of these resources, 15% have already been mined and 12% (just under 1 billion tons) are available for surface mining. Land use, primarily towns, restricts 16% of the resources. Technological factors, primarily stripping ratio and thick unconsolidated material, restrict 57% of the resources.

Most of the available Springfield resources will have to be mined by underground methods. Of the original resources that are at least 75 feet deep, 41% are available for underground mining. An additional 4% are available but with potential restrictions that make the resources less desirable. These potential restrictions are the presence of closely spaced oil wells, less stable roof strata, or close proximity to developing urban areas. The major technological factors that restrict mining are thin interburden between the Springfield Coal and an overlying seam, unfavorable thicknesses of bedrock and unconsolidated overburden, and coal less than 42 inches thick. Land use restricts underground mining of 5% of the resources, and 3% have already been mined or lost in mining.

The available resources are primarily located in the central and southeastern portions of the state and are well suited for high-efficiency longwall mining. The resources are relatively flat-lying with a consistent seam thickness over large areas; relatively free of faults, channels, or other geologic anomalies; located predominantly in rural areas free from oil wells and other surface development; and occur in minable blocks of hundreds of millions of tons. Whether or not the resources are ultimately mined depends on a variety of other factors that have not been assessed, including willingness of local landowners to lease the coal, demand for a particular quality of coal, transportation infrastructure, proximity of the deposit to markets, and cost and availability of competing fuels.

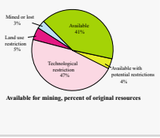
Remaining resources by county and availability by mining method (millions of tons)

	Remaining resources	Total available	Available by mining method: Surface	Underground
Cass	1,016	1,016	<1	1,016
Christian	1,233	399	-	399
Clark	1,664	989	-	989
Clay	1,996	1,237	-	1,237
Clinton	80	-	-	-
Coles	1,279	411	-	411
Crawford	1,278	100	-	100
Cumberland	1,315	36	-	36
DeWitt	1,496	308	-	308
Douglas	459	-	-	-
Edgar	1,121	292	-	292
Edwards	1,123	411	-	411
Effingham	2,181	848	-	848
Fayette	2,288	345	-	345
Ford	41	-	-	-
Franklin	2,066	1,211	-	1,211
Fulton	656	259	187	68
Gallatin	1,000	123	123	-
Hamilton	2,426	1,700	-	1,700
Jackson	243	153	30	123
Jasper	2,139	104	-	104
Jefferson	2,879	1,961	-	1,961
Lawrence	1,123	123	123	-
Lawrence	1,499	738	-	738
Livingston	214	-	-	-
Logan	2,807	1,375	-	1,375
McLean	3,956	176	-	176
Macon	2,383	1,898	-	1,898
Marion	2,490	1,512	-	1,512
Marion	1,000	268	62	206
Morgan	39	-	-	-
Moultrie	66	42	-	42
Perry	1,308	407	99	311
Perry	323	107	32	75
Pike	1,000	291	-	291
Randolph	179	68	68	-
Richland	1,702	1,290	-	1,290
Saline	824	445	4	441
Sangamon	3,078	1,663	225	1,404
Shelby	1,000	59	59	-
Shelby	1,958	692	-	692
Tazewell	458	-	-	-
Wabash	1,007	520	-	520
Warren	1	<1	<1	-
Washington	39	10	-	10
Wayne	2,950	1,394	-	1,394
White	1,000	1,000	-	1,000
Williamson	888	698	38	660
Woodford	247	-	-	-
Total	63,773	26,986	966	26,020

Availability of the Springfield Coal for mining, billions of tons

Numbers in parentheses are percent of original resources. Note: surface and underground resources do not add to total because coal 75 to 200 feet deep is included in both categories.

