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Availability of Coal Resources for Mining in Illinois

Albion South, Peoria West, Snyder-West Union, Springerton, and Tallula Quadrangles, Clark, Edwards, Hamilton, Menard, Peoria, Sangamon, and White Counties

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EXECUTIVE SUMMARY

This report is one of a series examining the availability of coal resources for mining in Illinois. It describes mapping of coal resources and related geologic features in five quadrangles (Albion South, Peoria West, Snyder-West Union, Springerton, and Tallula). Coal company and state government experts were interviewed to determine how regulatory restrictions, cultural features, mining technology, and geologic, economic, and environmental conditions affect resource availability in the five quadrangles. Mining conditions in the Peoria West and Tallula Quadrangles are representative of those associated with surface and shallow underground mining of the Herrin and Springfield Coals in the west-central portion of Illinois. The Peoria West Quadrangle is located in a near urban setting and the Tallula Quadrangle is located in a rural setting. Conditions in these quadrangles demonstrate how suburban development and the thickness of unconsolidated overburden relative to bedrock overburden restrict the availability of surface and underground minable resources.

The Albion South and Springerton Quadrangles are representative of mining conditions in that part of the Illinois Basin in southeastern Illinois where the coal lies at considerable depth. Mining conditions associated with the peat-contemporaneous Galatia Channel, the post-peat Anvil Rock Channel, wide fault zones, and areas of closely-spaced oil wells are some of the conditions that restrict the availability of resources in this area.

The Snyder-West Union Quadrangle is representative of mining conditions on the east-central margin of the basin. This is the only region in the state where the Jamestown Coal is thick enough to mine underground and one of only a few regions where the Danville and Seelyville Coals are underground minable. The thickness of interburden between the Danville and Jamestown Coals and partings in the Seelyville Coal were found to impose significant restrictions on available resources.

The tonnage of the original coal resources and the percentage available for mining in each quadrangle are shown in table 1. The category "Available with Conditions" is used for resources that meet the criteria for available coal, but have some additional characteristic that may ultimately limit their availability. In the Albion South and Springerton Quadrangles these are resources in areas of closely-spaced oil wells. Coal can and has been mined in such areas, but mining costs are higher and the use of longwall equipment may be impractical. In the Tallula Quadrangle and in part of the Peoria West Quadrangle, the conditionally available resources are resources that will only be recovered if the underlying seam is surface mined. Most of the conditionally available resources on the Peoria West Quadrangle are in areas where there are potential conflicts between mining and patterns of community development. Although mining is not legally restricted in these areas, the high land values, ongoing suburban development, potential for community opposition to or interference with mining activities, and long term liability for surface subsidence make it unlikely that mining will be attempted. In the Snyder-West Union Quadrangle, most resources are believed to have chlorine contents of close to 0.5% or higher. Although coal with this chlorine content can be used, there is no current market for the coal, and no coal in Illinois with this high of a chlorine content is being mined.

Technological factors such as stripping ratio, thickness of unconsolidated and bedrock overburden, thickness of interburden, block size, low yield of clean coal due to partings, and poor mining conditions associated with faults, channels, partings, and roof stratigraphy restrict the availability of 22% to 72% of the resources in each quadrangle. Land-use features (towns, roads, railroads, cemeteries, abandoned mines) restrict another 1% to 39% of the resources. Peoria West is the only one of the quadrangles studied that has had any significant mining. About 11% of the original resources have been mined out.

Table 1 Summary of the original resources and their availability for mining in the Albion South, Peoria West, Snyder-West Union, Springerton, and Tallula Quadrangles; millions of tons and (percent of original resources).

Quadrangle	Original	Mined out	Available	W/conditions	Technological	Land use
Albion South	725	0 (0)	363 (50)	39 (5)	311 (43)	13 (2)
Peoria West	485	55 (11)	10 (2)	115 (23)	117 (25)	188 (39)
Snyder-West Union	1,027	0 (0)	0 (0)	432 (42)	587 (57)	8 (1)
Springerton	901	0 (0)	602 (67)	77 (9)	205 (23)	16 (2)
Tallula	358	5 (1)	40 (11)	12 (3)	258 (72)	43 (12)

INTRODUCTION

Accurate estimates of the amount of coal resources available for mining are needed for planning by federal and state agencies, local communities, utilities, mining companies, companies supplying goods and services to the mining industry, and other energy consumers and producers. Current inventories of coal resources in Illinois provide relatively accurate estimates of the total amount of coal in the ground (e.g. Treworgy et al. 1997b), but the actual percentage that is minable is not well defined. Environmental and regulatory restrictions, the presence of towns and other cultural features, current mining technology, geologic conditions, and other factors significantly reduce the amount of coal available for mining.

Recognizing this difference between the reported tonnage and the tonnage of actual minable coal, the United States Geological Survey (USGS) initiated a program in the late 1980s to assess the amount of available coal in the United States (Eggleston et al. 1990). As part of this ongoing, cooperative effort, the Illinois State Geological Survey (ISGS) is assessing the availability of coal resources for future mining in Illinois. This report assesses the availability of coal resources in five quadrangles: Albion South, Peoria West, Snyder-West Union, Springerton, and Tallula (fig. 1). It also discusses the implications of these findings to the availability of coal for mining in larger regions of the state. The background of this program and a detailed description of the framework for the investigations in Illinois are provided in previous reports (e.g. Treworgy et al. 1994).

Selection of Quadrangles

Treworgy et al. (1994) divided Illinois into seven regions, each representing a distinct combination of geologic and physiographic characteristics (fig. 1), and selected two to four quadrangles representative of the mining conditions in each region. Quadrangle selection and resource assessment both focus on resources that have the highest potential for development (e.g. thick or lower sulfur content seams). This approach ensures that the most economically important deposits receive sufficient study and that little time is spent on coal that is unlikely to ever become available for mining.

Maps at 1:24,000-scale showing the major coal seams, related geology, mines, and land use in each quadrangle were compiled based on previous regional investigations of mining conditions, resources, and geology. These maps provided the basis for detailed discussions with experts from mining companies, consulting firms, and government agencies active in the Illinois mining industry to identify the factors that affect the availability of coal in each quadrangle. Each quadrangle was discussed with three or more experts to develop a set of criteria defining available coal. These rules were then applied to each quadrangle to calculate the available resources and identify the factors that restrict significant quantities of resources from being minable.

The quadrangles studied for this report were selected to provide data for several objectives. The Peoria West Quadrangle is the fourth quadrangle to be assessed in region 2 and completes the set of individual quadrangle studies of mining conditions in that region. There has been extensive mining in the quadrangle, but significant surface minable and shallow underground minable resources remain. The ongoing growth of nearby urban areas raises the potential for conflicts between mining and other land use. The Tallula Quadrangle represents mining conditions along the subcrop of the Herrin and Springfield Coals in region 3 and completes the set of studies planned for that region. The Albion South and Springerton Quadrangles complete the quadrangle studies planned to assess major deposits of low to medium sulfur Springfield Coal in southeastern Illinois (regions 4 and 7), as well as deep underground minable deposits of the Herrin and Davis Coals. The Snyder-West Union Quadrangle is the first study of this series that looks at the coal resources in east-central Illinois (region 5). This area contains significant resources in several seams that are only minable in limited areas of the state: the Danville, Jamestown, Survant, and Seelyville.

Coal Resource Classification System

The ISGS follows the terms and definitions of the USGS coal resource classification system (Wood et al. 1983). With minor modifications to suit local conditions, these definitions provide a standardized basis for compilations and comparisons of nationwide coal resources and reserves.

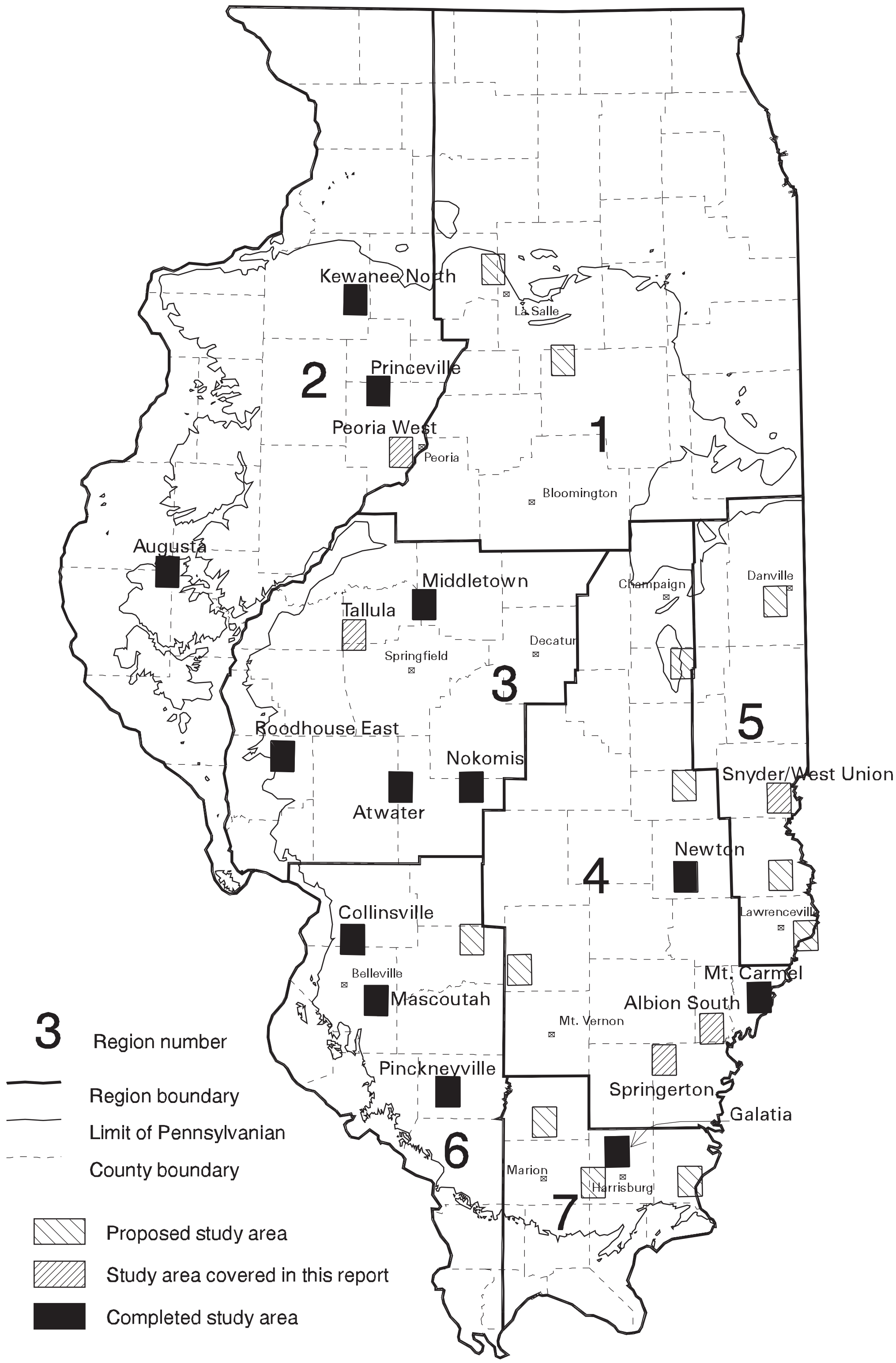


Figure 1 Coal resource regions and quadrangle study areas

The term “original resources” refers to the amount of coal resources originally in the ground prior to any mining. The ISGS has traditionally defined resources as all coal in the ground that is 18 or more inches in thickness and less than 150 feet deep, or all coal 28 or more inches thick. This definition was modified for this report to include coal less than 200 feet deep and at least 12 inches thick. These modifications were made to provide consistency with our estimates of original and available resources in the quadrangles previously studied.

The term “available coal” is not a formal part of the USGS system, although it is commonly used by the USGS and many state geological surveys. Available coal, as used in this report, does not imply that particular coal deposits can be mined economically at the present time. Rather, the term designates deposits that have no significant characteristics likely to make them technically, legally, or economically unminable for the foreseeable future. Determining the actual cost and profitability of these deposits requires further engineering and marketing assessments.

Sources of Data

Geologic data for this study were compiled from drillers logs, core descriptions, and geophysical logs from coal and oil tests. Mine boundaries were compiled from the best available mine map for each mine. In cases where no map was available, the location of the mine was marked with a point symbol and, if possible, the general area of mining was delineated. Surface elevations were acquired from USGS 7.5-minute topographic maps. Information on land cover features such as cemeteries, roads, railroads, and towns were compiled from topographic maps or extracted from USGS Digital Line Graph files. All major surface features were verified by field reconnaissance. The coal resources in the Peoria West Quadrangle were mapped for previous studies (Cady 1952, Smith and Berggren 1963). No significant new stratigraphic data are available for this quadrangle, so the thickness and depth maps from the previous studies were used for this assessment of available coal.

Previous Investigations

The ISGS has evaluated the availability of coal resources in thirteen other quadrangles located in the northwestern, central, and southern parts of the state (Treworgy et al. 1994, Treworgy et al. 1995, Jacobson et al. 1996, Treworgy et al. 1996a, 1996b, and Treworgy et al. 1997a). Seventeen coal seams have been assessed in these studies. The coal found to be available for mining in each quadrangle ranged from as little as 18% to as much as 79% of the original resources.

Each quadrangle represents a different geologic and geographic setting in Illinois and each quadrangle study identifies and defines factors that influence the availability of resources in that setting. Some factors, such as roof conditions, are different for each seam while other factors, such as minimum seam thickness, are applicable to all seams. Some factors, such as cemeteries, have the same effect on mining throughout the state while the effects of other factors, such as roads, are dependent on the region of the state and value of the underlying coal.

FACTORS AFFECTING THE AVAILABILITY OF COAL

Most factors that restrict mining are based on economic and social considerations and are not absolute restrictions on mining. Companies can choose to mine in areas of severe roof or floor conditions if they are willing to bear the higher operating costs, interruptions and delays in production, and lower employee morale that result from operating in these conditions. It is possible to surface mine through most roads and undermine small towns if a company is willing to invest the time and expense necessary to gain approval from the appropriate governing units and individual landowners, and to mitigate damages. Previous economic and social conditions have at times enabled companies to mine in areas where some factors are now restrictive. The current highly competitive price environment in the coal industry, which makes coal that is more expensive to mine uneconomic, is expected to prevail in the Illinois Basin indefinitely. Therefore, the criteria used to determine available coal for this report are likely to cover mining conditions for the foreseeable future.

The following factors, which define available coal in the five quadrangles are a composite set of rules based on our interviews with mining companies (table 2). The restrictions are organized according to the mining method they apply to; surface or underground mining as currently practiced in Illinois.

Table 2 Criteria used to define available coal in the Albion South, Peoria West, Snyder-West Union, Springerton, and Tallula Quadrangles.

Surface Mining

Technological Restrictions

- Minimum seam thickness
  - Main seam: 1 foot
  - Overlying seams: 0.5 feet
  - Underlying seams: 1 foot
- Maximum depth: 200 feet
- Maximum glacial and alluvial overburden: see table 3
- Stripping ratio (cubic yards of overburden/ton of raw coal; volumes and weights not adjusted for swell factors or cleaning losses):
  - Maximum: 25:1
  - Maximum average: 20:1
- Minimum size of mine reserve (clean coal)
  - Cumulative tonnage needed to support a mine and preparation plant: 10 million tons
  - Individual block size:
    - Less than 40 ft of overburden: 150 thousand tons
    - More than 40 ft of overburden: 500 thousand tons

Land use restrictions

- 100 ft buffer: Cemeteries, Railroads, State highways, Other paved roads (Peoria West only), High voltage transmission towers
- 200 ft buffer: Large underground mines
- 500 ft buffer: Subdivisions
- 2,640 ft buffer: Towns

Underground Mining

Technological Restrictions

- Minimum seam thickness: 3.5 ft
- Minimum bedrock cover:
  - Springfield Coal on the Peoria West Quadrangle and all coals on the Tallula Quadrangle: 75 ft
  - Herrin Coal on the Peoria West Quadrangle: 40 ft
- Minimum size of mining block (clean coal):
  - Peoria West, Tallula: 20 million tons
  - Albion South, Snyder-West Union, Springerton: 40 million tons
- Albion-Ridgeway Fault: no mining within 1,000 ft
- Galatia Channel: no mining of the Springfield Coal within 2,640 ft
- Dykersburg Shale: no mining in the Springfield Coal in areas with abrupt changes in shale thickness
- Anvil Rock Sandstone: no mining of the Herrin Coal where sandstone is less than 5 ft above the coal or within 1,800 ft of the main channel
- Partings:
  - Minimum yield: 65% clean coal recovered per ton of material mined
  - No mining of coal with partings greater than 1 ft thick over extensive areas (e.g. 40 acres or more)
  - No mining individual benches of Springfield Coal where partings are more than 3 ft thick

Land use restrictions

- 200 ft buffer: Abandoned mines
- 100 ft buffer (Peoria West), 200 ft (Snyder-West Union, Tallula), 400 ft (Albion South, Springerton):
  - Towns and subdivisions, churches and schools, cemeteries, high voltage transmission towers (Peoria West), interstate highways, airports

Available with Conditions

- Only if surface mined in combination with overlying or underlying seam:
  - Resources meet criteria for stripping ratio and/or block size only when combined with resources in an underlying or overlying seam.
- Closely-spaced oil wells: Areas of 4 or more active or abandoned wells on 20 acre spacings or closer
- Potential land use conflicts:
  - All otherwise available surface or underground minable coal within 2,640 ft of towns or subdivisions in areas where land use patterns are incompatible with mining.
- Coal quality limitations: resources with chlorine contents > 0.4%

Surface minable coals were found in the Peoria West and Tallula Quadrangles. All quadrangles contained underground minable coal.

Surface Minable Coal

Depth of Seam Depending on their thickness, coals less than 175 to 200 feet deep can be mined by either surface methods or underground methods (provided there is sufficient bedrock cover). The choice of surface or underground methods will depend on the comparative cost of extraction and the overall character of a company's reserves at a specific site. For example, if a company's reserve block is primarily deeper than 150 feet, it may elect to mine all of the coal by underground methods. Coals may be unavailable for surface mining due to their stripping ratio, a function of depth and thickness. Stripping ratio is discussed separately below.

Thickness of Seam The minimum thickness of coal for surface mining is 1 foot for the lowermost seam in an interval to be mined, and 0.5 feet for overlying seams within the interval. Thinner seams are impractical to recover because the amount of out-of-seam dilution becomes too great a percentage of the material handled.

Stripping Ratio The stripping ratio is the ratio of cubic yards of overburden that must be removed to recover one ton of coal. Whereas the thickness and depth of coal that can be economically mined are controlled in part by technical factors such as mining equipment, the maximum stripping ratio is strictly an economic limit. Coals with high stripping ratios may be more economical to mine by underground methods or may remain unmined until the market price for coal rises relative to production costs.

Companies calculate stripping ratios on the basis of the anticipated tonnage of clean coal that will be produced. This calculation requires assumptions about the type and performance of mining and washing equipment to be used, as well as tests of the washability of the coal. For this study, the stripping ratios are based on the tonnage of in-place coal. This tonnage excludes partings, commonly clastic sediment deposited in the peat by nearby streams. This tonnage is probably 5 to 15 percent higher than the actual tonnage of clean coal after mining and cleaning losses.

Some companies use a “swell factor” to account for the increase in volume of overburden after it is blasted. Swell factors for lithologies typically encountered in Illinois mines range from 1 (no swell) for sand to 1.7 for shale (Allsman and Yopes 1973). Although this is a large range, this swell factor requires such detailed site-specific knowledge about the quantities of different lithologies in the overburden (e.g. shale, limestone, sand, clay), that we could not use it in our calculations. Cubic yards of overburden were calculated simply from the total thickness of consolidated and unconsolidated material overlying the coal.

For this study, the maximum stripping ratio adopted for available coal was 25 cubic yards of overburden per ton of in-place coal (25:1). The maximum average stripping ratio for any mining block was 20:1. Because we have not used clean coal tonnages or swell factors, these ratios are higher than the limits currently used by most companies.

Thickness of Bedrock and Unconsolidated Overburden Thick deposits of glacial drift or alluvial sediment can restrict surface mining because of their potential to slump into the pit, fail under the weight of large draglines, and allow excessive groundwater flow into the pit (fig. 2). A minimum amount of bedrock overburden is needed to ensure that the coal is not weathered, and to provide stable material to hold the toe of the spoil pile. The maximum thickness of unconsolidated material that can be handled is dependent on the lithologic composition of the overburden, its physical properties (e.g. load bearing capacity, permeability), and the presence or absence of groundwater. The minimum bedrock and maximum glacial drift thicknesses that were handled by the companies we interviewed also depended on the mining plan and the type of equipment they were using to remove overburden.

We did not compile sufficient information to assess the lithology and physical properties of the unconsolidated sediment in the quadrangles studied. The experience of the companies suggests that for an overburden thickness of 50 feet or less, a minimum of 10 feet of bedrock cover is needed. For overburden between 50 and 100 feet thick, one-third to one-half the material should be bedrock (table 3). The maximum thickness of unconsolidated overburden that can be handled over a large mining area is approximately 50 feet. Small areas of thicker unconsolidated overburden can be mined, but large areas of thick unconsolidated overburden will be avoided.

Size and Configuration of Mining Block A mine reserve must contain sufficient tonnage to allow companies to recover the costs of developing a mine (e.g. drilling, land acquisition, construction of surface facilities, initial box cuts and shafts, and purchase of equipment). Because of lower development costs, greater equipment mobility, and flexibility in operating plans, surface mines can be developed with smaller reserves and mining blocks than underground mines. Surface mines can be developed using trucks and earthmoving equipment that can be readily transported to the site.

Although there are exceptions, most Illinois coals are cleaned to some degree before final shipment. The coal can be trucked from the mine pit over the existing road network to a central preparation plant. The minimum reserve for a surface mine is 10 million saleable tons. For this study we assumed that this is equivalent to about 12.5 million tons of raw coal in place. The reserve may be distributed among a number of adjacent blocks. Each mining block should contain at least 150 thousand tons of saleable coal if the coal is less than 40 feet deep or 500 thousand tons if the coal is greater than 40 feet deep.

Land Use Although any land use or surface feature can be undermined or mined through if a company obtains permission from the owner and agrees to repair damages, companies generally find it impractical to mine under or through certain features because of the expense of restoring the feature, or the social and political hurdles required to obtain the necessary permission. This study considers all coal under towns, rural subdivisions, railroads, airports, high voltage transmission towers, schools, churches, and cemeteries as unavailable for surface mining.

Roads can be a significant barrier to surface mining. Because of local opposition to mining and the relatively low value of coal beneath roads (because of seam thickness), most roads in the western and northwestern parts of the state, including the Peoria West Quadrangle, are considered a restriction to surface mining. In southern Illinois, the general acceptance of surface mining by the local population

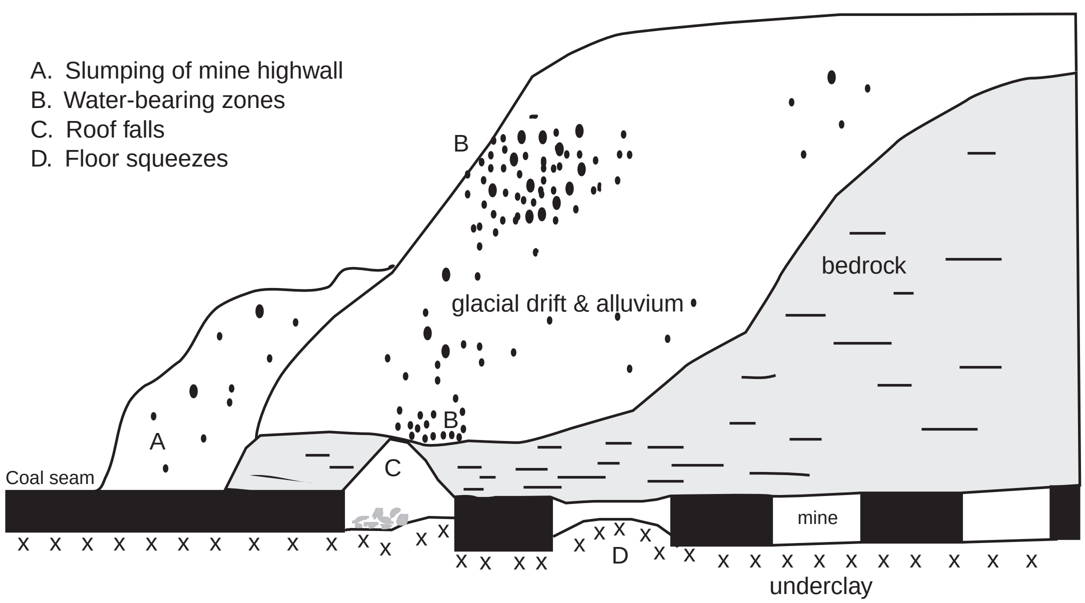


Figure 2. Problems encountered in surface and underground mines that have overburden consisting of thick unconsolidated sediments over thin bedrock.

and the higher tonnage of coal per acre make it feasible for companies to surface mine through lightly used roads. We considered only state and federal highways to be a restriction to surface mining in the Tallula Quadrangle.

A buffer of unmined coal must be left around any property or surface feature that cannot be disturbed. State law requires that surface mines leave a 100 foot buffer around churches and schools. Although the law requires only a 100 foot buffer around dwellings, in practice a larger buffer is left around towns because of the potential disturbance by dust, vibrations from blasting, and disruption of water wells. We used a buffer of 500 feet around rural subdivisions and a half mile around towns.

Abandoned Mine Workings Illinois law requires that surface mines have an unmined barrier of coal 500 feet wide around active or abandoned underground mine workings. This requirement may be waived under certain conditions and surface mines have in many instances mined through all or portions of small abandoned underground mines. This may be done because the extent of the underground workings is not known or the area of the underground workings is so small that it is not worth the expense of diverting the surface operation around it. Large abandoned underground mines are commonly avoided by surface mining because the amount of recoverable coal is significantly reduced and there is a potential for large quantities of water to be present in the abandoned mine. For this study, we assumed that surface mines will obtain waivers to mine through small abandoned underground mines and to mine within 200 feet of large abandoned underground mines.

Underground Minable Coal

Depth of Seam The depth of coals in Illinois (most resources are less than 1,500 feet deep) is not by itself a technological restriction on mining. Coals as deep as 1,000 feet are currently being mined. However, it is more expensive to develop a mine in deeper resources, so larger mining blocks are required.

Thickness of Seam For this study, 3.5 feet is the minimum thickness of available coal for underground mining. Mining thinner seams, although technologically possible, is economically unfeasible because larger reserve blocks are required, movement of miners and equipment is more difficult, normal out-of-seam dilution from the roof and floor becomes a larger percentage of the material handled, and the tonnage produced per mining cycle is reduced. These factors make it difficult to extract coal at a rate sufficient to recover the capital investment in facilities for a modern underground mine.

Thickness of Bedrock and Unconsolidated Overburden Underground mining requires adequate bedrock overburden to support the mine roof and seal the mine against water seepage down from the surface (fig. 2). If the bedrock cover is too thin (or significantly weathered), the mine roof may not be strong enough to support the overburden. Unconsolidated overburden material (glacial drift and alluvium) is not self-supporting and can add considerable pressure to the mine roof and pillars. Weak underclay, which can block mine entries and make the roof unstable by squeezing out from under pillars, is commonly associated with areas where less than half of the overburden is bedrock.

In addition to the dangers and expense of roof failures and floor squeezes, fractures resulting from mine roof failure may extend to the bedrock surface and allow water to enter the mine. At best, water seepage makes the movement of equipment more difficult and creates additional expenses for pumping and disposing of the water. In the worst case, the influx of water is rapid and equipment may be

Table 3 Minimum thickness of bedrock and maximum thickness of unconsolidated deposits surface-minable for specified thicknesses of overburden (feet).

Overburden	Mininum bedrock	Maximum Unconsolidated
10	10	0
20	10	10
30	10	20
40	10	30
50	10	40
60	20	40
70	23	47
80	30	50
90	40	50
>100		50

damaged and the lives of miners threatened. In 1883, 69 miners drowned in the Diamond Mine near Braidwood (Dept. of Mines and Minerals 1954). Other, less serious, cases of mine flooding have occurred over the years.

A conservative rule used by some companies that is likely to guarantee good mining conditions is that the thickness of bedrock overburden should exceed the thickness of unconsolidated overburden. However, the amount of bedrock required can vary, depending on local geologic conditions such as the depth of the seam, composition of the bedrock overburden, and thickness of the glacial overburden.

Rock strength tests are needed to determine the minimum bedrock for specific areas. For these studies we have used minimum thicknesses based on mining practice in nearby areas or areas with similar roof strata. We used 75 feet as the minimum thickness of bedrock for underground mining in the Tallula Quadrangle and for the Springfield Coal in the Peoria West Quadrangle. The overburden above these coals is mostly shale. Some limestone and sandstone are present above the Herrin Coal in the Peoria West Quadrangle. Because these rock types are stronger than shale, for example, greater proportions of limestone and sandstone in the bedrock mean less bedrock is needed than might otherwise be the case. We used 40 feet for the minimum bedrock cover for the Herrin Coal in the Peoria West Quadrangle.

Thickness of Interburden Between Seams The interburden between two coal seams must contain competent strata of sufficient thickness so that mining of one seam will not disrupt the stability of the roof or floor of the other seam (Chekan et al. 1986). The minimum thickness of interburden required between two seams depends on several geo-technical variables, including the lithology of the interburden, the thickness and depth of the coals, and the method and sequence of mining the two seams (Hsiung and Peng 1987a, 1987b).

Among the quadrangles studied for this report, only the thickness of interburden between the Danville and Jamestown Coal in the Snyder-West Union Quadrangle was of concern. The interburden consists of varying amounts of shale, siltstone, sandstone, and claystone. Where this interburden is less than 40 feet thick, only one of the coals can be mined. In this case, we assumed that the Danville Coal would be the preferred seam because of its higher quality.

Faults Faults disrupt mining operations and increase mining costs by displacing the coal seam, weakening the mine roof, and creating paths for the flow of gas or water into the mine (Nelson 1981). Displacements of even a few feet are difficult or impossible for longwall equipment to negotiate. Larger displacements block all mine advancement and may require extensive tunneling through rock to re-enter the coal bed on the opposite side. The amount of coal restricted from mining by faults depends on the characteristics of the specific fault. If a fault is a single sharp plane, mining can advance to it from either side and little if any coal is lost. In other cases, the zone of disturbance can be hundreds of feet wide. For example, mine operators in the Wabash Valley Fault System have encountered numerous minor faults, intense jointing, and substantial dips in the coal seam within a zone several hundred feet wide parallel to the main fault (Marvin Thompson and Alan Kern, personal communication). Some large in-flows of water and some squeezing of the floor after mining were experienced in this area. Using careful advance planning and extra exploratory drilling, operators have mined across these zones (Koehl and Meier 1983). Mining within the fault zone is kept to a minimum because of the expense and delay of supporting the weakened mine roof and altering the mine plan to work through or around displaced blocks of coal. In practice, mining operations routinely advanced to within 200 to 2,000 feet of the main fault trace (fig. 3). Because the distance of advance is dependent on conditions encountered at the time of mining, this report assumes that, on average, a zone of 1,000 feet on either side of the main fault trace will be left unmined.

Partings Peat accumulation was periodically interrupted by deposition of clastic sediments from nearby streams. These layers of sediment, commonly called partings, can be a fraction of an inch to tens of feet thick. Partings can cause roof stability problems, reduce the productivity of a mine, increase the wear of mining and coal preparation equipment, reduce the efficiency of the mine's preparation plant, and increase the amount of waste material that must be stored in waste piles and slurry ponds. Partings more than a few inches thick in coal left in the mine as pillars tend to slough off and

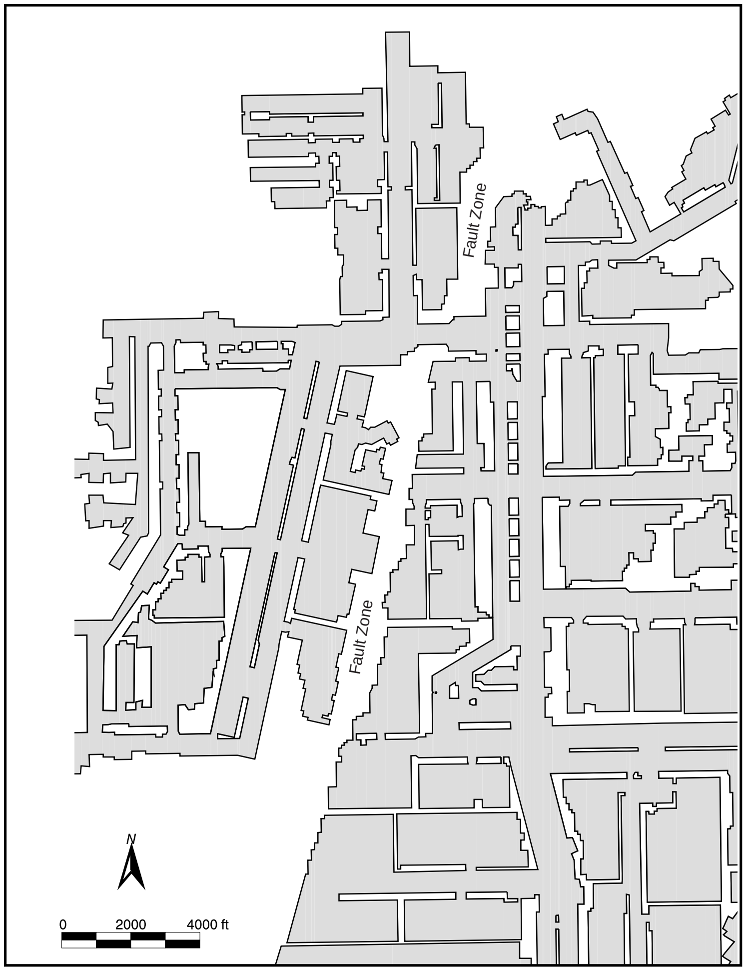


Figure 3 Unmined areas adjacent to one of the faults in the Wabash Valley Fault System.

reduce the stability of pillars (Jeffrey Padgett, personal communication). Over time, this may result in roof falls in the mine and subsidence damage to surface property.

Partings may vary in number, thickness, and position within the seam (fig. 4). Partings restrict mining if they create inaccessible coal or unstable roof conditions or if the yield of clean coal (tonnage of saleable coal / tonnage of material mined) falls below an economical level. Small areas of low yield will be mined if necessary to access other reserves. Large areas with excessive parting material are not mined.

Where partings are less than a few feet thick the entire seam is mined and the rock material must be separated from the coal at the cleaning plant. Because of the extra wear on equipment and the longer cutting time required, one foot of parting material is considered the maximum that is feasible to mine for any extended area. A yield of clean coal equal to 65% of the tonnage of material mined is considered by most companies to be the minimum necessary for an operation to be economic. In calculating yield for these quadrangles, we assumed 0.5 feet of out-of-seam dilution from roof and floor material, 5% loss of coal in cleaning, and specific gravities of 1.3 and 2.6 for coal and rock.

If the amount of parting material exceeds the tonnage of clean coal that can be recovered, only the coal above or below a parting will be mined (if possible). For example, in figure 4a, the lower 2-plus feet of the seam consisting of coal and shale would be left in the floor, and only the upper 6-plus feet of coal would be mined. However, thick partings in the Springfield Coal adjacent to the Galatia Channel, such as shown in figs. 4d-g, have been found to present special problems. These partings thicken over such a short distance that the upper bench of coal has too steep a pitch to mine. The parting material

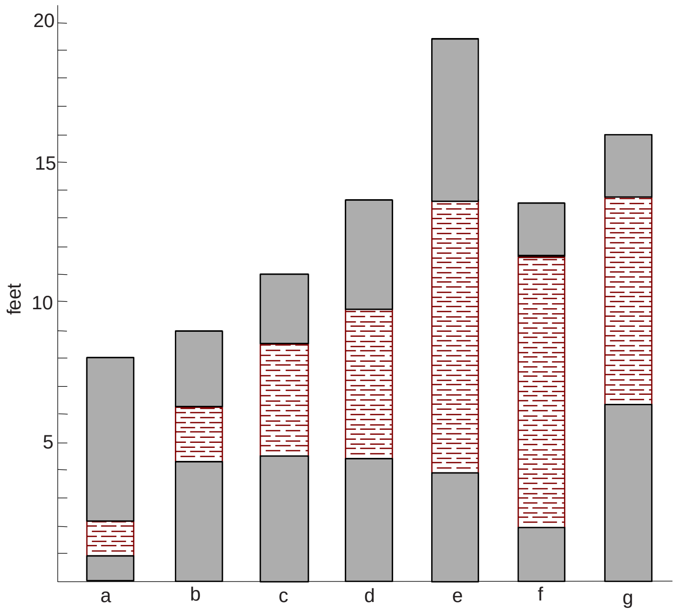


Figure 4 Examples of partings in the Springfield Coal in the Springerton Quadrangle.

consists of laminated shale that is so weak it is difficult to bolt, and massive roof falls are common. The companies familiar with these conditions said they would avoid mining either bench of coal.

Dykersburg Shale The Dykersburg Shale Member is a unit of light to dark gray shales, siltstones, and sandstones deposited directly on the Springfield Coal in the vicinity of the Galatia Channel (fig. 5). The unit is as much as 100 feet thick adjacent to the channel and thins and pinches out from the channel for several hundred feet to several miles. The Dykersburg makes a stable roof with two known exceptions: certain facies found near the Galatia Channel (described below in section on “Galatia Channel”) and in areas where there is an abrupt change in thickness of the Dykersburg over a short distance (fig. 6). In some areas the Dykersburg varies only 10 to 20 feet in thickness over a mile or more. In other areas the change in thickness is more abrupt, thinning 60 to 80 feet over less than 0.5 miles. These areas of abrupt thinning have been correlated with severe roof conditions in mines. It is not known whether the weakness of the roof in these areas is due to the effects of differential compaction of sediments, a change in facies, ancient slumps of the unlithified sediments, or a combination of these and other factors. Because of the severity of the roof falls experienced in these areas, companies avoid mining under areas of abrupt changes in the thickness of the Dykersburg. These areas are considered in this study to be unavailable for mining.

A possible third zone of weak roof conditions may exist at the edges of the Dykersburg Shale. Mining companies reported encountering poor roof conditions in some areas of the Energy Shale (a unit above the Herrin Coal, but depositionally analogous to the Dykersburg) at the deposit’s margins where the shale is about 10 to 20 feet thick (Treworgy et al. 1996b). The shale in these areas does not bond well to the overlying strata and is difficult to hold with roof bolts. Only in limited areas has coal been mined under the margins of the Dykersburg Shale. The experts we interviewed were not familiar with roof conditions in these areas.

Anvil Rock Sandstone The Anvil Rock Sandstone was deposited some time after the drowning and initial burial of the Herrin peat swamp. The sandstone most commonly occurs as a sheet facies and it is present over a broad area of the southern Illinois coal field east of the Du Quoin Monocline. The sandstone is also found filling long sinuous channels that extend for miles across the western and southern portions of the coal field (fig. 7). These channels eroded down through the Herrin Coal and vary in width (at the horizon of the Herrin) from a few hundred feet to more than two miles. Adjacent to the major channels that cut through the coal are minor channels that cut down nearly to or into the top of the coal. Severe roof problems are encountered in places where the sandstone is within 5 feet of the top of the coal bed (fig. 8). In these areas, the Brereton Limestone, the preferred anchoring zone for roof bolting, is commonly missing. The interval between the coal and the sandstone is weak, particularly if the normal rock sequence has been replaced by channel scour. In addition, holes drilled into the sandstone for roof bolting allow water to enter the mine, especially if, as it is in some areas, the water is under pressure. The zone where these conditions are found extends 1,200 to 2,000 feet from the main area where the coal has been washed out. We did not have sufficient data in our study area to delineate this zone (nor will there be enough data in most areas that have only had reconnaissance drilling). We used a buffer of 1,800 feet from the main channel to represent the approximate zone where mining of the Herrin Coal is unlikely to occur due to these conditions. In practice, mining may advance closer or not so close depending on the local conditions encountered.

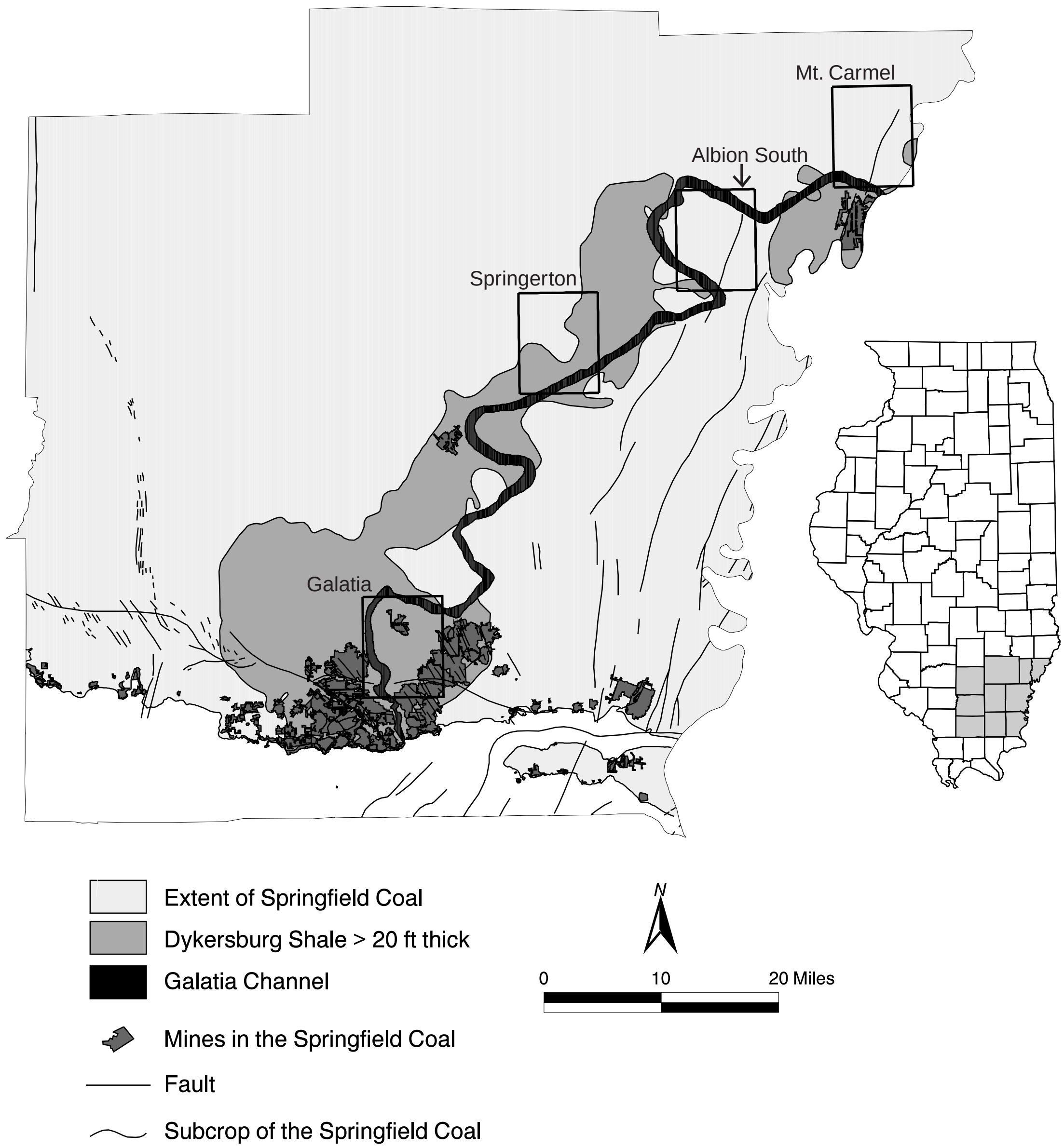


Figure 5 Extent of the Dykersburg Shale and the Galatia Channel and the location of quadrangles studied (from Treworgy and Bargh, 1993).

Galatia Channel The Galatia Channel, a drainageway through, and contemporaneous with, the peat swamp of the Springfield Coal, has strongly influenced the thickness, quality, and minability of the Springfield Coal (fig. 5). The coal is generally thick (6 feet to more than 8 feet) in a zone along and extending from one to several miles away from this channel (Hopkins 1968). Immediately adjacent to the channel, the coal is commonly split into two or more benches separated by shale, siltstone, and sandstone a few inches to tens of feet thick. Within the course of the channel the coal is missing, and is replaced by sandstone, siltstone, and shale. Unstable roof conditions, abrupt variations in seam thickness, local washouts of the seam, and other poor mining conditions are encountered in the Springfield Coal near the Galatia Channel (fig. 6). These conditions are difficult to predict and delineate, even with data from closely spaced drill holes. Mines are commonly laid out so that areas of potential problems can be probed and abandoned if conditions are found to be unfavorable. In some areas, severe problems have been encountered as much as a mile from the channel. To estimate the amount of coal that may be unminable because of conditions related to the Galatia Channel, this study considered coal less than a half mile from the channel to be unavailable for mining. In some areas this coal

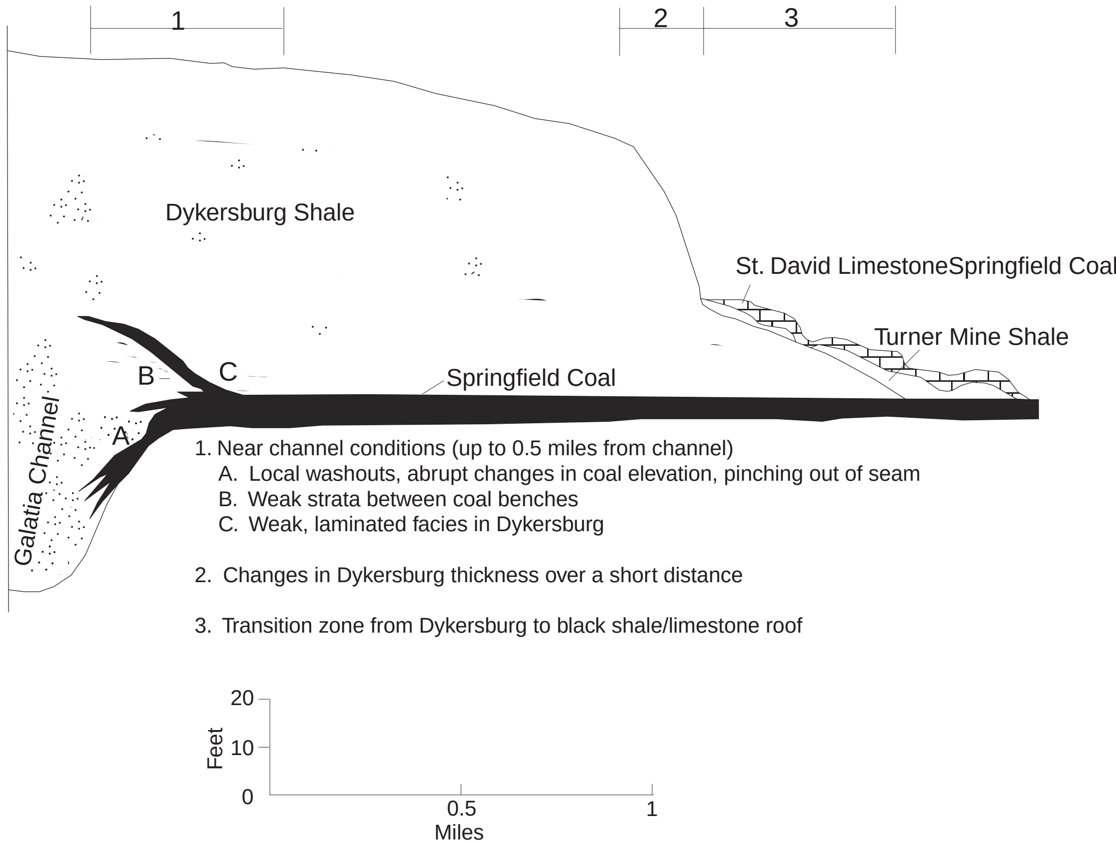


Figure 6 Areas of adverse mining conditions in the Springfield Coal near the Galatia Channel.

may ultimately be found to be minable, but in other areas coal farther from the channel will likely be found to be unminable.