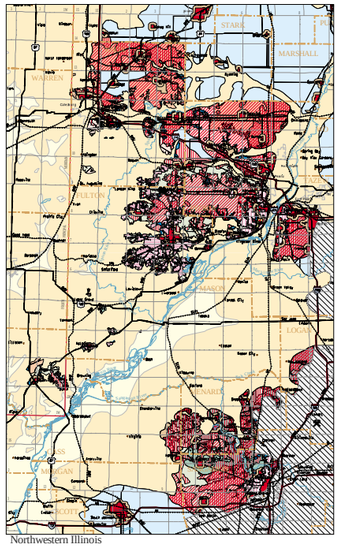
	Total	Mining method: Surface	Underground	Pounds of sulfur/mill. Btu: <1.67	1.67 to 2.5	>2.5
Original	65.1	8.8	63.0	1.8	10.3	53.1
Mined	2.2 (3)	1.1 (13)	1.8 (3)	0.4 (23)	1.8 (5)	
Remaining	63.0 (97)	8.7 (87)	61.2 (97)	1.4 (77)	8.5 (97)	
Available	27.0 (41)	0.9 (12)	26.1 (41)	0.8 (46)	26.2 (41)	
Available with potential restrictions	2.6 (4)	<0.1(<1)	2.6 (4)	0.2 (12)	2.4 (4)	
Technological restrictions	30.2 (47)	4.5 (57)	29.6 (47)	0.2 (14)	29.0 (47)	
Land use restrictions	3.2 (5)	1.2 (14)	3.0 (5)	<0.1 (4)	3.1 (5)	



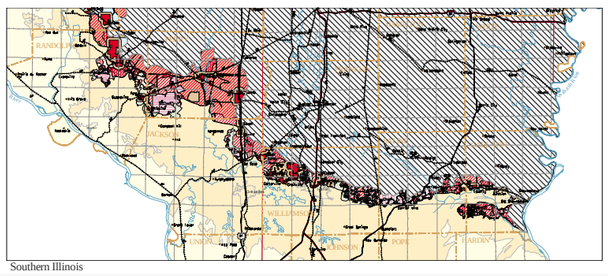
Available for mining, percent of original resources

Surface Mining

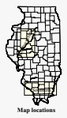
The areas of available surface minable coal are limited in tonnage and areal extent. Towns, high stripping ratios, and thick unconsolidated overburden restrict mining of significant quantities of resources. Future surface mining operations will be smaller in size and production relative to past operations and will use mobile equipment that can be easily moved to another site.



Northwestern Illinois



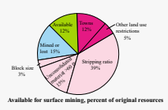
Southern Illinois



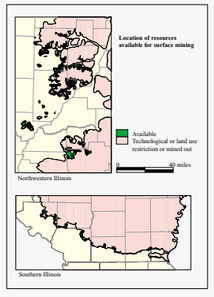
Map locations

Resources available for surface mining, millions of tons and percent of original resources

Original	**7,804**
Mined (percent of original)	**1,274 (15)**
Remaining (percent of original)	**6,410 (85)**
Available	**920 (12)**
Available w/ potential restrictions	**15 (<1)**
Potential land use conflict	15 (<1)
Land use restrictions	**1,247 (16)**
Towns	1,129 (14)
Roads	65 (1)
Pipelines	62 (1)
Public lands	39 (<1)
Railroads	39 (<1)
Underground mines	173 (2)
Airports	11 (<1)
Major dams	<1 (<1)
Technological restrictions	**4,472 (57)**
Stripping ratio	3,064 (39)
Thick unconsolidated material	1,195 (15)
Block too small	214 (3)



Available for surface mining, percent of original resources



Factors influencing the availability of coal for surface mining

COAL THICKNESS
- Greater than 66 inches
- 42 to 66 inches
- 28 to 42 inches
- Less than 28 inches
- Insufficient data
- Sandstone channel

OTHER GEOLOGIC FACTORS
- Rocks of Pennsylvanian System eroded
- Extent of rocks of Pennsylvanian System

MINED AREAS
- Mined area: surface
- Mined area: underground
- Active mine

SURFACE FEATURES
- Stream or small river
- Large river, lake

POTENTIAL RESTRICTIONS
- Potential land use conflict

LAND USE RESTRICTIONS
- Town not restrictive to mining
- Land use restriction (see table above)
- U.S. Highway
- Interstate
- Railroad
- Pipeline

TECHNOLOGICAL RESTRICTIONS
- Coal depth greater than 200 feet
- Unfavorable stripping ratio
- Unconsolidated overburden thickness greater than 60 feet
- Mining block too small

Scale 1:500,000
0 — 40 miles
0 — 40 kilometers

Underground Mining

Most of the resources of Springfield Coal will have to be mined by underground methods. The available resources are primarily located in the central and southeastern portions of the state and are well suited for high-efficiency longwall mining. The resources are relatively flat-lying, have a consistent seam thickness over large areas, are relatively free of faults, channels, or other geologic anomalies, are located predominantly in rural areas free from oil wells and other surface development, and occur in minable blocks of hundreds of millions of tons. To avoid high mining costs resulting from unfavorable geologic conditions, companies siting underground mines should avoid areas of thick drift and thin bedrock cover, areas in close proximity to the Galatia Channel and fault zones, areas of closely spaced oil wells, and areas in the transition zone at the edge of the Dykerohmy Shale.