Size and Configuration of Mining Block Because of the shallow depth of coal in the Peoria West and Tallula Quadrangles, underground mines can be opened from a highwall, boxcut, or shallow slope, and exploratory drilling will be relatively inexpensive. The minimum reserve block for an underground mine in these quadrangles is 20 million tons of clean coal (equivalent to approximately 40 million tons of raw coal in place, excluding partings). This assumes room-and-pillar mining and a recovery rate, after cleaning, of 50%. Higher recovery can be attained with longwall mining, but this is offset by the need for more saleable coal to pay back the higher initial investment in equipment.

The coals in the Albion South, Snyder-West Union, and Springerton Quadrangles are several hundred feet below the surface. Because of the higher initial exploration and development costs for a mine at these depths, we used a minimum block size of 40 million tons of clean coal (80 million tons of raw coal in place, excluding partings) in these quadrangles.

Mine blocks must have dimensions that are suitable for layout of a mine. Narrow blocks of coal with convoluted shapes (such as between abandoned mines or other barriers) cannot be safely and economically mined by underground mining methods.

Land Use Limited extraction may take place under small towns with populations of a few hundred. However, unless such an area is crucial to development of the mine layout, it will generally be avoided. This study considers all coal under towns, schools, churches, and cemeteries as unavailable for underground mining. Some companies that we have interviewed do not mine under railroads. However, in recent years, at least two longwall mines in Illinois, the Monterey No. 1 Mine and the Orient No.

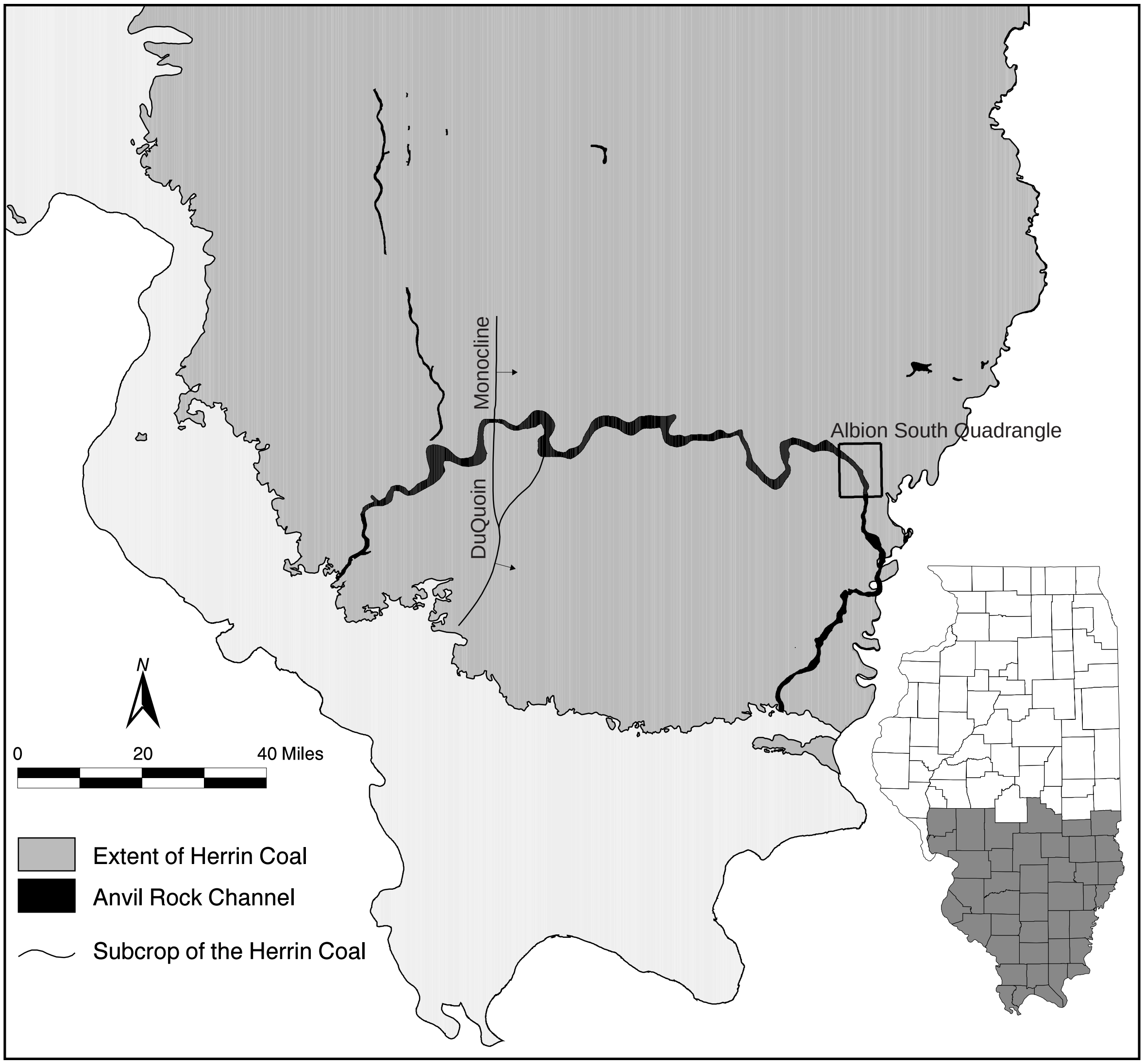


Figure 7 Areas of Herrin Coal eroded by Anvil Rock channels (Modified from Treworgy and Bargh 1984a).

6 Mine, have extracted coal underlying railroads. This study therefore, considers coal underlying railroads to be available for underground mining. Interstate highways are the only significant road restriction for underground mining. Peoria West is the only quadrangle of the five in this report that has an interstate highway. High voltage transmission towers are commonly not barriers to underground mining. Mine layouts can be planned to locate high extraction areas away from towers or controlled subsidence of the tower can be coordinated with the power company. However, transmission towers were considered restrictions to underground mining in the Peoria West Quadrangle because of the size and number of towers and the close proximity of other surface developments that limit options for laying out a mine. Because of the large number of high voltage transmission towers in the Peoria West Quadrangle, the location of individual towers was not mapped for this study. Instead, a 100 foot-wide path along the corridor occupied by the transmission lines was mapped and 10% of the area was assumed to be restricted by transmission towers.

A buffer of unmined coal must be left around any property or surface feature that cannot be disturbed. The size of the buffer depends on the depth and thickness of the coal, the composition of the overburden, and the angle of draw used to calculate the area that could be affected by subsidence from underground mining. A buffer size was selected for each quadrangle in this study based on the approximate depth of potential underground mining. For quadrangles with coals only a couple of hundred feet deep, we used a conservative figure for angle of draw of 45 degrees. For quadrangles with deeper

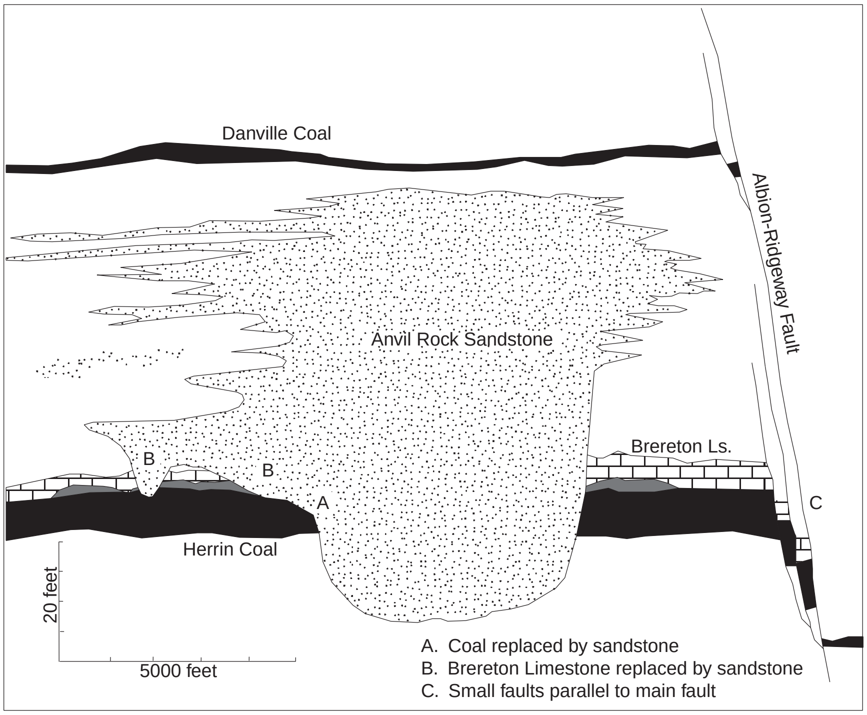


Figure 8 Unfavorable mining conditions associated with the Anvil Rock Sandstone and Wabash Valley Fault System in southeastern Illinois.

mining, the angle of draw would be much smaller. Buffer sizes for all features were 100 feet for the Peoria West Quadrangle, 200 feet for the Snyder-West Union and Tallula Quadrangles, and 400 feet for the Albion South and Springerton Quadrangles.

Abandoned Mine Workings Illinois law requires that underground mines leave an unmined barrier of coal 200 feet wide around abandoned underground mine workings. A larger barrier may be required if the extent of the mine workings is not accurately known.

Coal Available, but With Conditions

Previous studies in this series have classified coal as available or restricted. An exception has been coal that is available only if surface mined in combination with an overlying or underlying seam. In this study, three additional situations are identified where it is useful to qualify the availability of resources: closely-spaced oil wells, potential land use conflicts, and coal quality limitations. These are cases where resources meet the criteria for available coal, but have some significant negative characteristic that should be considered when comparing these deposits to other available resources.

Closely-Spaced Oil Wells A block of unmined coal must be left around oil wells unless they are abandoned and known to be plugged to MSHA standards. Numerous, closely-spaced oil wells (e.g. one well every 20 acres or less), whether active or abandoned, can restrict the availability of coal for mining, either by limiting access to the coal or raising the cost of mining. Unless closely-spaced wells are plugged they limit the development of entries and panels and prohibit longwall mining. There are no clear-cut formulas for determining what number or spacing of wells constitute a restriction to mining, nor can the area of coal restricted by wells be precisely defined prior to the development of a mine plan. If a well is abandoned, the mining company has only the expense of plugging the well (which is not insignificant). If a well is active, the company must negotiate its purchase. The benefits of plugging a well are measured on a well-by-well basis and determined by the value of the coal that can be recovered as well as efficiencies that may be achieved in the mine layout. Areas of coal on the edge of a mine property may be left unmined if they contain numerous wells, whereas wells in strategic areas needed for main entries or development of longwall panels may be worth plugging.

In this study we delineated areas of four or more wells drilled on 20 acre-spacings or closer. Resources in these areas are considered to be available, but we list them in a separate category because it is questionable whether much of the coal will ever be mined. Development of these resources will be delayed until resources with a lower mining cost have been depleted. The economic reality of mining that forces companies to maximize profits instead of maximizing recovery of resources is likely to cause companies to mine around these high cost resources, thereby sterilizing them from future mining.

Potential Land Use Conflicts As a result of the study of the Peoria West Quadrangle, we created an additional classification for resources: "Available, with potential land use conflicts". This category was needed to accurately represent the amount of resources realistically available for mining. About 25% of the resources in the Peoria West Quadrangle meet the land use and technological criteria for available coal. However, most, if not all, of these "available" resources are in areas that, although lacking any specific land use or technological restrictions, are relatively densely populated and experiencing ongoing suburban development. Land values are probably unfavorably high for mining, and both surface and underground mines are likely to be viewed by the local population and government as incompatible with community development. The potential for community opposition to and interference with mining activities, as well as the long term liability for subsidence damage from underground mining, are significant restrictions to mining. All of the mining experts we interviewed said that because of these conditions, they would not risk their company's financial resources by attempting to put together a mining block and developing a mine in this area. In all cases, this was a subjective decision that was not based on readily measurable criteria. However, this opinion was so pervasive among companies that we could not ignore its implications. The category "available, but with potential land use conflicts" is used in this report to identify areas that are legally and technically minable, but that are highly unlikely to be mined because of conflicts with other land uses. This category includes available surface or underground minable resources within 0.5 mile of a town or subdivision in areas where land use patterns are incompatible with mining.

Coal Quality Limitations The quality of the coal has a great influence on its marketability, but generally not on its availability for mining. For example, coals with low sulfur and chlorine content and high heat content are more marketable than coals with high sulfur and chlorine content and lower heat content. In some cases, a premium quality coal may command a high enough price to allow companies to absorb the higher cost of mining under unfavorable geologic conditions. The coals in the quadrangles studied for this report are, with the exception of the coals in the Snyder-West Union Quadrangle and the Springfield Coal in the Springerton Quadrangle, similar in quality to the majority of coal resources found in the state. The Danville Coal in the Snyder-West Union Quadrangle and the Springfield Coal in portions of the Springerton Quadrangle are believed to have a sulfur content of perhaps as small as 1%. The market demand for lower-sulfur coals is currently higher than for high-sulfur coals; however, the price paid for lower sulfur coals is not appreciably higher. Conversely, although high-sulfur coals are socially out of favor, the market demand for high-sulfur coal produced at a competitive price remains steady. Therefore, variations in sulfur between individual coals are not considered in evaluating the availability of these coals.

All of the coals in the Snyder-West Union Quadrangle are believed to have a relatively large chlorine content (> 0.5%). Coals with chlorine contents at this level can be used, but the market for them is very limited at this time. Use of high-chlorine coals requires extra cleaning to remove as much chlorine as possible and/or specially designed boilers and possibly higher maintenance costs for the boilers. These factors do not restrict the availability of high-chlorine coals for mining. However, because of the limited market for these coals and the lack of any past or planned mining in Illinois of any resources with this high of a chlorine content, we have designated them as "available, with quality limitations."

AVAILABLE RESOURCES

Availability of Coal in the Peoria West Quadrangle, Western Illinois

The Peoria West Quadrangle is representative of mining conditions in region 2 associated with shallow deposits of the Danville, Herrin, and Springfield Coals and slightly deeper deposits of the Colchester Coal (fig. 9). The quadrangle is the fourth to be studied in this region. The geology and coal resources of the quadrangle are similar to the Kewanee North and Princeville Quadrangles (Treworgy et al. 1996b, Treworgy et al. 1997a), but the setting of the quadrangle, located on the western edge of the city of Peoria, is considerably more urban.

The Peoria West Quadrangle is predominantly an upland area. To the east is the Illinois River valley. The Kickapoo Creek valley crosses the northern and eastern portions of the quadrangle (fig. 10). The cities of Peoria and Bartonville cover the eastern quarter of the quadrangle. Small towns and rural subdivisions are spread across the remainder of the quadrangle. A significant portion of the rural subdivision development is new. Other major developments on the quadrangle include Peoria International Airport, interstate highways 74 and 474, railroads, and high voltage transmission lines.

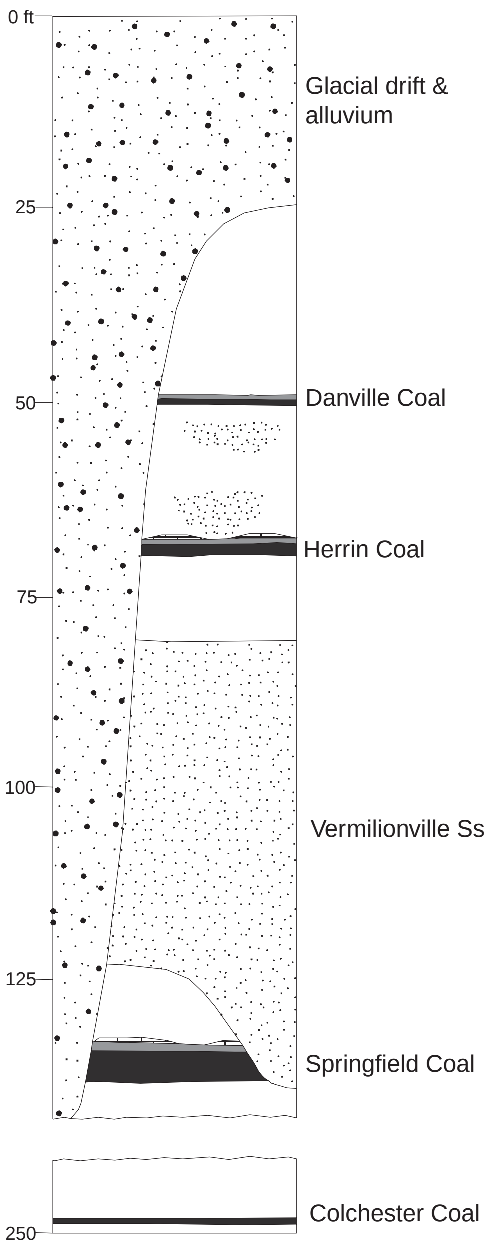


Figure 9 Selected stratigraphic units, Peoria West Quadrangle.

Geology and Coal Resources The quadrangle is covered with alluvium and glacial drift. In most of the quadrangle the drift is less than 50 feet thick, but it exceeds 200 feet in thickness in a bedrock valley along and north of Kickapoo Creek.

Coal resources are present in four seams: the Danville, Herrin, Springfield, and Colchester Coals. The coal resources were mapped as parts of regional studies by Cady (1952) and Smith and Berggren (1963). No significant new coal test holes have become available since 1963. The resource map of the Colchester Coal used in this study is a combination of the information from two previous studies. The maps of the thickness and depth of the Danville, Herrin, and Springfield Coals are from Smith and Berggren (1963).

The Danville Coal averages 1.5 feet thick in this area (fig. 11) and lies less than 50 to a little more than 100 feet deep. The coal has been mined in this quadrangle only where the underlying Herrin Coal was surface mined. It is not known if these mines actually produced the Danville Coal or merely dumped it in the spoil pile with the other overburden material.

The Herrin Coal lies 25 to 35 feet below the Danville and averages 4 feet thick in the quadrangle, except in the southern quarter, where it averages 3 feet thick (fig. 12). The depth to the coal is 50 to almost 200 feet, except in narrow zones where it crops out along the southern edge of Kickapoo Creek valley and some of the smaller stream valleys in the southern part of the quadrangle (fig. 13). The only mining of this coal has been in the northwest quarter of the quadrangle. Early underground miners preferred the underlying Springfield Coal because the

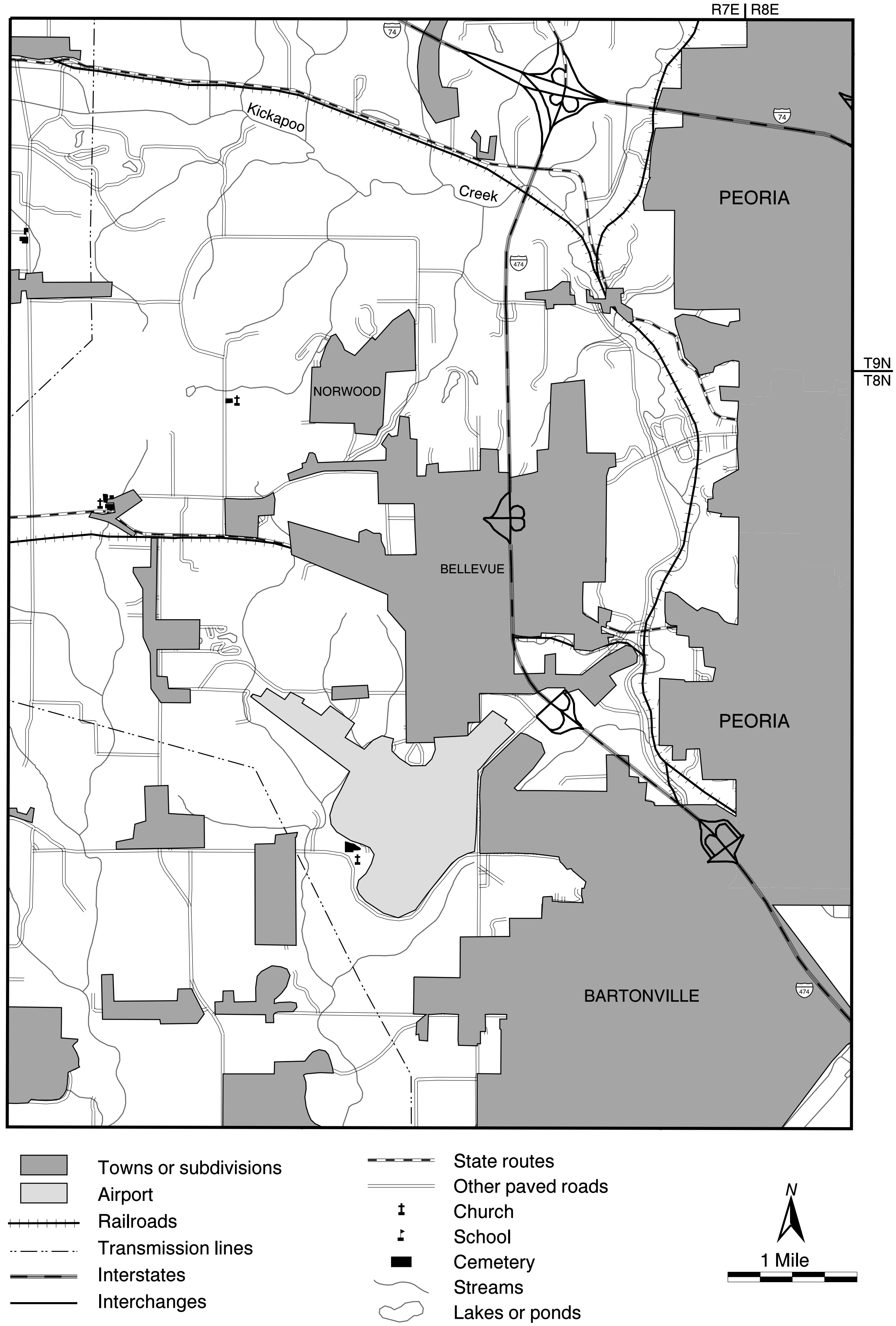


Figure 10 Surface features, Peoria West Quadrangle.

Figure 11 Thickness of the Danville Coal, Peoria West Quadrangle.

Figure 12 Thickness of the Herrin Coal, Peoria West Quadrangle.

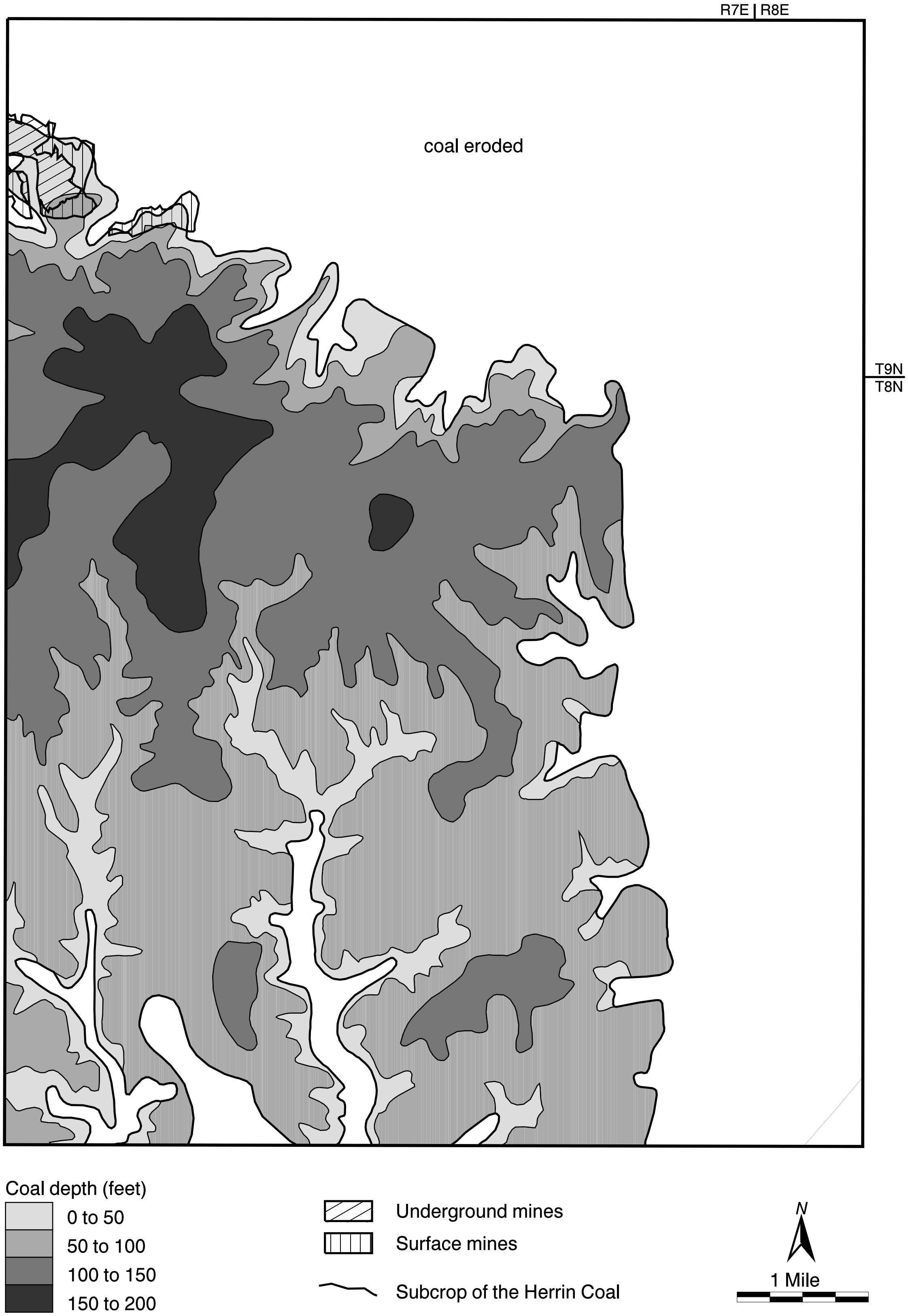


Figure 13 Depth of the Herrin Coal, Peoria West Quadrangle.

Herrin contains abundant clay dikes and a persistent thin parting. The Herrin has been extensively surface mined to the west of the quadrangle where there are broad areas with favorable stripping ratios.

The Springfield Coal lies about 65 feet below the Herrin Coal and averages 4 to 4.5 feet thick (fig. 14). The coal is missing in the southern part of the quadrangle along a zone a half-mile wide and about 3 miles long. This zone is part of a larger feature that is believed to be a channel that cut down through the coal sometime after the original peat swamp was buried (Cady 1921). The northern extent of the channel is not known and additional areas of coal may have been eroded northward of the channel as currently mapped. Throughout much of the quadrangle the coal lies 150 to just over 200 feet deep (fig. 15). Underground mines have depleted most of the resources along the eastern and southern sides of the quadrangle. Mining began in the 1800s and continued until 1968. With the advent of large excavating equipment, the underground mines in this area were abandoned in favor of surface mining of the Herrin Coal, and to a lesser extent the Springfield Coal, in nearby areas west of this quadrangle.

The Colchester Coal is about 100 feet below the Springfield Coal and averages 30 inches thick. The coal is believed to underlie all of the quadrangle and is more than 200 feet deep, except in the Kickapoo Creek and Illinois River flood plains where it may be as shallow as 100 feet. Due to lack of data, no resources of Colchester Coal have been mapped along the west edge of the quadrangle. The Colchester was mined in only one mine in this quadrangle, a small underground mine on the west side of Peoria. Several square miles of Colchester Coal have been mined, primarily by surface methods, a few miles to the south of the quadrangle.

Available Coal Of the 485 million tons of resources in the Peoria West Quadrangle, 2% (10 million tons) is available for mining, an additional 1% (5 million tons) is available if coals are surface mined in combination with underlying or overlying seams, and 22% (109 million tons) is available, but with potential land use conflicts (table 4, fig. 16).

There are 42 million tons of Danville Coal in the quadrangle. About 2% of the Danville is available if it is surface mined in combination with the Herrin and Springfield Coals (fig. 17). An additional 12% is available if surface mined with the other coals, but with potential land use conflicts. Land use restricts mining of 66% of the Danville resources. Stripping ratio restricts 20% of the resources, and less than 1% has been mined, or destroyed by mining of the underlying Herrin Coal.

About 2% of the 127 million tons of Herrin Coal is available for mining and 42% is available with potential land use conflicts (figs. 18 and 19). Land use restricts 37% of the resources and technological factors (primarily block size for underground mining and stripping ratio for surface mining) restrict 17%. Although more of the Herrin resources are classified as available (including those available with a potential land use conflict) for underground mining than surface mining, the historical preference for mining the underlying Springfield Coal (94 out of 108 underground mines in the county) suggests that roof conditions and the quality of the Herrin are not attractive for underground mining.

Of the 180 million tons of Springfield Coal in the quadrangle, about 4% (6 million tons) is available and 29% (54 million tons) is available with potential land use conflicts (figs. 20 and 21). Land use restricts 20% of the resources, technological factors restrict 16%, and 30% has been mined out. Block size and bedrock thickness are the primary technological restrictions for underground mining. Stripping ratio is the primary technological restriction for surface mining.

The original resources of Colchester Coal are 136 million tons, of which less than 1% has been mined. None of these resources are available for mining (fig. 22). All of the resources are too thin for underground mining. The resources shallow enough for surface mining (less than 200 feet deep) have either too high of a stripping ratio or land use restrictions.

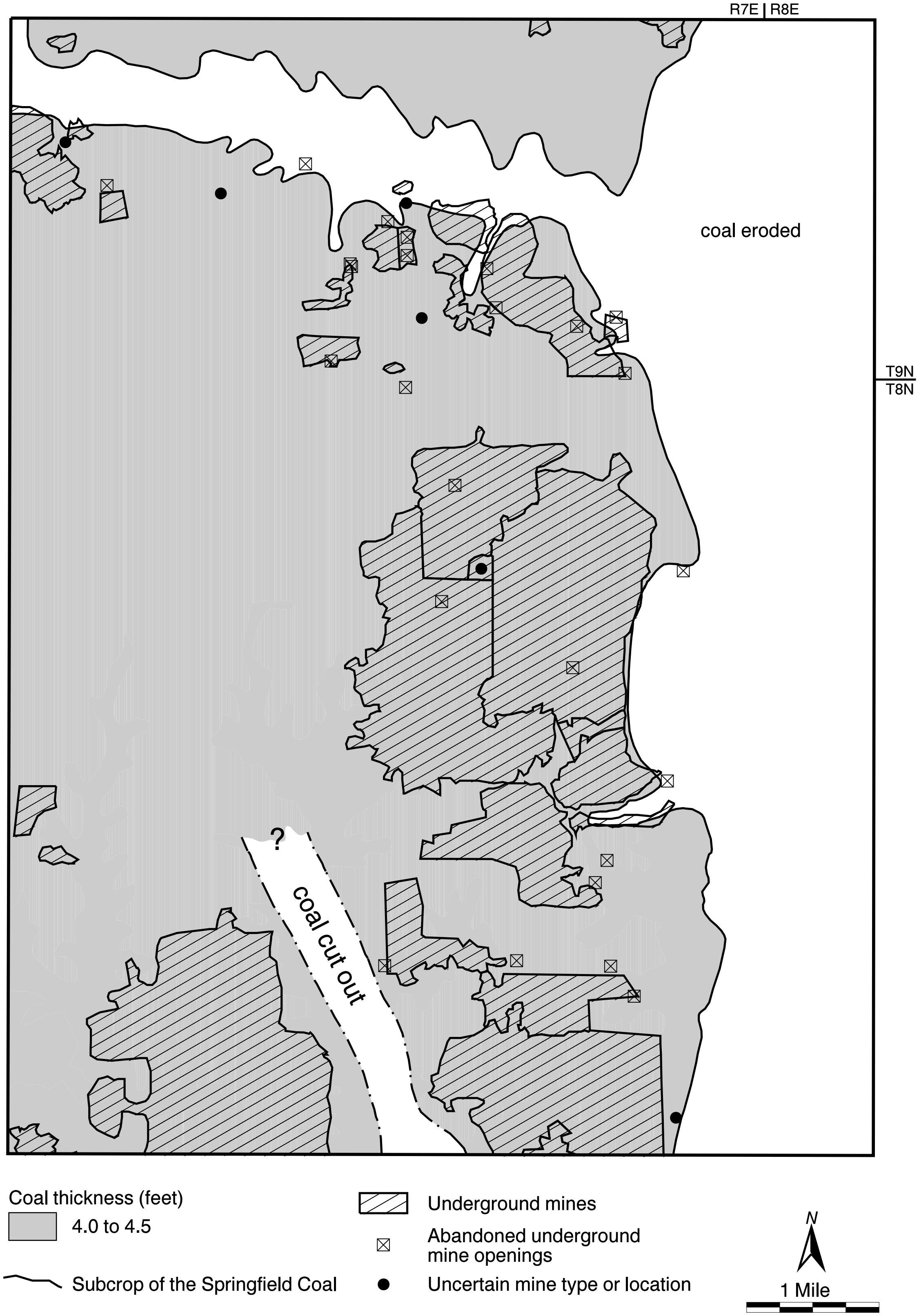


Figure 14 Thickness of the Springfield Coal, Peoria West Quadrangle.

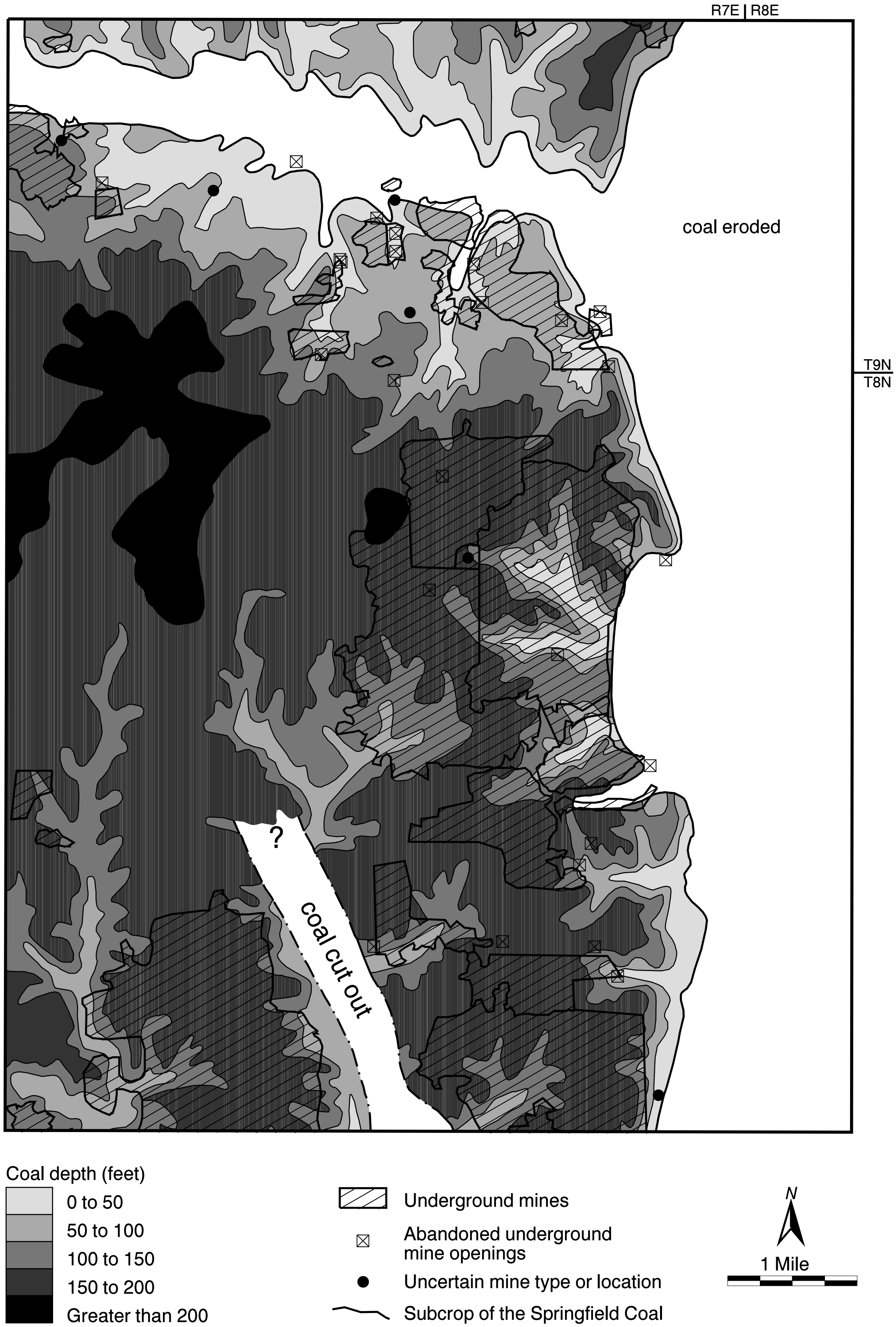


Figure 15 Depth of the Springfield Coal, Peoria West Quadrangle.

Table 4 Availability of coal resources for mining in the Peoria West Quadrangle; thousands of tons and (percent of original resources). Note: some resources are reported in both the surface minable and underground minable categories.

	Danville	Herrin	Springfield	Colchester	Total
Original	41,822	127,438	179,812	136,279	485,351
Available	0	2,504 (2)	7,095 (4)	- -	9,599 (2)
Available with other seams*	928 (2)	952 (1)	2,986 (2)	- -	4,866 (1)
Available, potential conflict	5,140 (12)	53,661 (42)	51,780 (29)	- -	110,582 (23)
Mined out	111 (<1)	1,701 (1)	53,200 (30)	76 (<1)	55,089 (11)
Land use restriction	27,413 (66)	47,406 (37)	36,613 (20)	76,448 (56)	187,879 (39)
Technological restriction	8,229 (20)	21,213 (17)	28,139 (16)	59,755 (44)	117,336 (24)
Surface minable (0 to 200 ft deep)					
Original	41,822	127,437	169,083	53,902	392,583
Available	- -	2,505 (2)	7,095 (4)	- -	9,599 (2)
Available w/other coals	928 (2)	952 (1)	2,986 (2)	- -	4,866 (1)
Available, conflict	5,140 (12)	18,856 (15)	13,008 (8)	- -	37,004 (9)
Mined out	111 (<1)	1,701 (1)	53,200 (32)	73 (<1)	55,085 (14)
Land use restriction	27,413 (66)	80,323 (63)	67,180 (40)	44,047 (82)	219,303 (56)
Technological restriction	8,229 (20)	23,100 (18)	25,614 (15)	9,782 (18)	66,725 (17)
Land use restrictions					
Towns	23,488 (56)	68,971 (54)	47,654 (28)	42,780 (79)	182,892 (47)
Cemeteries	30 (<1)	81 (<1)	84 (<1)	- -	195 (<1)
Church or school	7 (<1)	21 (<1)	21 (<1)	- -	49 (<1)
Parks	- -	- -	- -	339 (<1)	339 (<1)
Airport	2,471 (6)	6,864 (5)	4,096 (2)	- -	13,432 (3)
Transmission lines	265 (<1)	834 (<1)	692 (<1)	- -	1,791 (<1)
Railroad	74 (<1)	197 (<1)	139 (<1)	349 (<1)	759 (<1)
Highways	1,078 (3)	3,356 (3)	4,930 (3)	843 (2)	10,206 (3)
Near underground mine	- -		9,565 (6)	75 (<1)	9,640 (3)
Technological restrictions					
Stripping ratio	8,229 (20)	20,159 (16)	17,479 (10)	9,782 (18)	55,649 (14)
Unconsolidated overburden	- -		5,091 (3)	- -	5,091 (1)
Block size	- -	2,941 (2)	3,045 (2)	- -	5,985 (2)

Table 4 Cont.

	Danville		Herrin		Springfield		Colchester		Total	
Underground minable (Herrin >40 ft deep, others >75 ft deep)										
Original	-		110,697		163,523		82,236		356,455	
Available	-	-	-	-	-	-	-	-	-	-
Available: conflict**	-	-	49,217	(45)	55,807	(34)	-	-	105,024	(30)
Mined out	-	-	267	(<1)	50,747	(31)	3	(<1)	51,017	(14)
Land use restriction	-	-	43,717	(40)	32,680	(20)	32,260	(39)	108,657	(30)
Technological restriction	-	-	17,495	(16)	24,289	(15)	49,973	(61)	91,757	(26)
Land use restrictions										
Towns	-	-	36,825	(33)	18,233	(11)	26,304	(32)	81,363	(23)
Cemeteries	-	-	99	(<1)	102	(<1)	58	(<1)	258	(<1)
Church or school	-	-	35	(<1)	24	(<1)	21	(<1)	80	(<1)
Parks	-	-	-	-	-	-	339	(<1)	339	(<1)
Airport	-	-	6,208	(6)	4,096	(3)	4,050	(5)	14,354	(4)
Near mine	-	-	122	(<1)	8,970	(5)	15	(<1)	9,108	(3)
Transmission lines	-	-	84	(<1)	232	(<1)	589	(<1)	905	(<1)
Interstate highway	-	-	344	(<1)	1,022	(<1)	883	(1)	2,250	(<1)
Technological restrictions										
Thin bedrock	-	-	223	(<1)	5,533	(3)	-	-	5,757	(2)
Block size	-	-	9,603	(9)	18,755	(11)	-	-	28,359	(8)
Coal <42" thick	-	-	7,669	(7)	-	-	49,973	(61)	57,642	(16)

*Available if surface mined in combination with underlying and/or overlying seams.
** Available, but with potential land use conflicts.

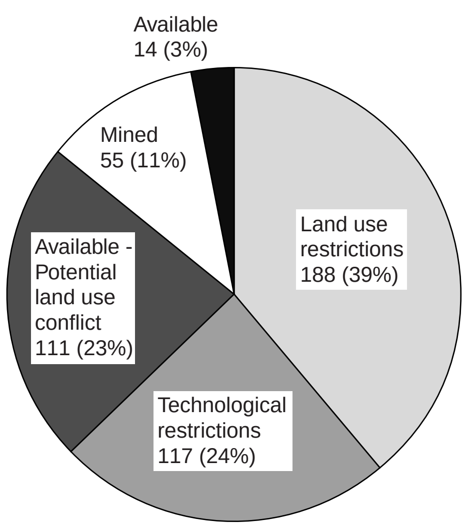


Figure 16 Availability of coal resources, Peoria West Quadrangle; millions of tons and (percent of original resources.

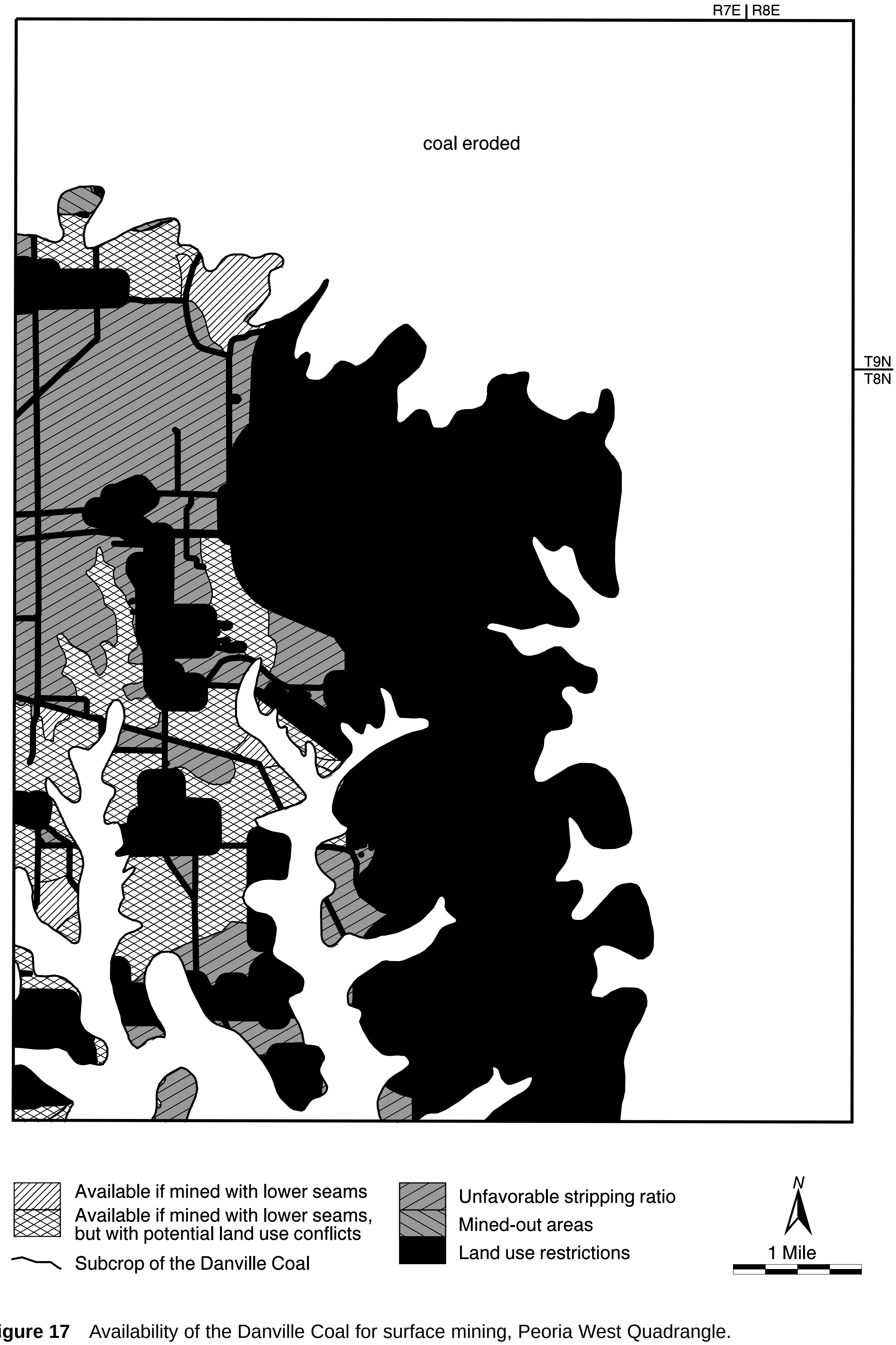


Figure 17 Availability of the Danville Coal for surface mining, Peoria West Quadrangle.

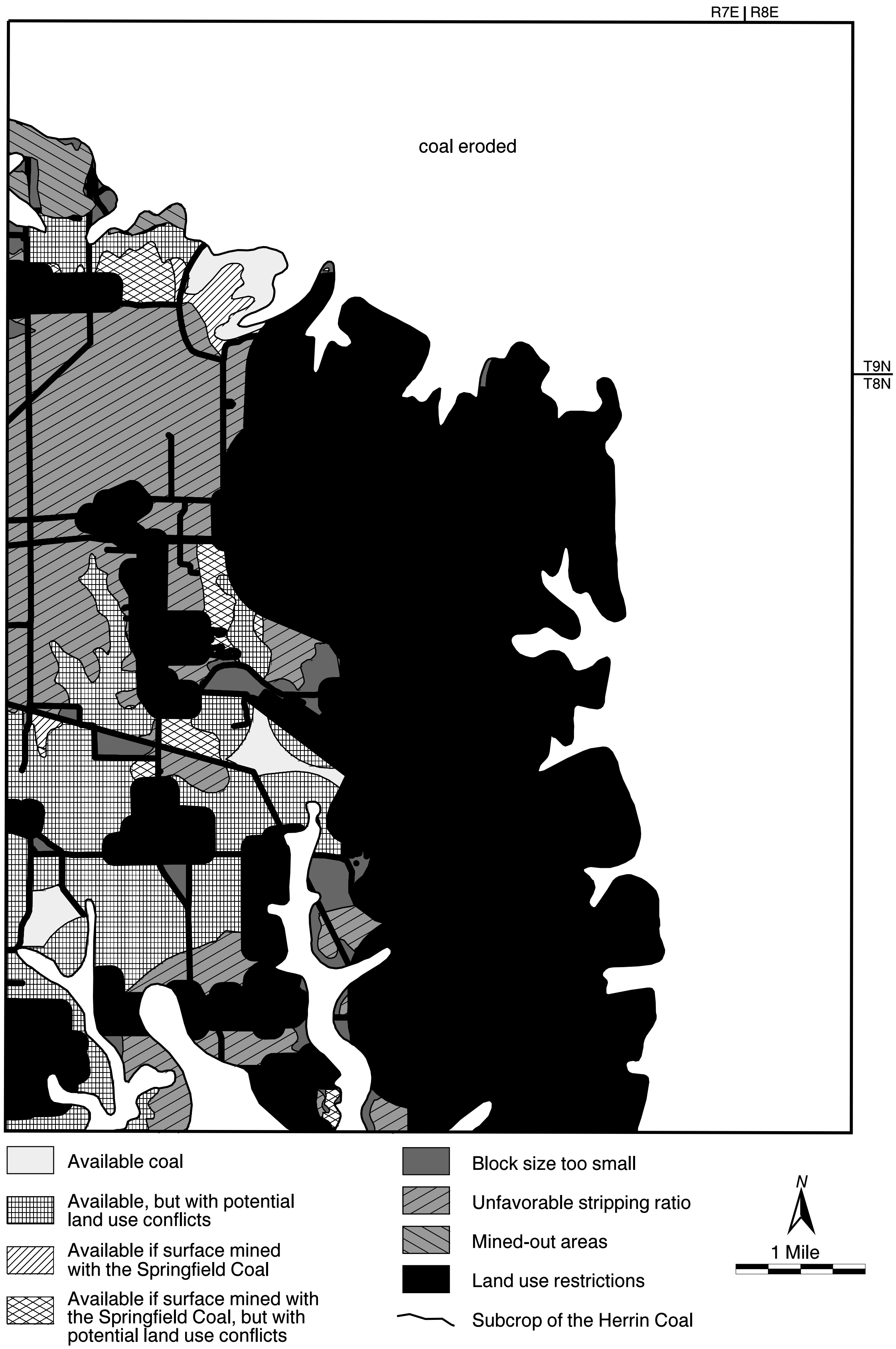


Figure 18 Availability of the Herrin Coal for surface mining, Peoria West Quadrangle.