Acknowledgments

We are especially appreciative of the information given to us by mining experts on criteria that limit the minability of coal. Interviews were conducted with AMAX Coal Company, Arch Minerals, Arclar Coal Company, Black Beauty Coal Company, Consolidation Coal Company, Cyprus-AMAX Coal Company, Freeman United Coal Mining Company, Kerr-McGee Coal Company, MAPCO Coal Inc., Midstate Coal Company, Monterey Coal Company, Old Ben Coal Company, Peabody Coal Company, Sahara Coal Company, Sugar Camp Coal Company, Tarrin Coal Company, Weir International Mining Consultants, and the Illinois Office of Mines and Minerals.

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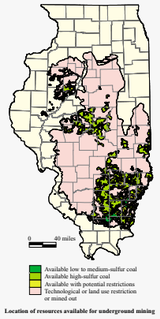
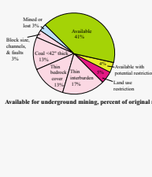


Location of resources available for underground mining

Resources available for underground mining, millions of tons and percent of original resources

Original	**62,990**
Mined (percent of original)	**17,764 (28)**
Remaining (percent of original)	**45,226 (072)**
Available	**26,109 (41)**
Available with potential restrictions	**2,708 (4)**
Oil wells	1,326 (2)
Underworked seam	504 (<1)
Thin or no data (100 ft thick)	1,382 (<1)
Potential land use conflict	77 (<1)
Land use restrictions	**2,979 (5)**
Towns	1,765 (3)
Public lands	463 (<1)
Railroads	463 (<1)
Abandoned mines	190 (<1)
Interstate highways	100 (<1)
Major airports	9 (<1)
Dams	<1 (<1)
Technological restrictions	**29,460 (47)**
Thin interburden	19,048 (27)
Seam <42 inches thick	8,354 (13)
Thin bedrock cover	8,131 (13)
Block size	1,206 (2)
Near channel	817 (1)
Faulted	339 (<1)



Available for underground mining, percent of original resources

Factors influencing the availability of coal for underground mining

COAL THICKNESS
- Greater than 66 inches
- 42 to 66 inches
- 28 to 42 inches
- Less than 28 inches
- Split coal
- Insufficient data
- Sandstone channel

COAL DEPTH
- 200 feet
- 500 feet
- 1000 feet

OTHER GEOLOGIC FACTORS
- Rocks of Pennsylvanian System eroded
- Extent of rocks of Pennsylvanian System
- Low- to medium- sulfur coal

MINED AREAS
- Mined area: surface
- Mined area: underground
- Active mine

SURFACE FEATURES
- Stream or small river
- Large river, lake

POTENTIAL RESTRICTIONS
- Potential land use conflict
- 4 to 7 oil wells/40 acres
- Bedrock overburden thickness 75 to 100 feet
- Transition between the Dykerohmy Shale and Turner Mine Shale/St. David Limestone

LAND USE RESTRICTIONS
- Town not restrictive to mining
- Land use restriction (see table above)
- Greater than 7 oil wells/40 acres
- Interstate

TECHNOLOGICAL RESTRICTIONS
- Thin interburden *
- Bedrock overburden thickness less than 40 feet
- Bedrock overburden thickness 40 to 75 feet
- Bedrock to unconsolidated overburden ratio 0 to 0.5
- Bedrock to unconsolidated overburden ratio 0.5 to 1.0
- Area affected by faults/dikes
- Mining block too small
- Within 0.5 mile of Galatia Channel

* Interburden between the Herrin and Springfield Coals less than 40 feet and Herrin mined or thicker than Springfield

Scale 1:500,000
0 — 40 miles
0 — 40 kilometers

Base map compiled at the Illinois State Geological Survey from digital data provided by the U.S. Geological Survey, the Illinois Department of Transportation, and the Illinois State Geological Survey.
North American Datum 1983
Lambert conformal conic projection, standard parallels 33° and 45°.
Railroads updated to 1996.
Mined areas updated to January 1999.