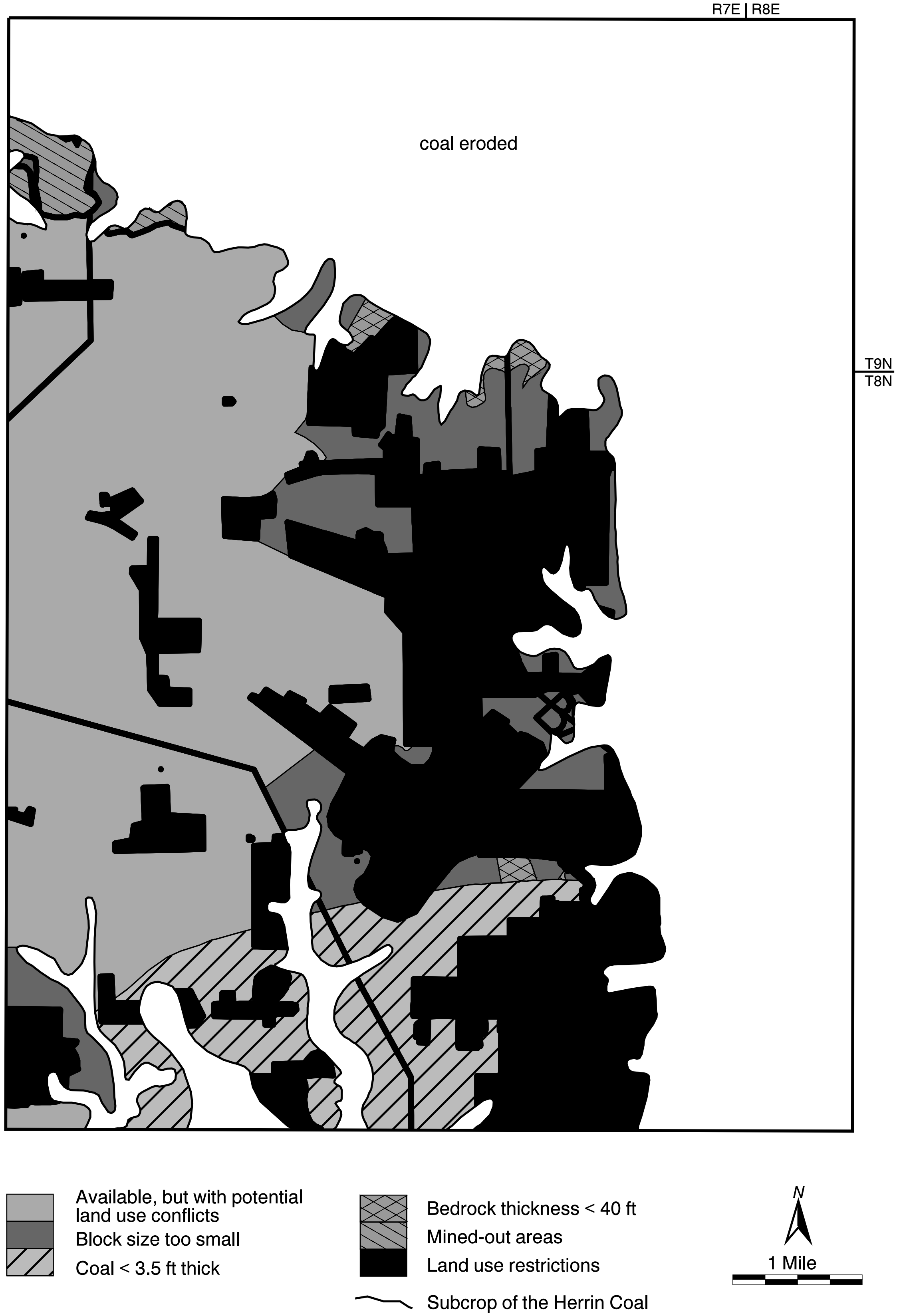


Figure 19 Availability of the Herrin Coal for underground mining, Peoria West Quadrangle.

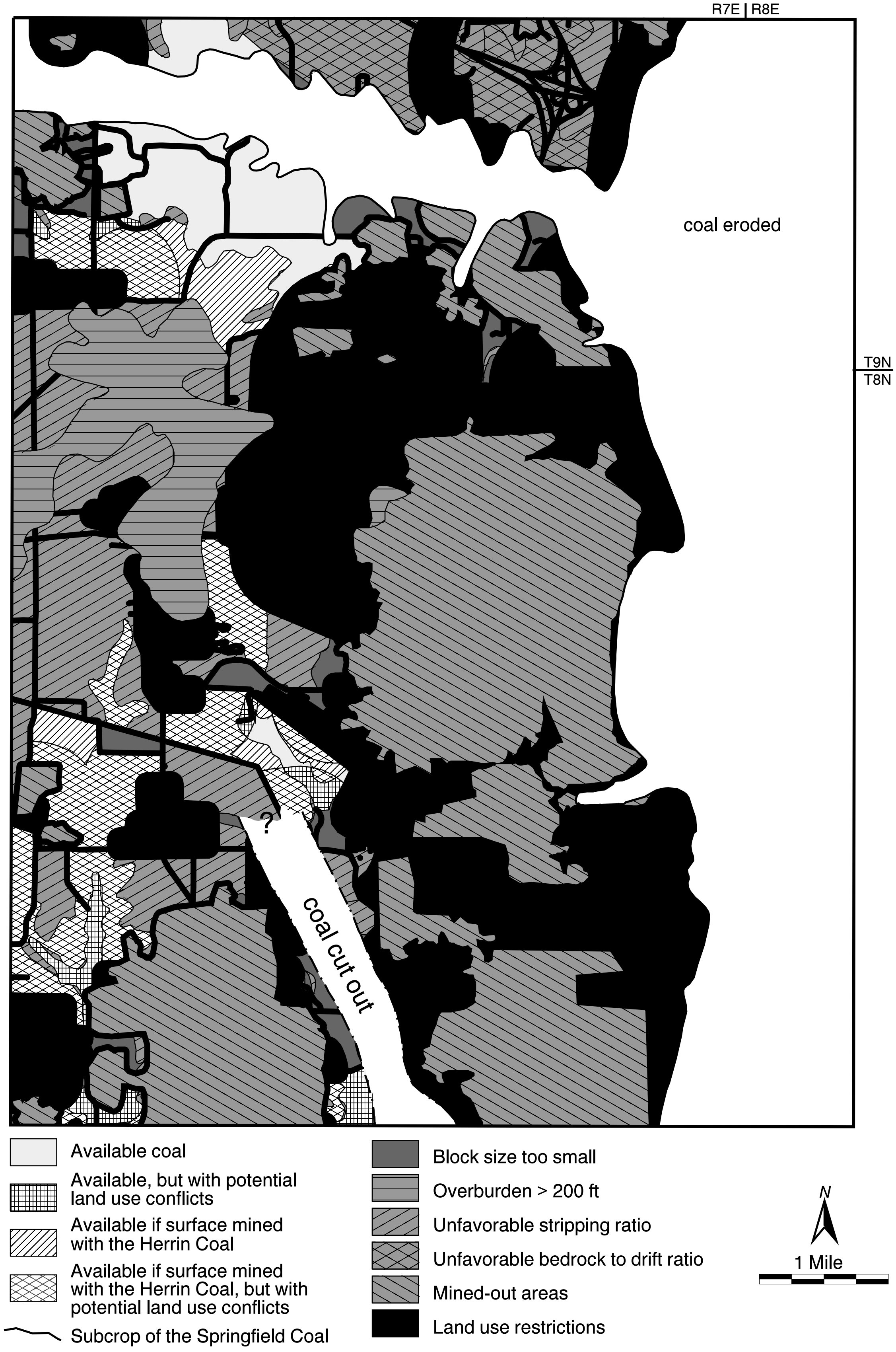


Figure 20 Availability of the Springfield Coal for surface mining, Peoria West Quadrangle.

Figure 21 Availability of the Springfield Coal for underground mining, Peoria West Quadrangle.

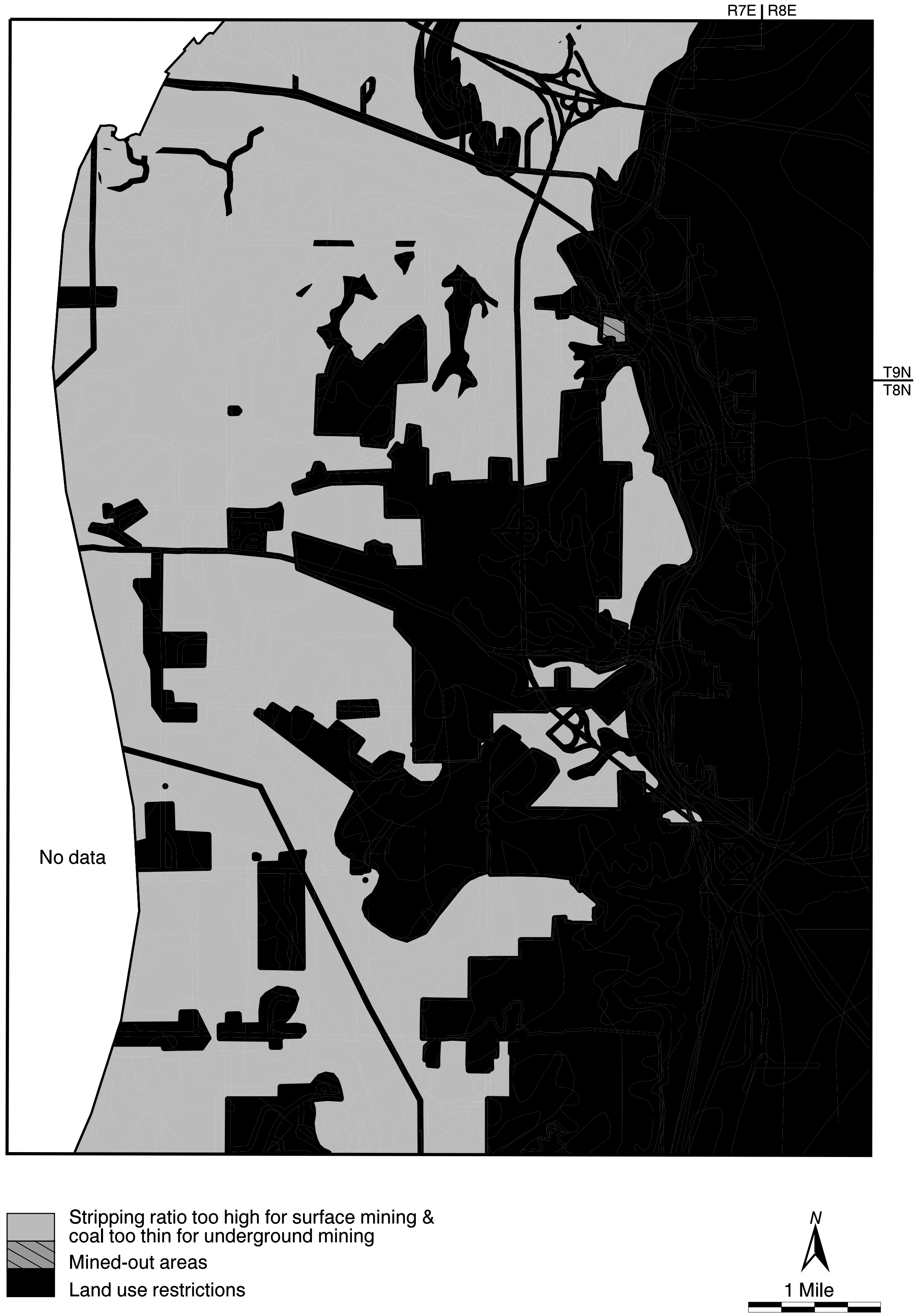


Figure 22 Availability of the Colchester Coal for mining, Peoria West Quadrangle.

Availability of Coal in the Tallula Quadrangle, West-Central Illinois

The Tallula Quadrangle is representative of shallow mining conditions near the subcrops of the Herrin and Springfield Coals in the west-central part of the state (fig. 23). The Pennsylvanian strata in west-central Illinois are overlain by 100 to more than 400 feet of glacial drift and younger alluvium. The Tallula Quadrangle, located 12 miles northwest of the city of Springfield, is covered mostly by row-crop farmland. Small wooded areas are present along some of the stream valleys. The towns of Tallula and Pleasant Plains (1990 populations: 598 and 701) are small farming communities that also provide homes to commuters working in Springfield (fig. 24). Other than the usual network of state and local highways, there is little infrastructure that will restrict surface or underground mining.

Geology and Coal Resources The surface topography of the quadrangle is relatively level and broken only by narrow stream valleys. However, the topography of the bedrock surface concealed beneath the glacial drift has a broad valley covering most of the northeast quarter of the quadrangle (fig. 25). Two narrower arms extend from this broad valley, one westward across the northern third of the quadrangle and one southward across the eastern third. Glacial drift within these bedrock valleys exceeds 150 feet in thickness.

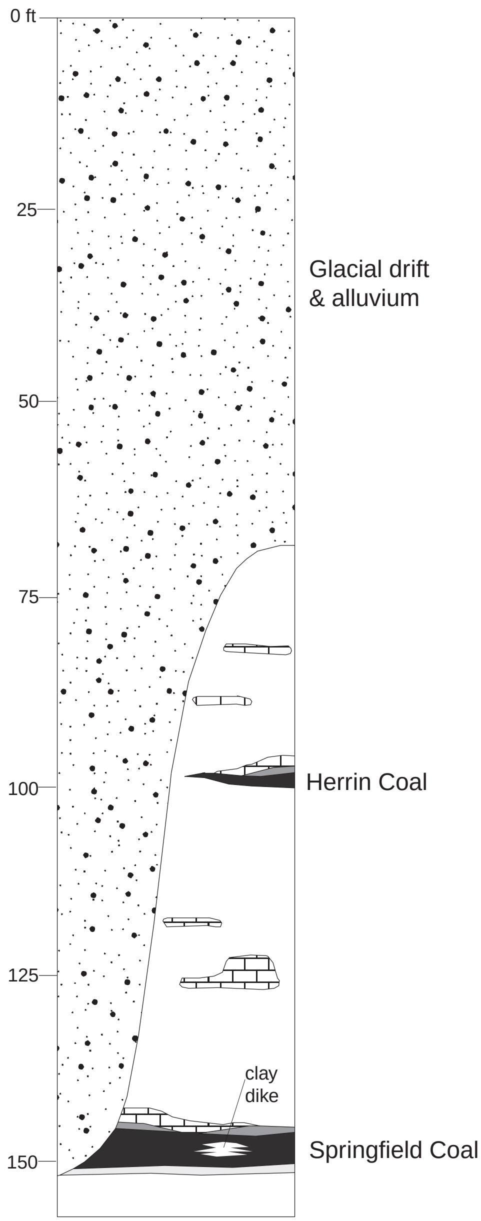


Figure 23 Selected stratigraphic units, Tallula Quadrangle.

The Herrin and Springfield Coals are the only two coals of interest to mining in the quadrangle. The Herrin Coal varies in thickness from less than 0.5 feet to almost 3.5 feet (fig. 26) and, due to pre-glacial erosion, the area underlain by the coal is highly irregular in shape. Most of the coal lies 50 to about 125 feet deep (fig. 27). The thinness of the seam, shallow buried depth, and thinness of the bedrock cover make the Herrin Coal minable only by surface methods. The stripping ratio of the coal is greater than 30:1 throughout most of the quadrangle (fig. 28).

The Springfield Coal is 4.5 to 6 feet thick throughout most of the quadrangle (fig. 29). Locally, the coal is thinner because of clay dikes and pre-glacial erosion. Although it may lie as shallow as 40 feet and as deep as 185 feet, the coal is 100 to 150 feet below the surface throughout most of the quadrangle (fig. 30). The Springfield Coal was mined underground at several locations near the towns of Tallula and Pleasant Plains. The last of these mines closed in 1956.

The thickness and depth of the Springfield Coal put it within the range of mining by either surface or underground methods. If surface mined in combination with the overlying Herrin Coal, the combined stripping ratio is less than 20:1 over much of the quadrangle (fig. 31). The thickness of the bedrock and unconsolidated (drift and alluvium) overburden are critical factors for underground mining. Unconsolidated overburden is 50 to 100 feet thick except along the buried bedrock valleys (fig. 32). The bedrock cover is less than 70 feet thick over most of the quadrangle (fig. 33). The ratio of bedrock to unconsolidated overburden is less than 1 in most of the quadrangle (fig. 34). This ratio, together with the lack of competent strata in the overburden, indicates that underground mining conditions will be difficult.

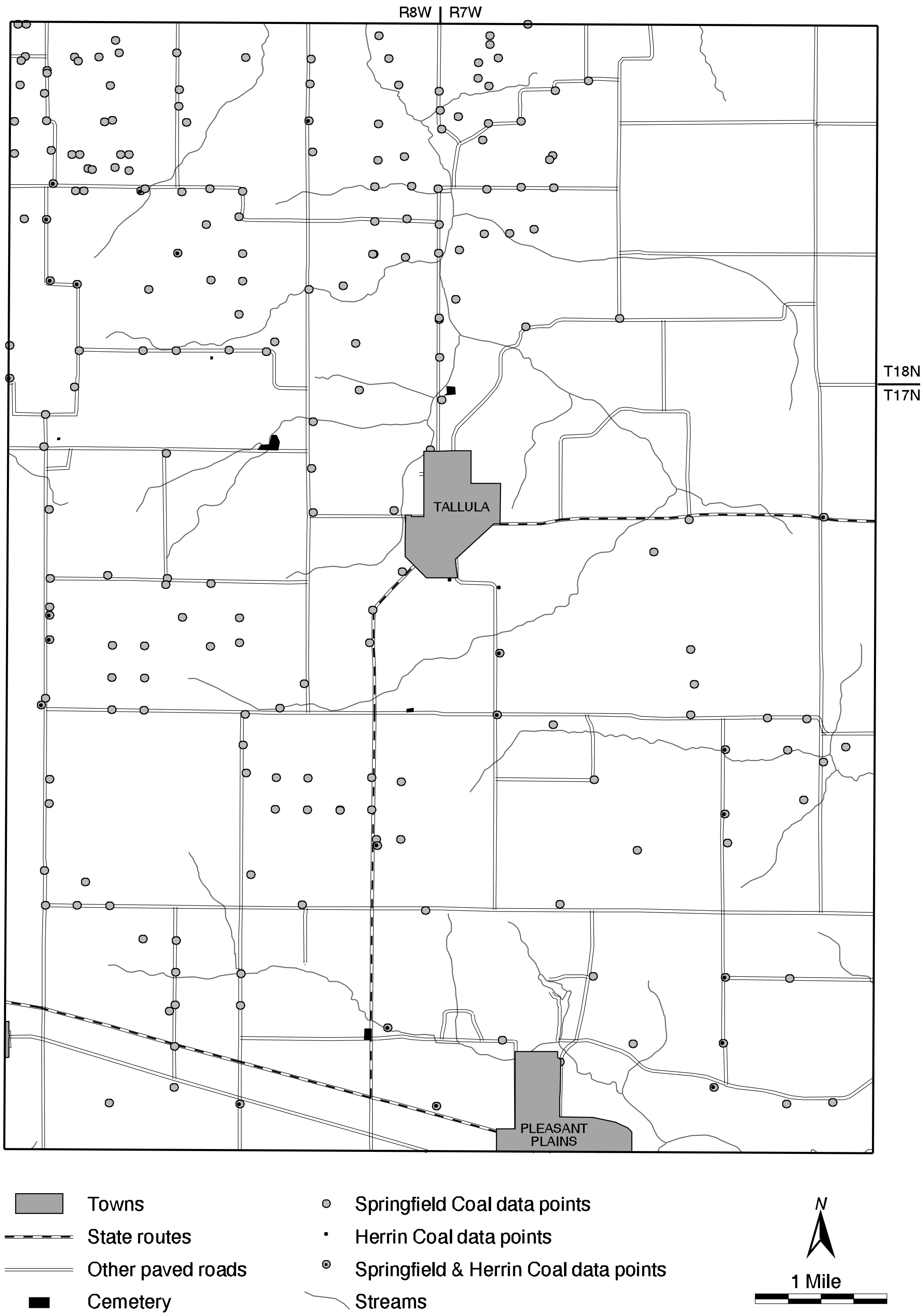


Figure 24 Surface features, Tallula Quadrangle.

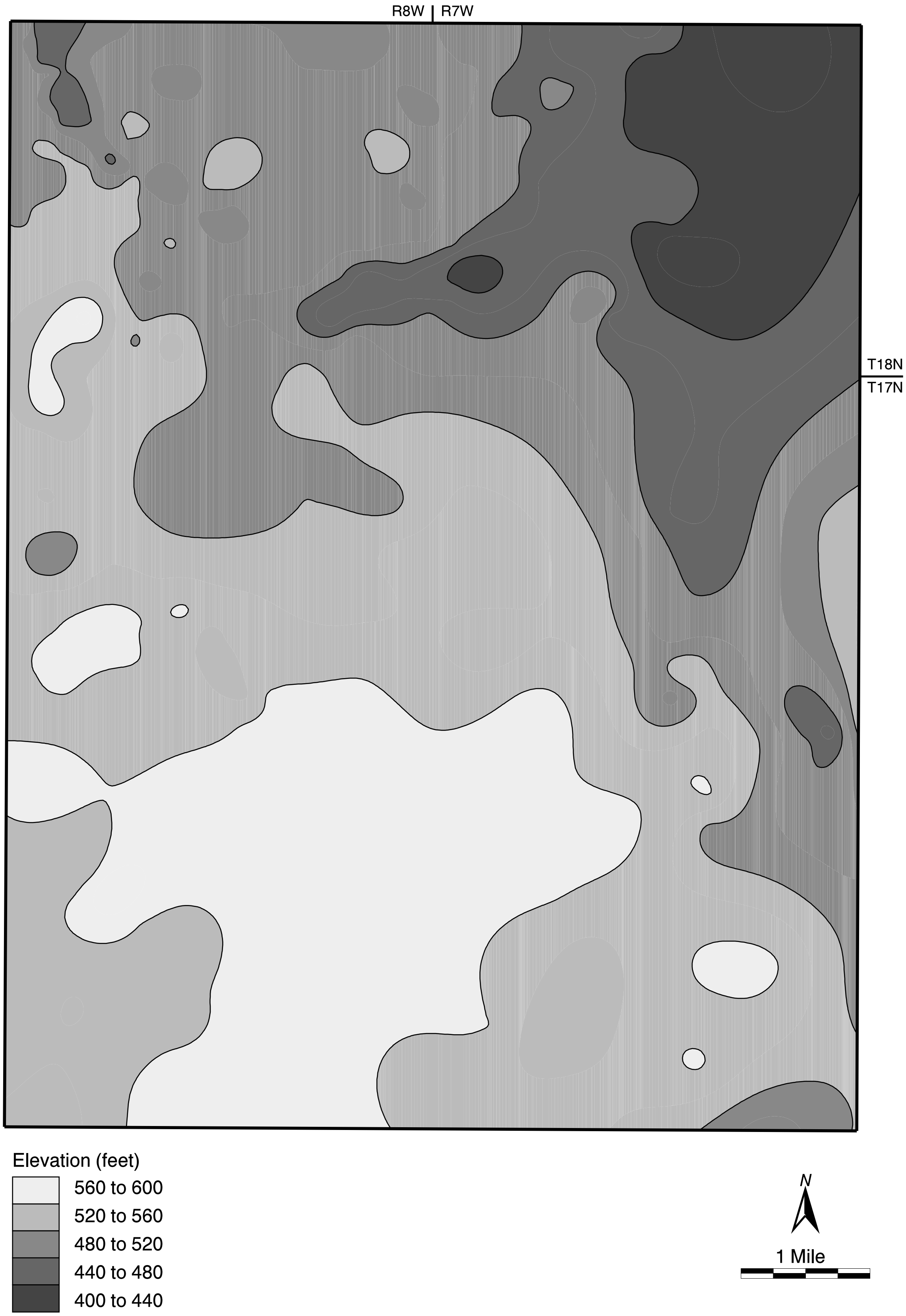


Figure 25 Elevation of the bedrock surface, Tallula Quadrangle.

Figure 26 Thickness of the Herrin Coal, Tallula Quadrangle.

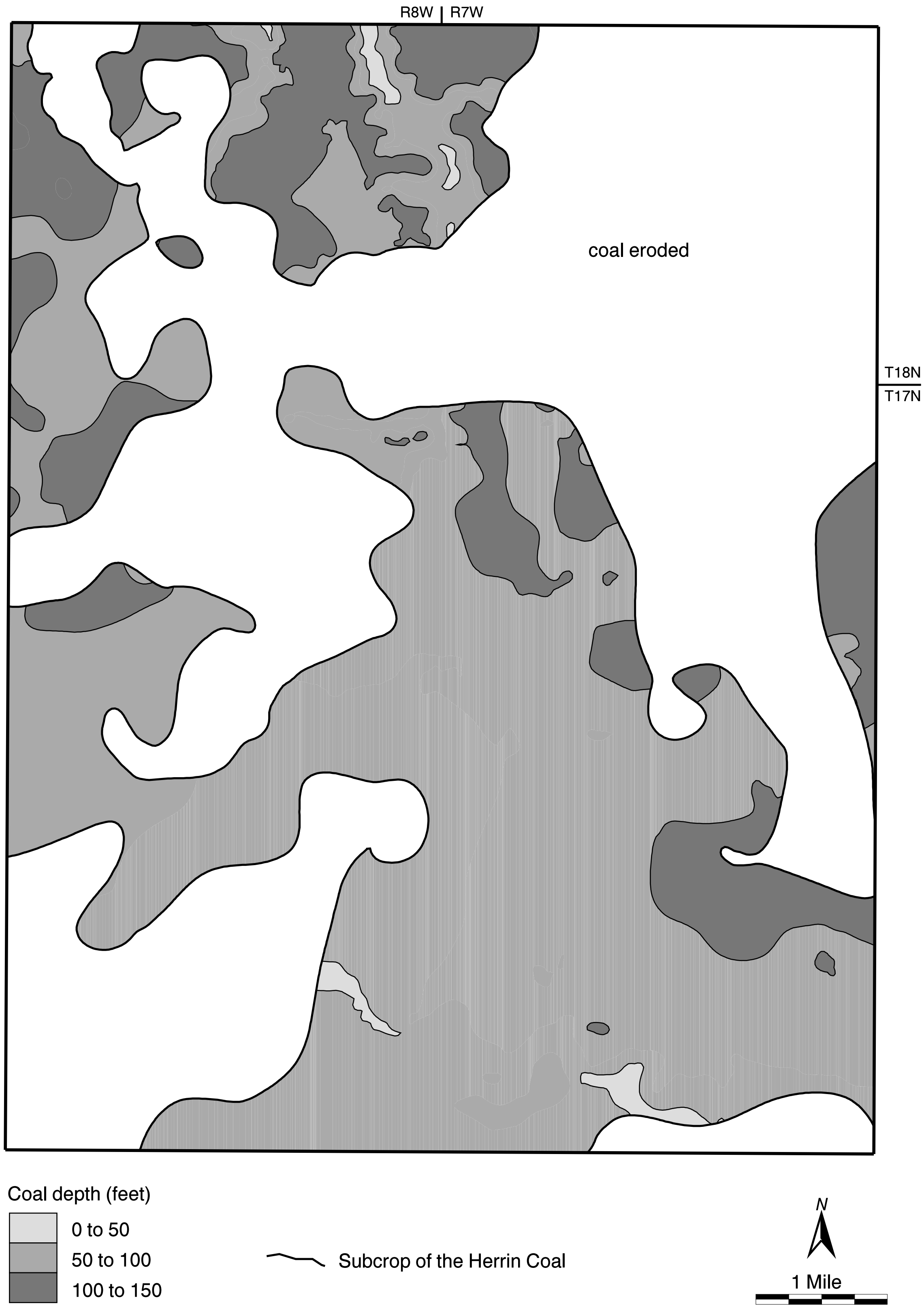


Figure 27 Depth of the Herrin Coal, Tallula Quadrangle.

Figure 28 Stripping ratio of the Herrin Coal, Tallula Quadrangle (cubic yards of overburden per ton of raw coal).

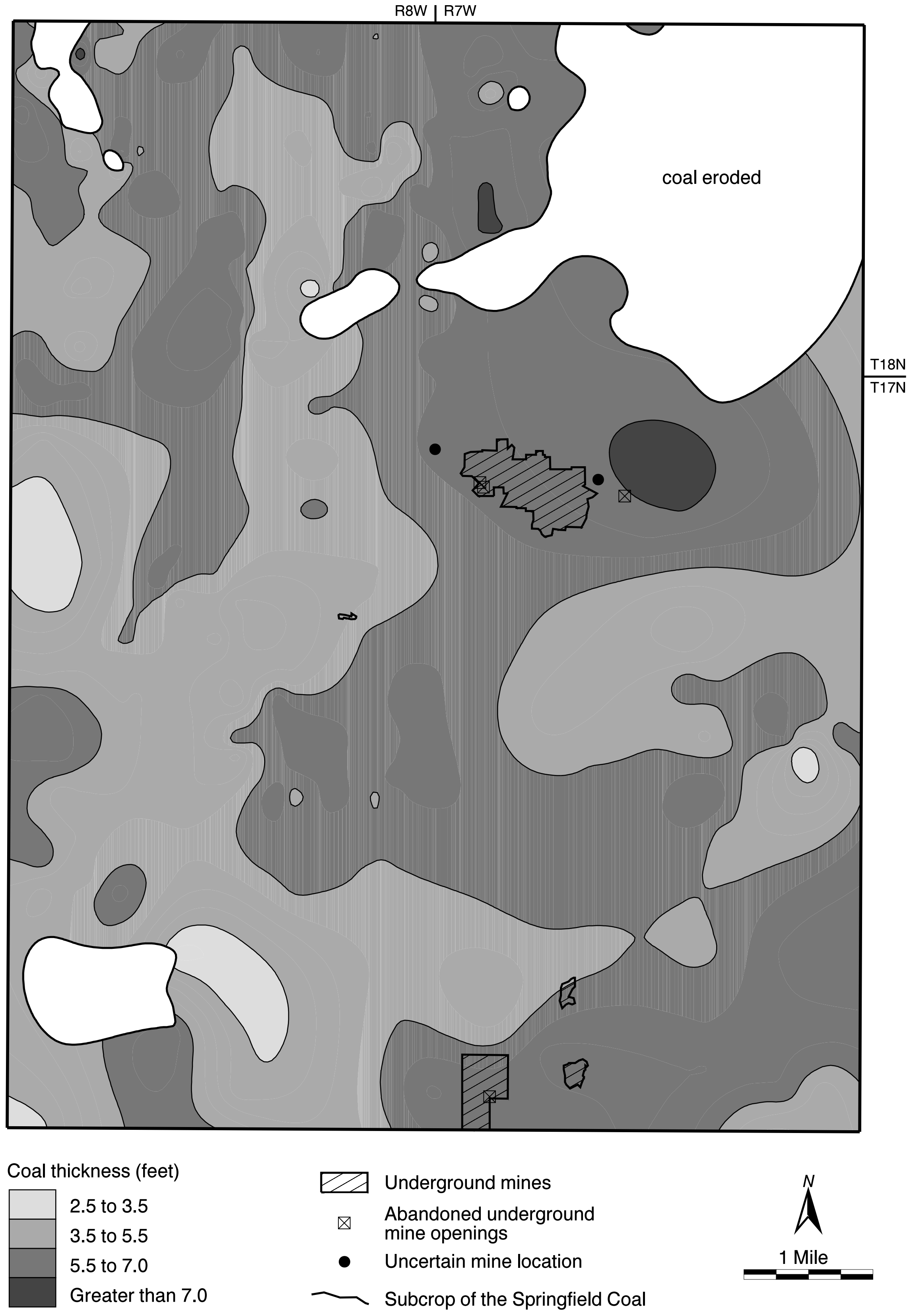


Figure 29 Thickness of the Springfield Coal, Tallula Quadrangle.

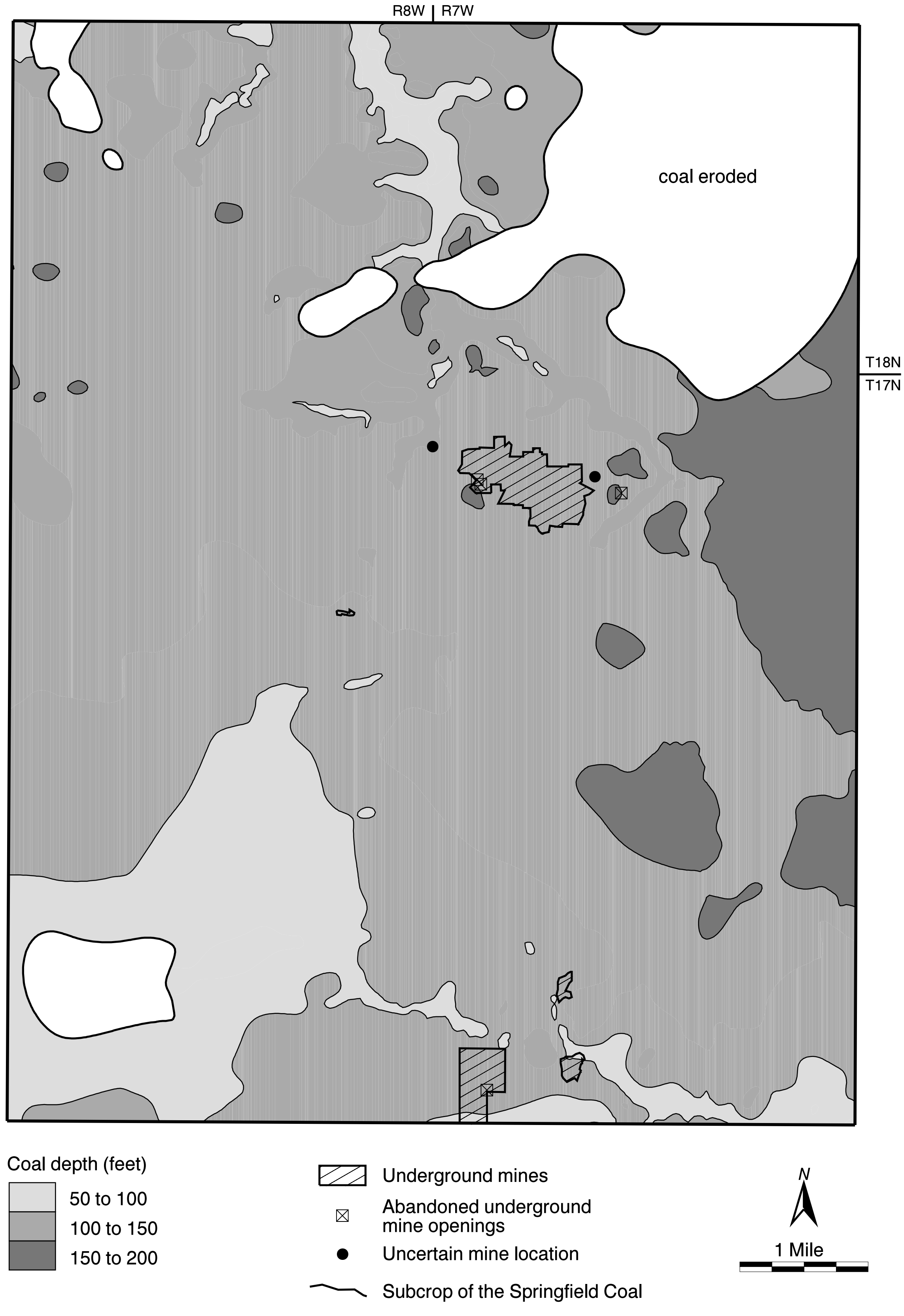


Figure 30 Depth of the Springfield Coal, Tallula Quadrangle.

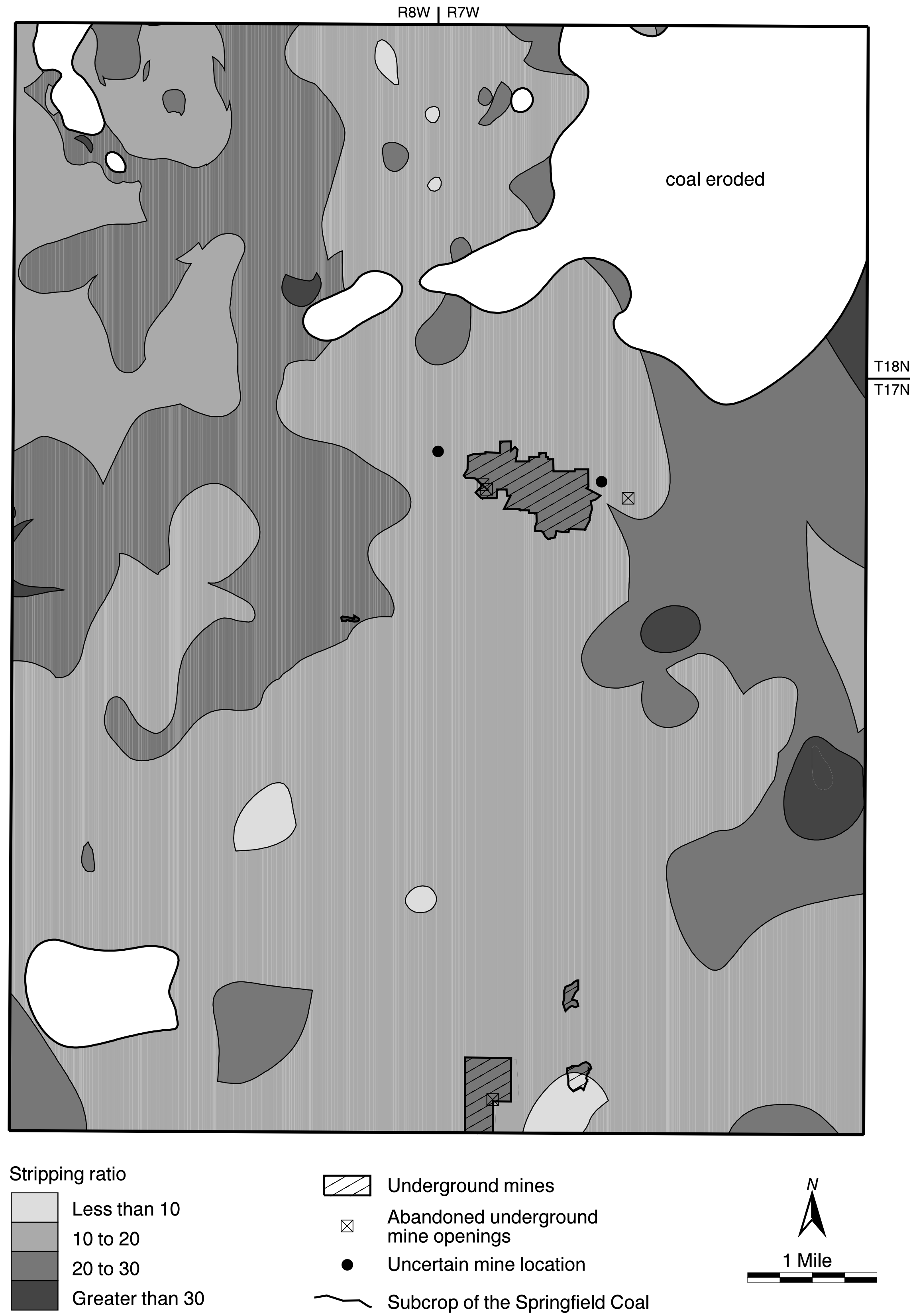


Figure 31 Stripping ratio of the Herrin and Springfield Coals combined, Tallula Quadrangle (cubic yards of overburden per ton of raw coal).

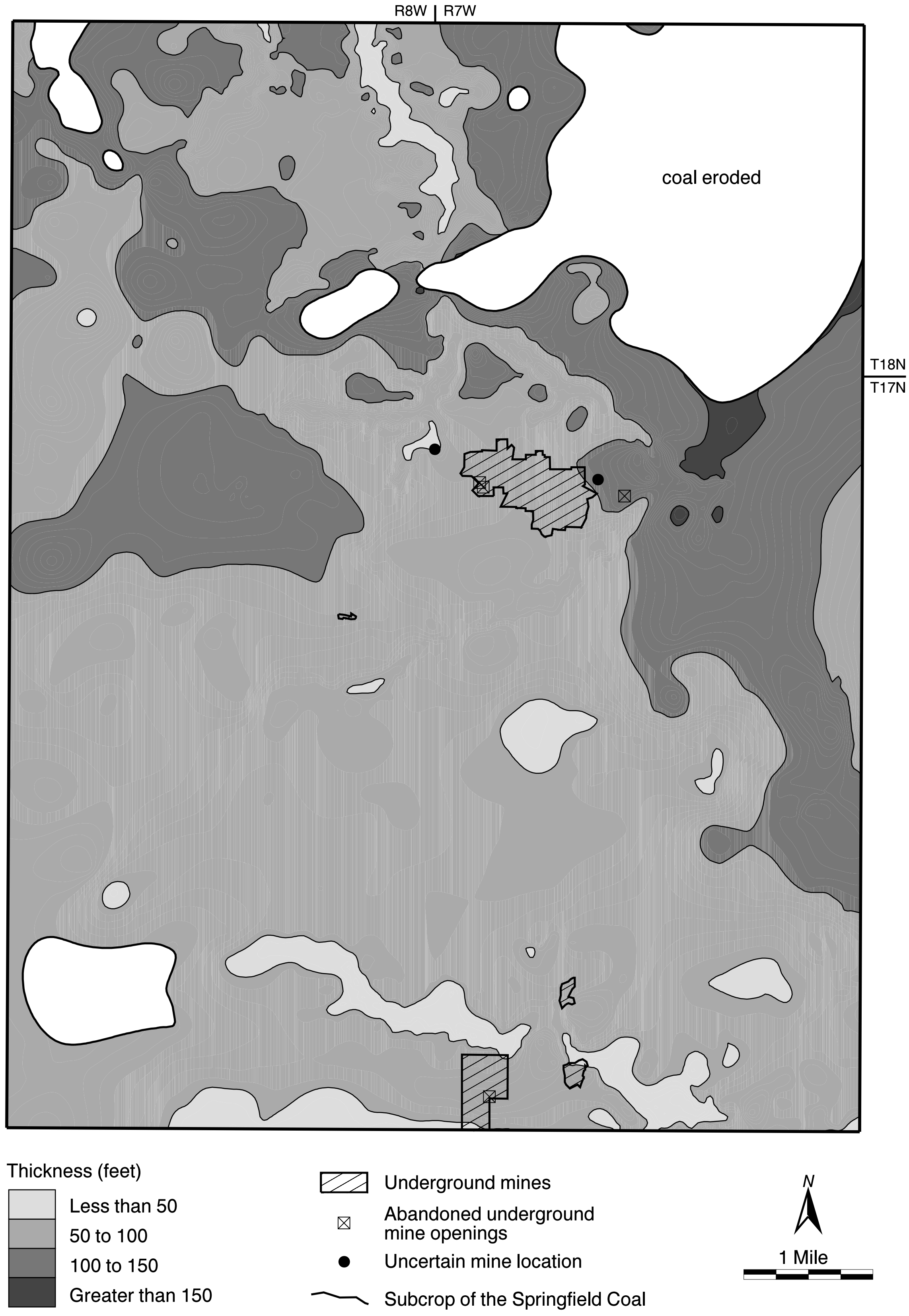


Figure 32 Thickness of unconsolidated overburden, Springfield Coal, Tallula Quadrangle.

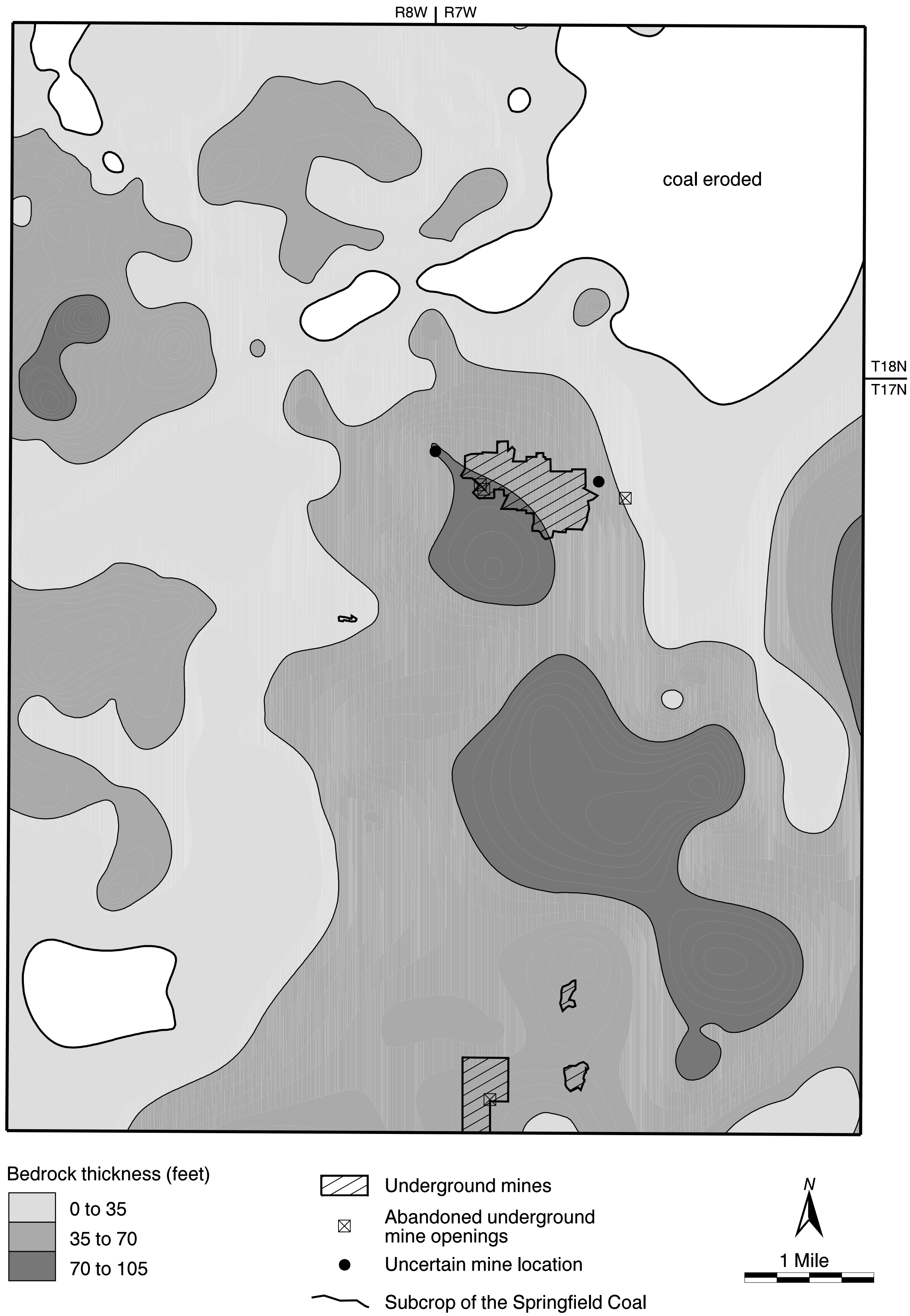


Figure 33 Thickness of bedrock overburden, Springfield Coal, Tallula Quadrangle.

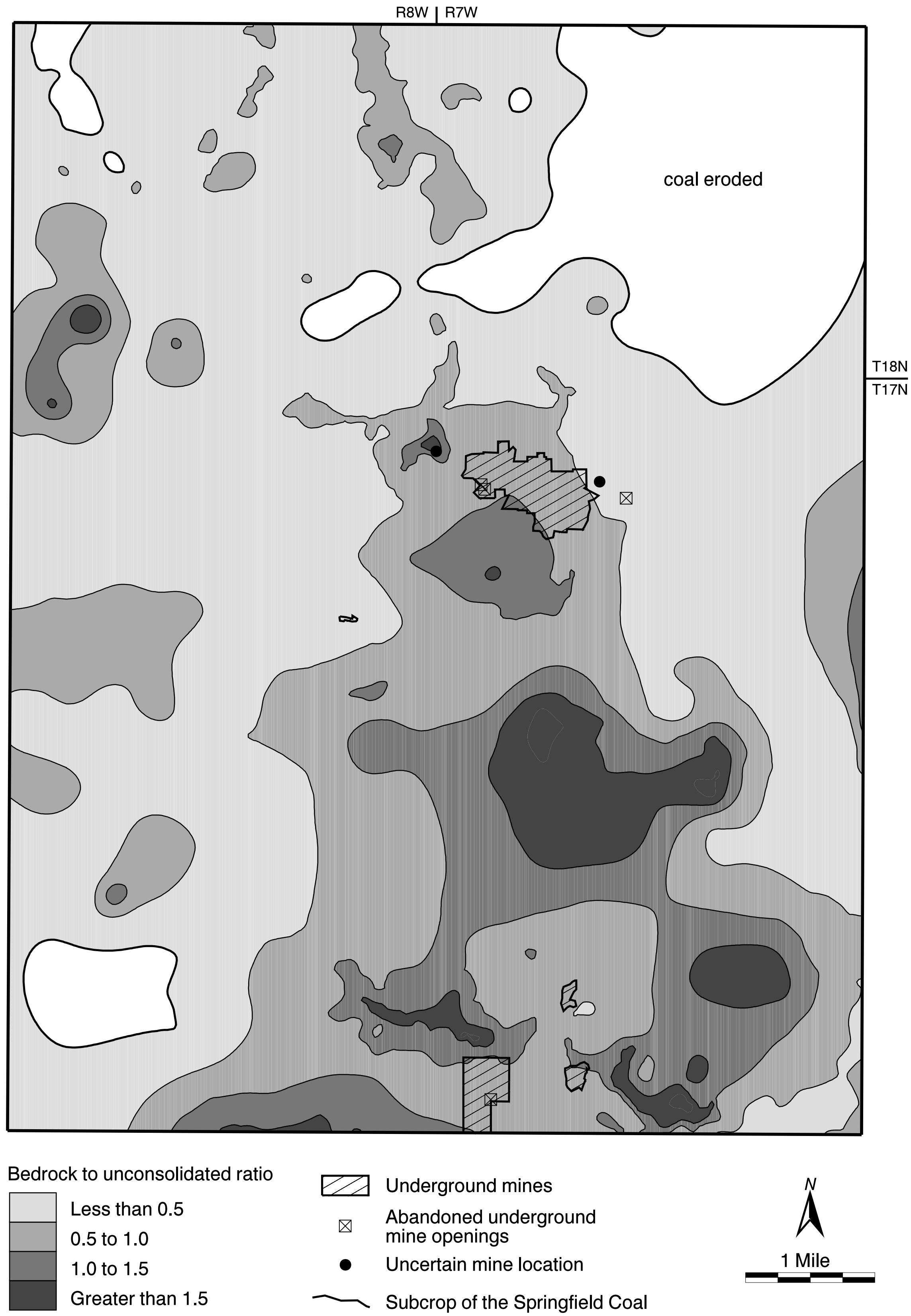


Figure 34 Ratio of bedrock to unconsolidated overburden, Springfield Coal, Tallula Quadrangle.

Available Coal Of the 351 million tons of original resources in the Tallula Quadrangle, 15% (52 million tons) is available for mining (table 5, fig. 35). This includes 12 million tons (3% of original resources) of Herrin Coal that are only available if surface mined in combination with the Springfield Coal. Technological factors, primarily unfavorable amounts of unconsolidated overburden relative to bedrock overburden and high stripping ratios, restrict 72% of the resources. Land use restricts 12% of the resources and 1% has been mined.

Herrin Coal resources are available only if surface mined in combination with the Springfield Coal (fig. 36). If this were done, 26% (12 million tons) of the Herrin resources is available. Technological factors restrict mining of 52% of the resources, and land use restricts 22%. The technological factor restricting mining of the Herrin Coal is primarily high stripping ratio.

About 13% of the resources of the Springfield Coal is available for surface mining (fig. 37). Technological factors restrict 75% of the resources and land use restricts 11%. The primary technological restriction is the thickness of unconsolidated overburden relative to bedrock overburden.

None of the Springfield Coal resources are available for underground mining (fig. 38). Areas with sufficient bedrock cover for underground mining are in blocks too small to support a mine. Note that a previous investigation of the availability of coal in the nearby Middletown Quadrangle cited unstable mine roof, in the form of thick Turner Mine Shale, and weak underclay as additional factors that limit the availability of the Springfield Coal (Treworgy et al. 1994). These factors were not applied in the Tallula Quadrangle because all the underground minable resources of Springfield Coal were restricted by other, more readily measurable, factors. However, these factors are probably present in the Tallula Quadrangle and will affect any underground mining of the Springfield Coal.

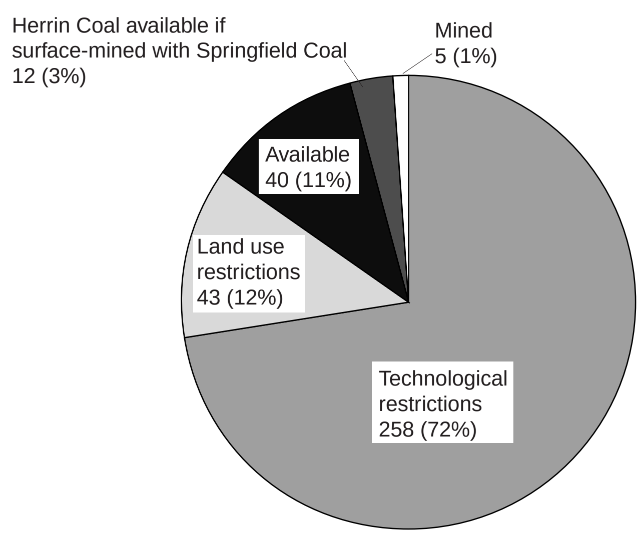


Figure 35 Availability of coal resources, Tallula Quadrangle; millions of tons and (percent of original resources).

Table 5 Availability of coal resources for mining in the Tallula Quadrangle; thousands of tons and (percent of original resources). Note: some resources are reported in both the surface minable and underground minable categories.

	Herrin	Springfield	Total
Original	45,921	312,107	358,027
Available	- -	40,478 (13)	40,478 (11)
Available with conditions*	11,936 (26)	- -	11,936 (3)
Mined out	- -	4,509 (1)	4,509 (1)
Land use restriction	10,226 (22)	33,060 (11)	43,285 (12)
Technological restriction	23,759 (52)	234,059 (75)	257,819 (72)
Surface minable (0 to 200 ft deep)			
Original	45,921	312,107	358,027
Available	- -	40,478 (13)	40,478 (11)
Avail. with conditions*	11,936 (26)	- -	11,936 (3)
Mined out	- -	4,509 (1)	4,509 (1)
Land use restriction	10,226 (22)	33,060 (11)	43,285 (12)
Technological restriction	23,759 (52)	234,059 (75)	257,819 (72)
Land use restrictions			
Towns	9,554 (20)	26,976 (9)	36,530 (10)
Cemeteries	39 (<1)	336 (<1)	374 (<1)
Roads	633 (1)	3,697 (1)	4,330 (1)
Abandoned mine	- -	2,051 (<1)	2,051 (<1)
Technological restrictions			
Stripping ratio	19,038 (41)	21,259 (7)	40,297 (11)
Block size	- -	12,178 (4)	12,178 (3)
Unconsolidated overburden	4,721 (10)	200,622 (64)	205,343 (57)
Underground minable (>75 ft deep)			
Original	4,703	312,107	316,810
Available	- -	- -	- -
Mined out	- -	4,509 (1)	4,509 (1)
Land use restriction	1,721 (37)	9,417 (3)	11,138 (4)
Technical restriction	2,982 (63)	298,180 (96)	301,162 (95)
Land use restrictions			
Towns	1,721 (37)	6,735 (2)	8,455 (3)
Cemeteries	- -	632 (<1)	632 (<1)
Abandoned mines	- -	2,051 (<1)	2,051 (<1)
Technological restrictions			
Thin bedrock	2,418 (51)	275,130 (88)	277,548 (88)
Block size	- -	23,050 (7)	23,050 (7)
Coal <42" thick	564 (12)	- -	564 (<1)

*Available if the underlying Springfield Coal is surface mined.

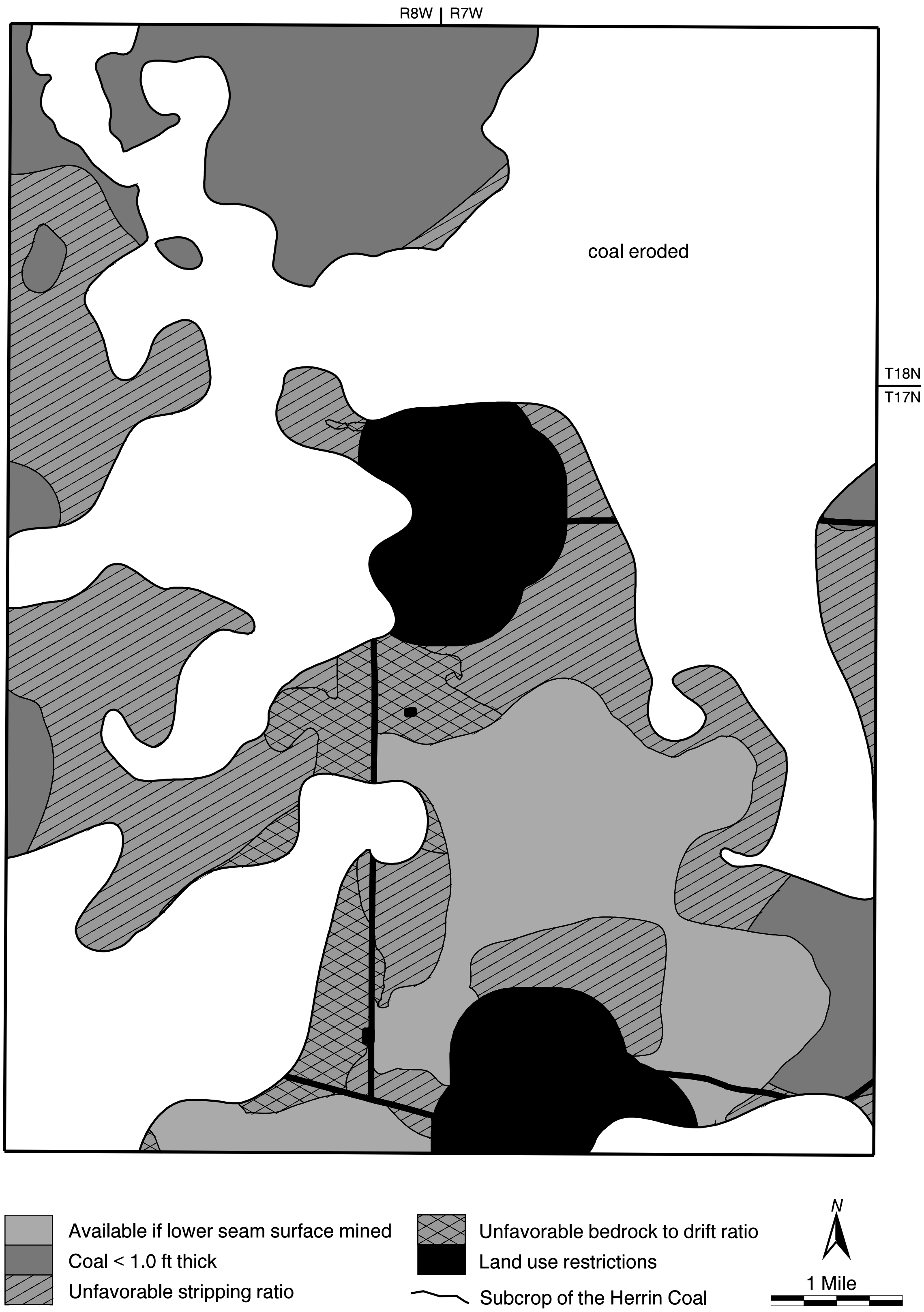


Figure 36 Availability of the Herrin Coal for surface mining, Tallula Quadrangle.

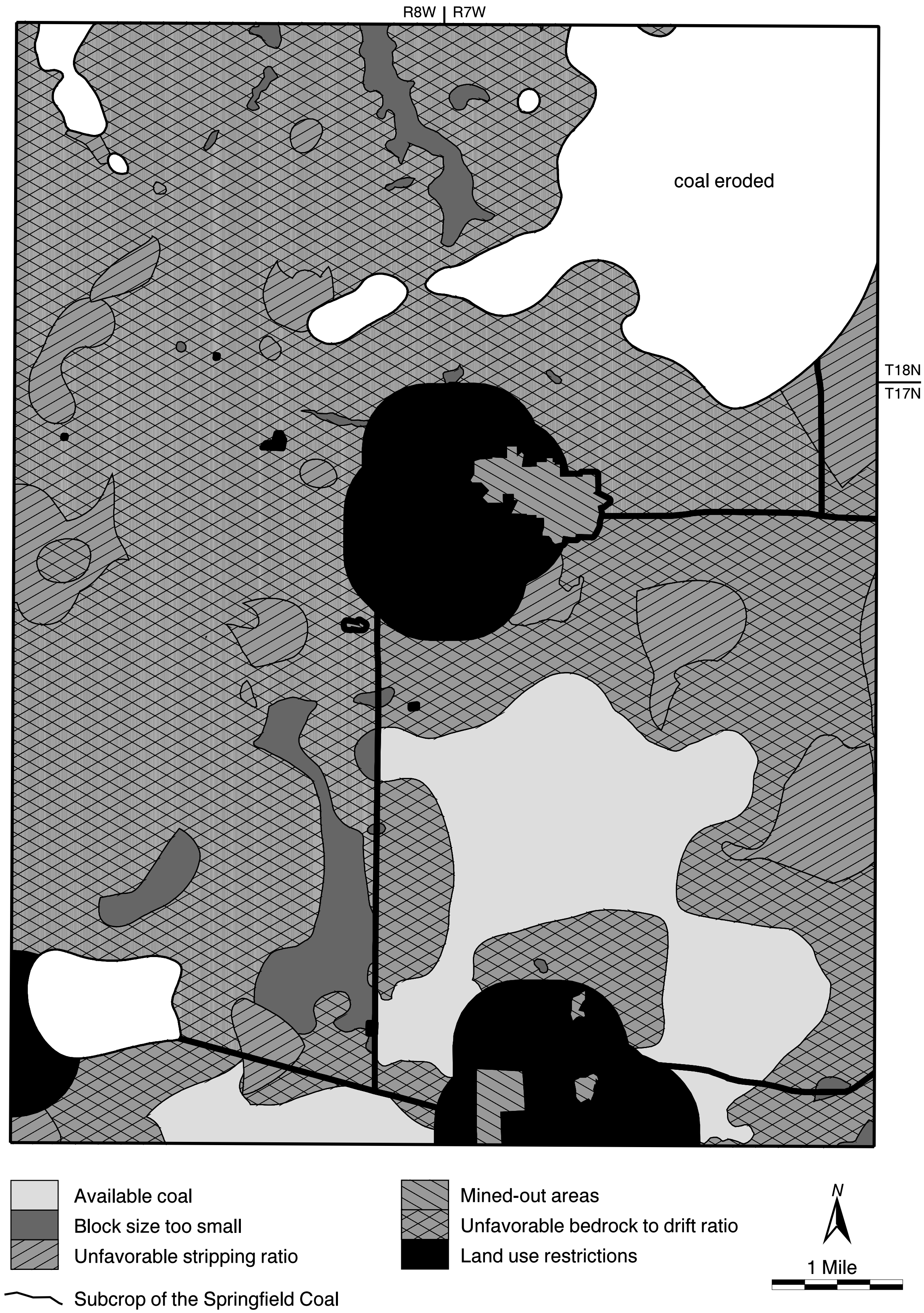


Figure 37 Availability of the Springfield Coal for surface mining, Tallula Quadrangle.

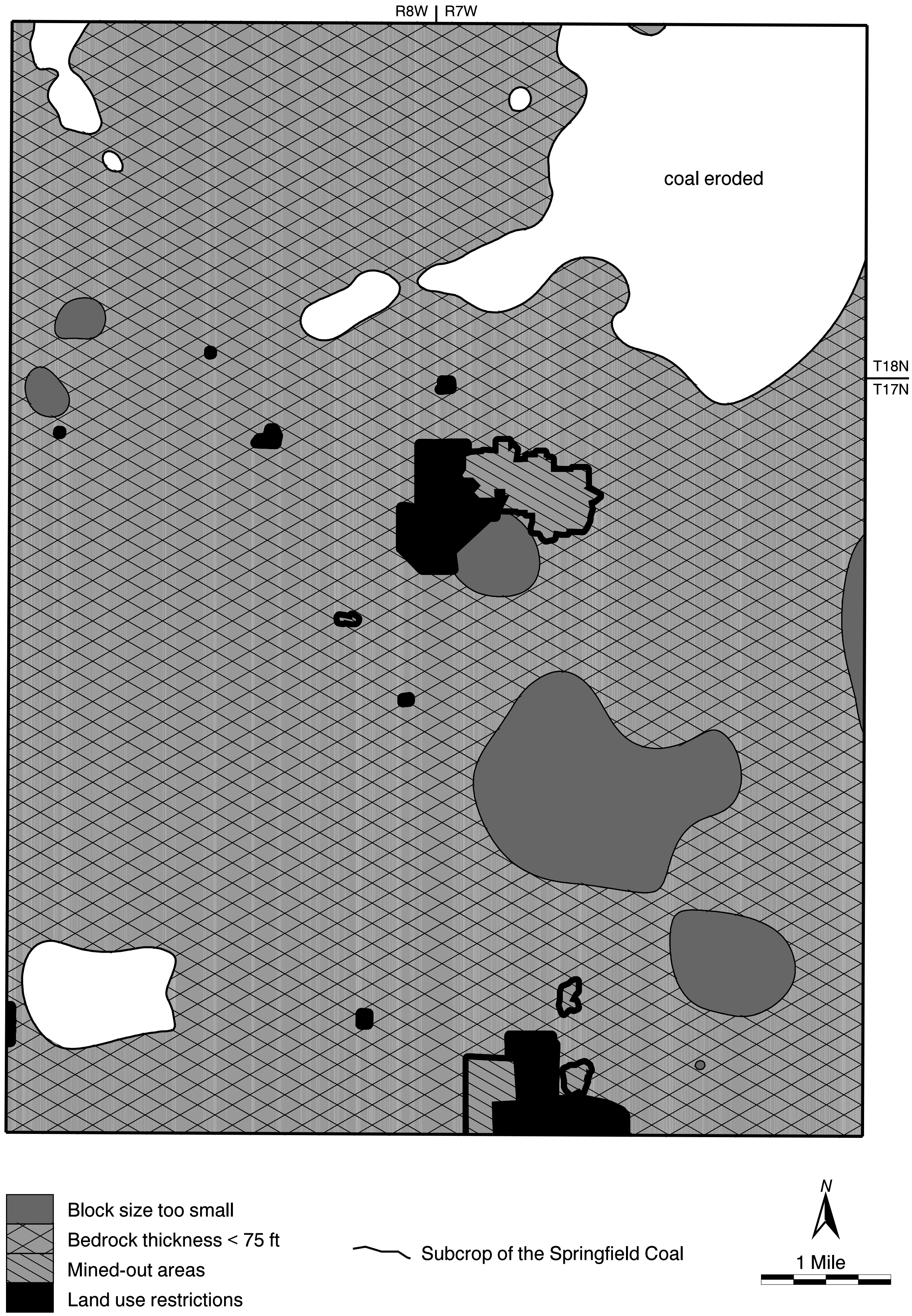


Figure 38 Availability of the Springfield Coal for underground mining, Tallula Quadrangle.

Availability of Coal in the Albion South and Springerton Quadrangles, Southern Illinois

The Albion South and Springerton Quadrangles are representative of underground mining conditions associated with deep deposits of Herrin, Springfield, Dekoven, and Davis Coals in much of southern Illinois (fig. 39). These quadrangles are 30 to 40 miles north of the outcrops of the major minable coals in the area, the Herrin, Springfield, and Davis Coals. The coals dip to the north from their outcrops and lie at depths of 750 to more than 1,300 feet in the study areas. No mining has taken place in these quadrangles, but three large mines are within a few miles to the south and east.

Both quadrangles are rural areas consisting of row-crop farming and pasture with scattered areas of small woodlands. The towns of Albion and Grayville (1990 populations: 2,116 and 2,043) lie at the northern and southeastern edges of the Albion South Quadrangle (fig.40). The towns of Springerton, Mill Shoals, and Burnt Prairie (1990 populations: 166, 893, and 71 respectively) lie in the Springerton Quadrangle (fig. 41). No interstate highways, parks, or other major surface developments are present. Both quadrangles have been heavily drilled for oil and gas (figs 42 and 43). All wells are drilled to target zones below the coals and the majority are either active producers of oil or are used as injection wells.

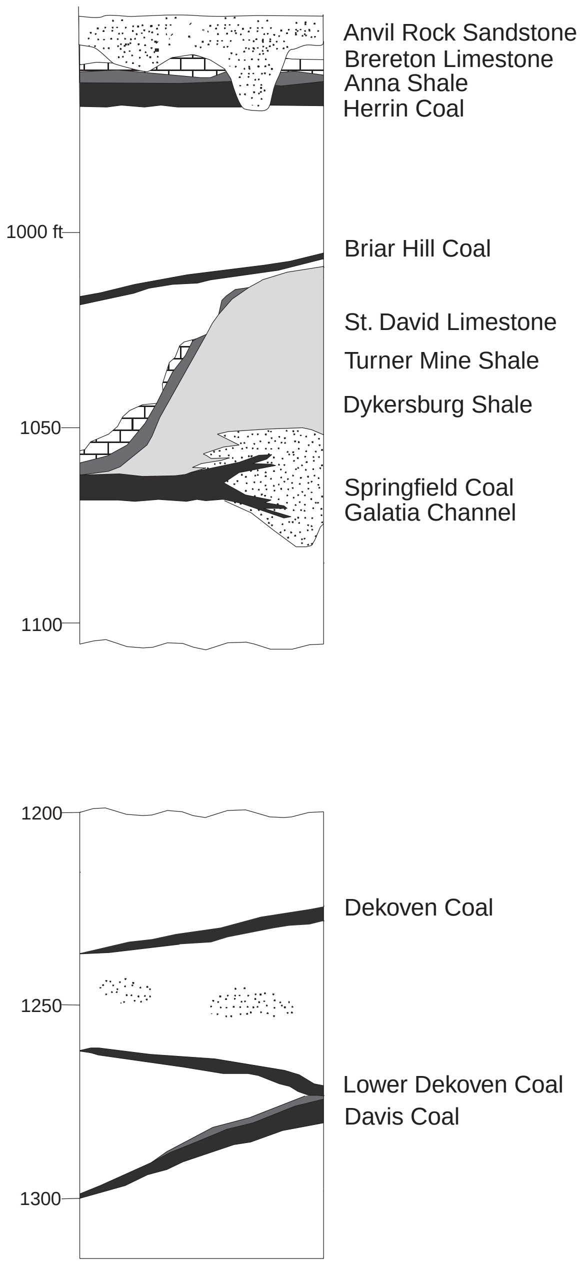


Figure 39 Selected stratigraphic units, Albion South and Springerton Quadrangles.

Geology and Coal Resources Coal resources have been mapped for the Herrin and Springfield Coals in both quadrangles, and for the Davis and Lower Dekoven Coals in the Springerton Quadrangle. Other coals are present, but are too thin or discontinuous to warrant mapping. The resources were mapped using data from ISGS files and proprietary data from coal companies.

The Albion-Ridgeway Fault, part of the Wabash Valley Fault System, cuts across the middle of the Albion South Quadrangle and apparently dies out near the northeast corner of the quadrangle (figs. 5 and 44). This high-angle normal fault displaces all of the Pennsylvanian coal-bearing rocks and underlying units. Maximum displacement of the Herrin Coal is about 120 feet in the southern and central parts of the quadrangle (fig. 44). Although the fault is mapped as a single break, mining adjacent to other faults in this system has encountered minor parallel faults, cross faults, severe jointing, influxes of water and gas, and substantial dips in the coal within a zone several hundred feet wide on either side of the fault.

The Herrin Coal has been eroded in the Albion South Quadrangle along the course of the Anvil Rock Channel (fig. 45). The coal is missing from the center of the channel and is a few feet thick in places along the margin where it was only partially eroded. Elsewhere in the quadrangle the coal ranges from 2 to 7.5 feet thick.

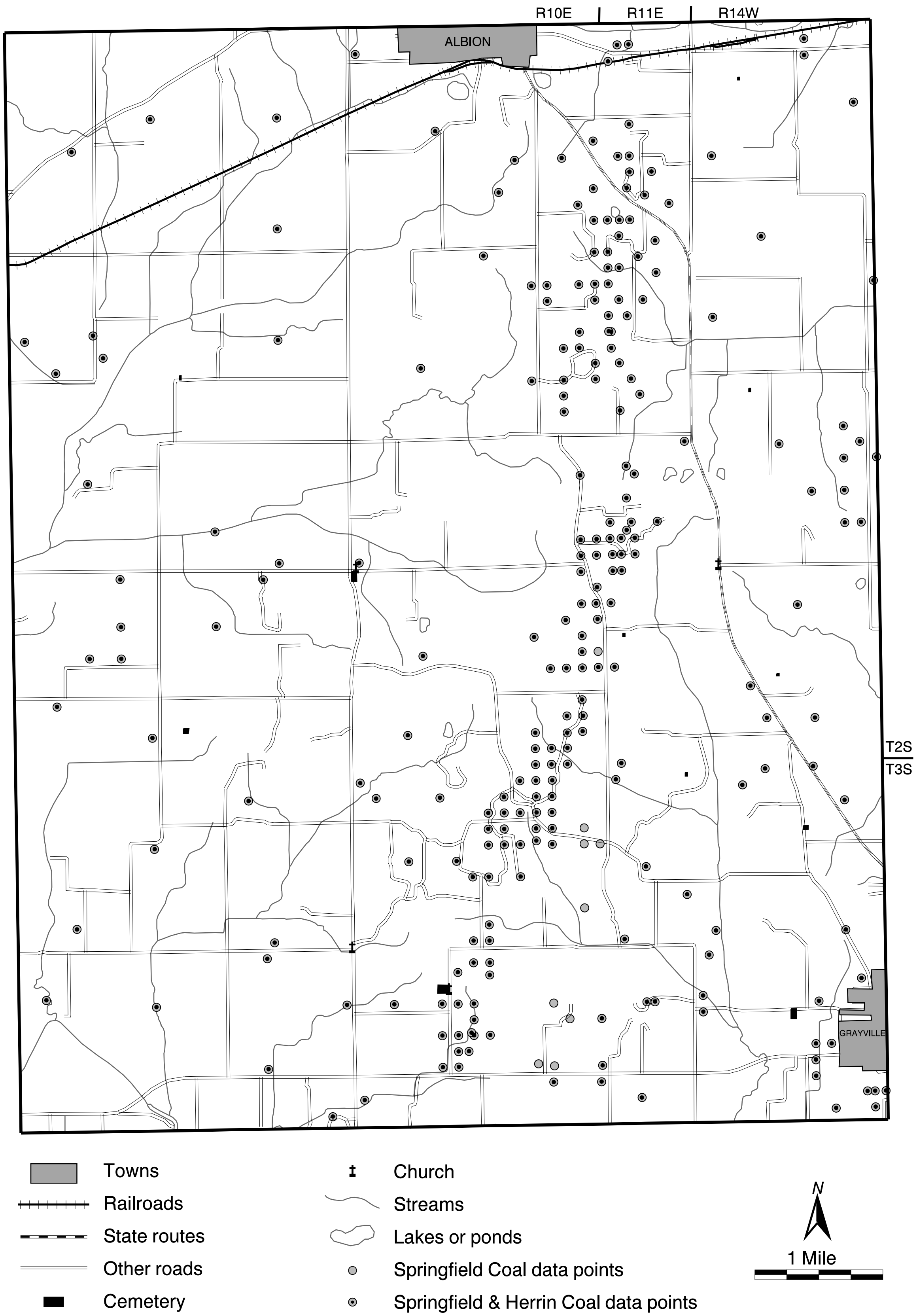


Figure 40 Surface features, Albion South Quadrangle.

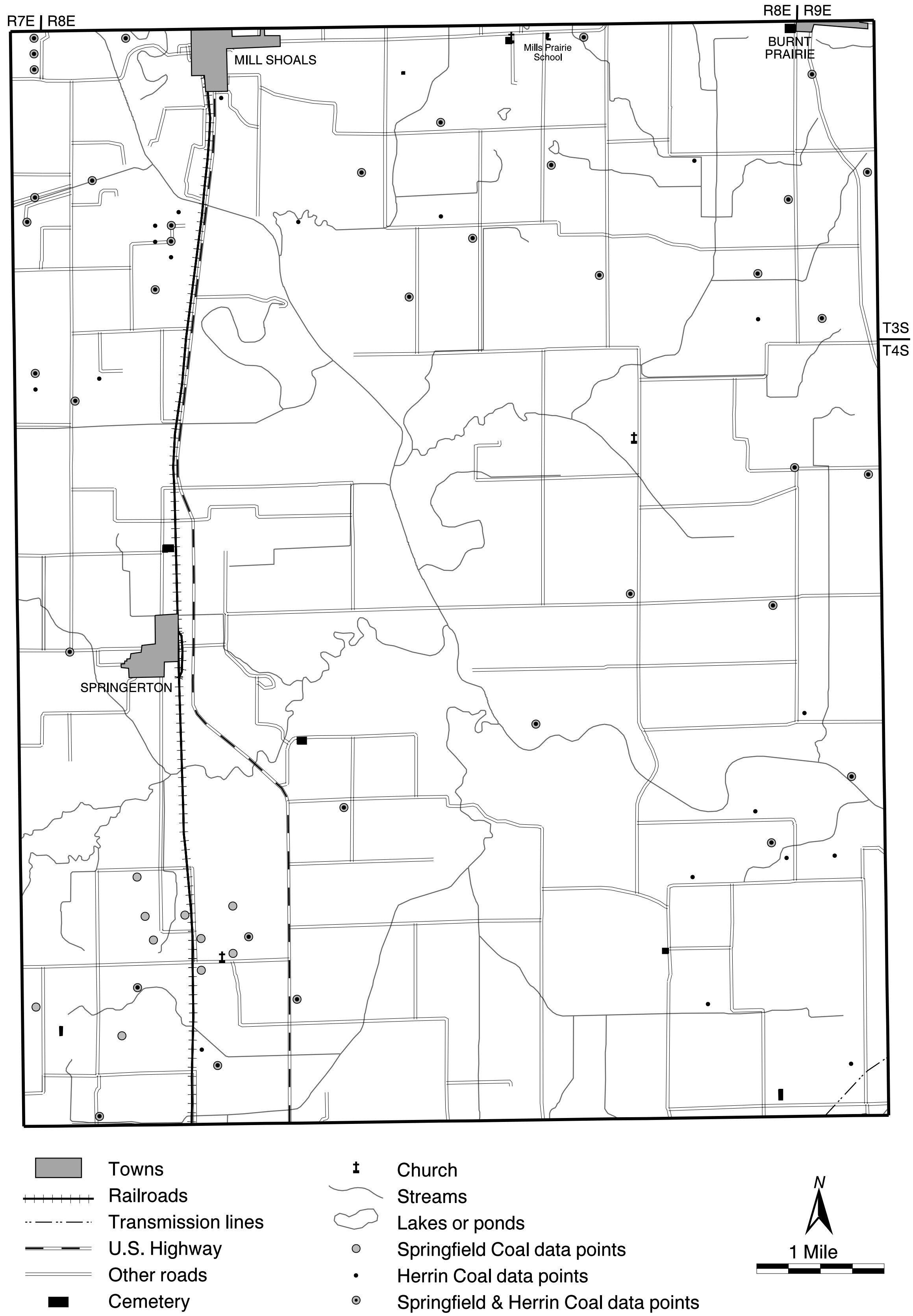


Figure 41 Surface features, Springerton Quadrangle.

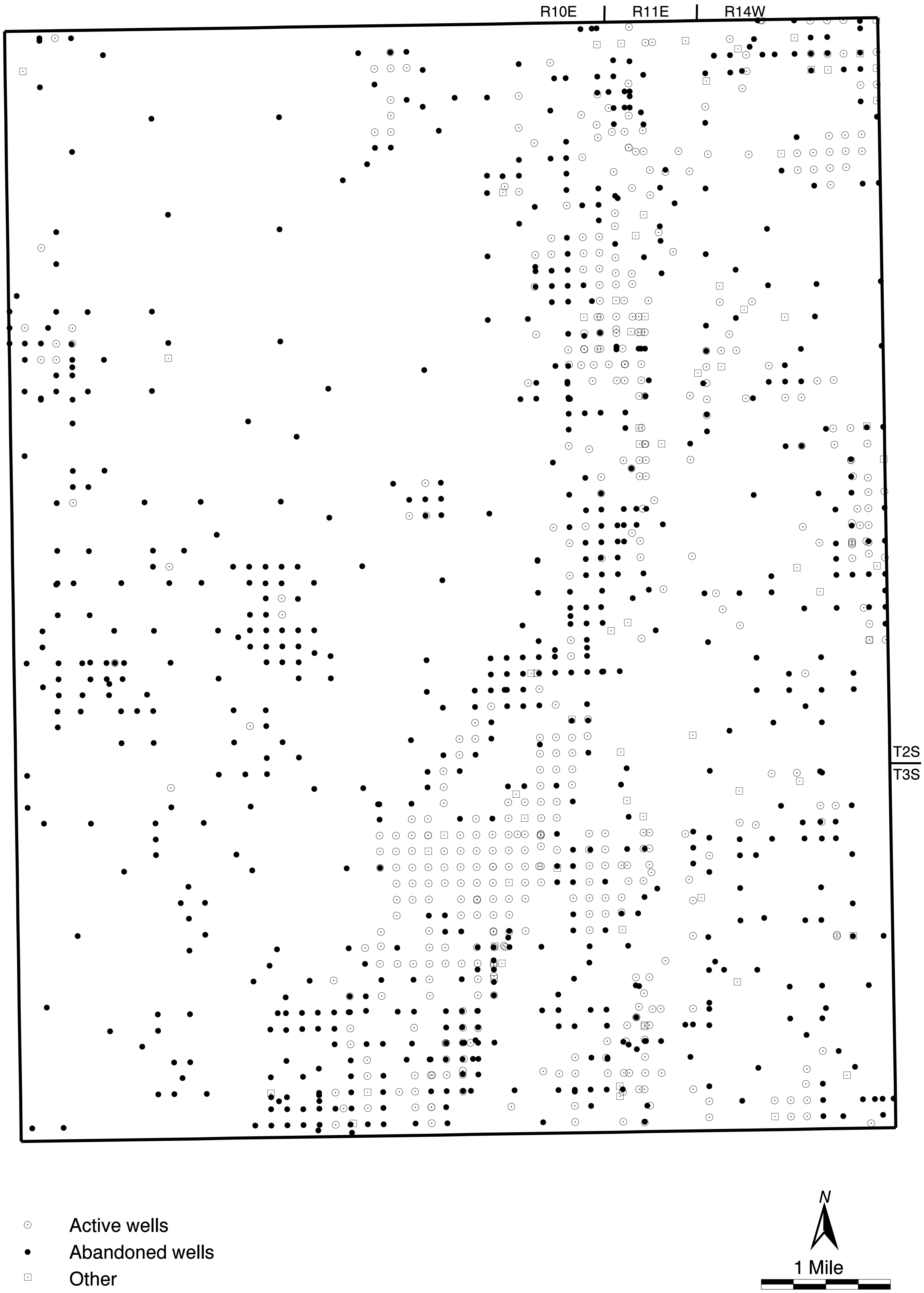
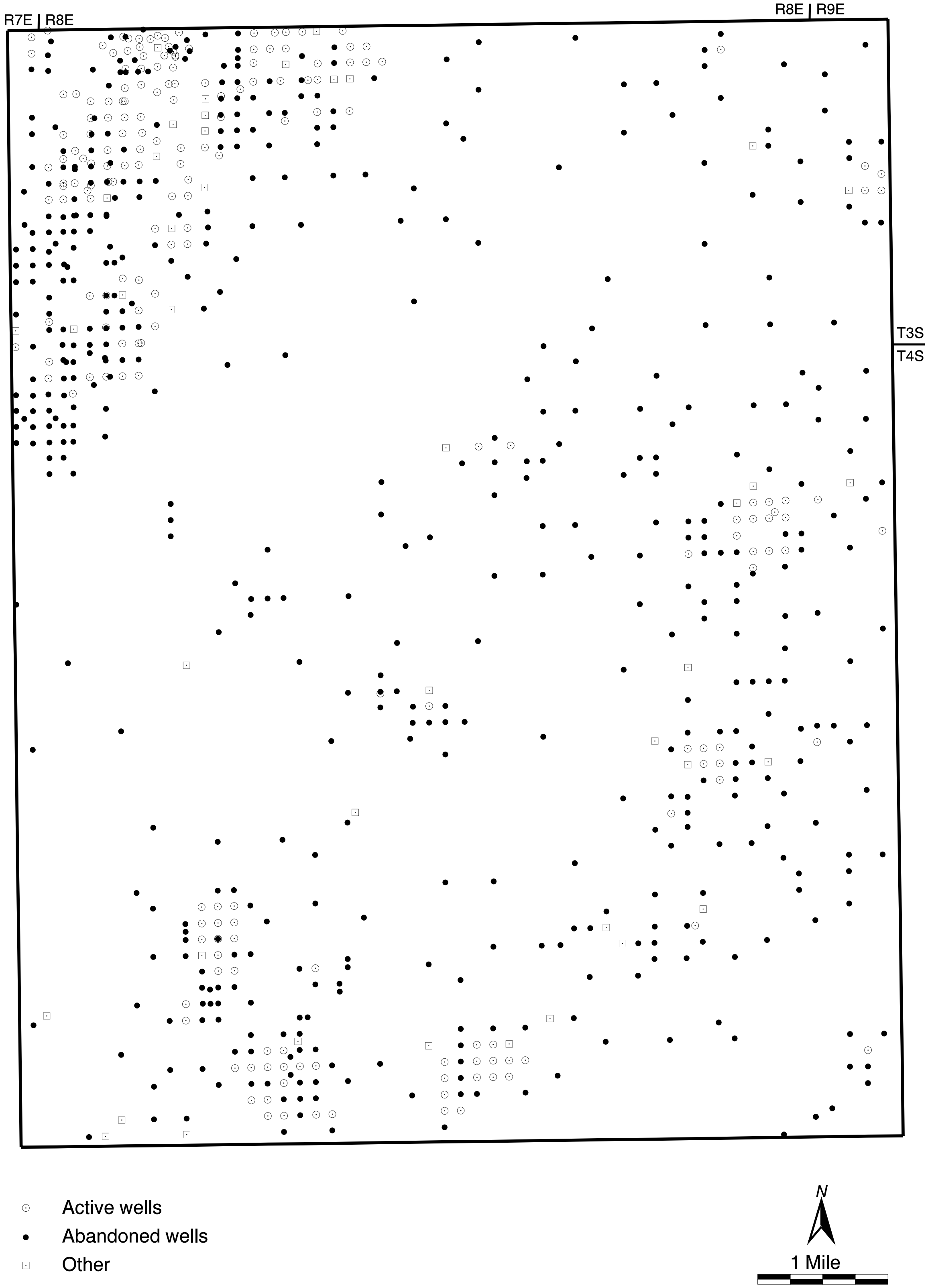


Figure 42 Well locations, Albion South Quadrangle.



⊙ Active wells
• Abandoned wells
⊡ Other

Figure 43 Well locations, Springerton Quadrangle.

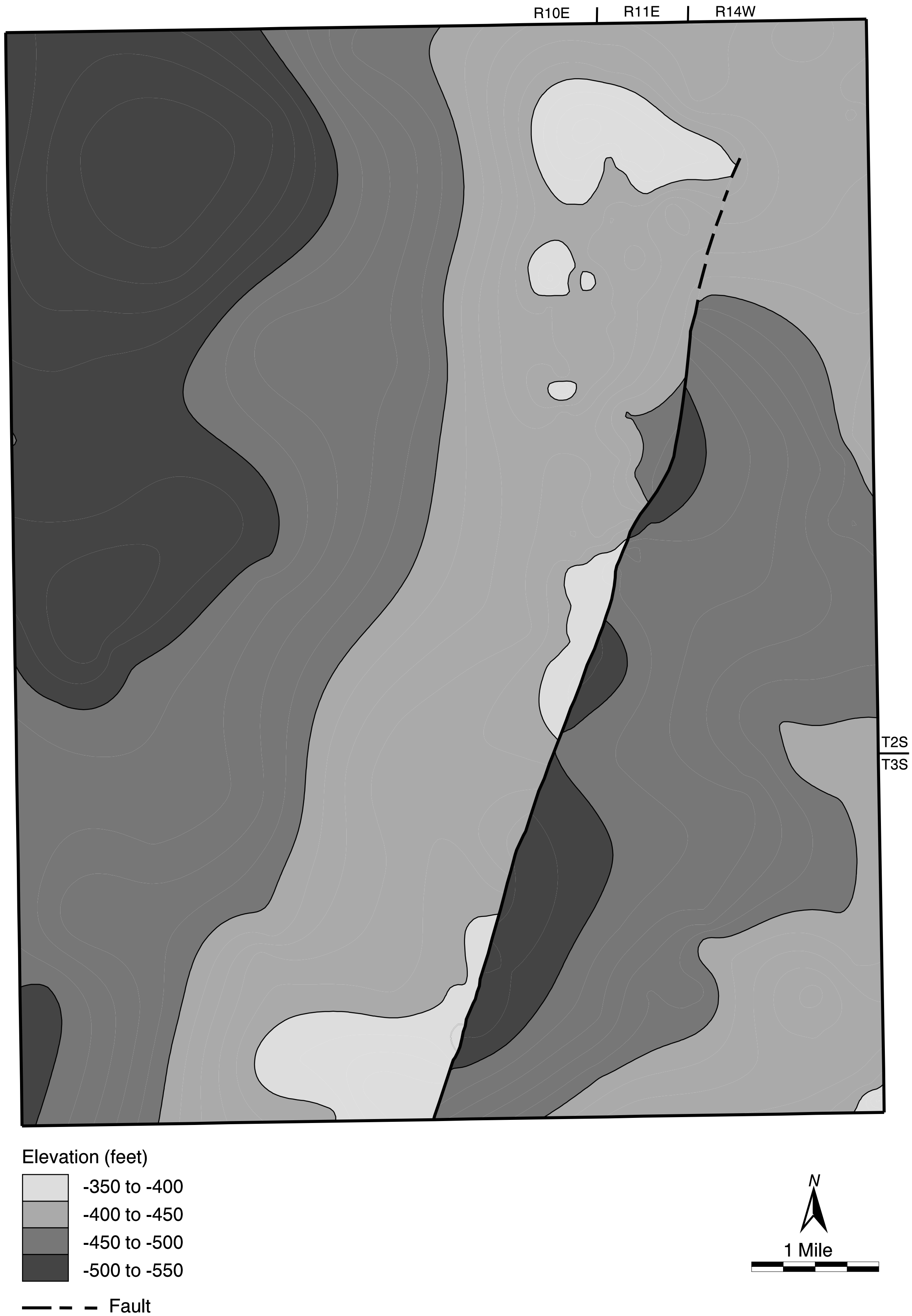


Figure 44 Elevation of the Herrin Coal, Albion South Quadrangle.

Figure 45 Thickness of the Herrin Coal, Albion South Quadrangle.

The Anvil Rock Channel lies just north of the Springerton Quadrangle and is not known to have eroded any Herrin Coal in that quadrangle. The Herrin ranges in thickness from 3 to 7 feet in the Springerton Quadrangle (fig. 46). The coal is 750 to just over 950 feet deep in the Albion South Quadrangle and 850 to 1,050 feet deep in the Springerton Quadrangle. Throughout most of both quadrangles the Herrin Coal is overlain by the normal sequence of black shales and limestones commonly found throughout Illinois. However, in places the Anvil Rock Sandstone has eroded through part or all of this sequence. Areas where the Anvil Rock Sandstone is within five feet or less of the coal extend more than a mile from the channel in parts of Albion South. Localized zones where the seam may be partially eroded may be encountered in these areas. In the Springerton Quadrangle, the lowermost roof strata - the Anna Shale and Brereton Limestone - are commonly present and the Anvil Rock Sandstone lies five feet or more above the coal.

The Springfield Coal lies about 100 feet below the Herrin Coal. In the Albion South Quadrangle, the Springfield ranges from a few feet to 10 feet in thickness, but is commonly more than 6.5 feet thick (fig. 47). The coal in the Springerton Quadrangle is up to a total of 10 feet in thickness in multiple benches, but more commonly it totals 5 feet (fig. 48). The Galatia Channel circles across the southern, western, and northern portions of the Albion South Quadrangle, and crosses the southern edge of the Springerton Quadrangle.

As is the case elsewhere along the Galatia Channel, areas of both unusually thin and thick coal are found near the channel, and partings in the seam are abundant. The area of thin coal and partings in the southwest quarter of the Springerton Quadrangle is probably an abandoned meander in the channel. Partings are present in the coal up to several miles from the channel in the Albion South Quadrangle. The data we used to map this area did not have a high enough resolution or dense enough spacing to accurately map the thickness of these partings, however most partings appeared to be near the top of the seam and less than 3 feet in thickness. Partings more than 2 feet thick were noted only near the channel. Partings more than a half mile from the channel are commonly a foot or less in thickness and will not cause the yield of clean coal to fall below 65%. Partings in the coal affect a smaller area in the Springerton Quadrangle, but where present can be several feet thick and present a restriction to mining (fig. 4). Available data are not spaced closely enough in the vicinity of these large partings to map their extent. We have represented the area affected by partings by drawing a quarter-mile buffer zone around general areas where they were reported.

The Dykersburg Shale overlies the Springfield Coal throughout most of the area in both of these quadrangles (figs. 49 and 50). In Albion South, the Dykersburg Shale is commonly less than 10 feet thick and cannot be positively identified on all geophysical logs. The Dykersburg Shale thickens locally, particularly adjacent to the channel, to about 60 feet. In places the thickness changes by 30 feet over as little as a quarter mile. Roof stability problems can be expected in these areas. The Dykersburg is 10 to 50 feet thick over most of the Springerton Quadrangle and locally exceeds 80 feet in thickness. Except for two areas in the southwest quarter of the quadrangle, the thickness changes in the Dykersburg are gradual and unlikely to cause roof control problems.

The Lower Dekoven Coal has been mapped in Saline and Gallatin Counties and is known to extend northward into the basin. The Lower Dekoven in the Springerton Quadrangle was mapped for this study. The coal lies 100 to 300 feet below the Springfield Coal and is less than a foot to 3.5 feet in thickness (fig. 51). The Lower Dekoven is not economically minable by itself, but because it occurs a short interval above the Davis Coal, some possibilities exist for mining the two seams together. The Davis Coal in the Springerton Quadrangle is less than 2.5 to more than 5.5 feet thick (fig. 52). The interval between the coals ranges from less than a foot to more than 40 feet (fig. 53). Both seams can be mined with the parting in the northern third of the Springerton Quadrangle where the clean coal yield is greater than 65% (fig. 54).

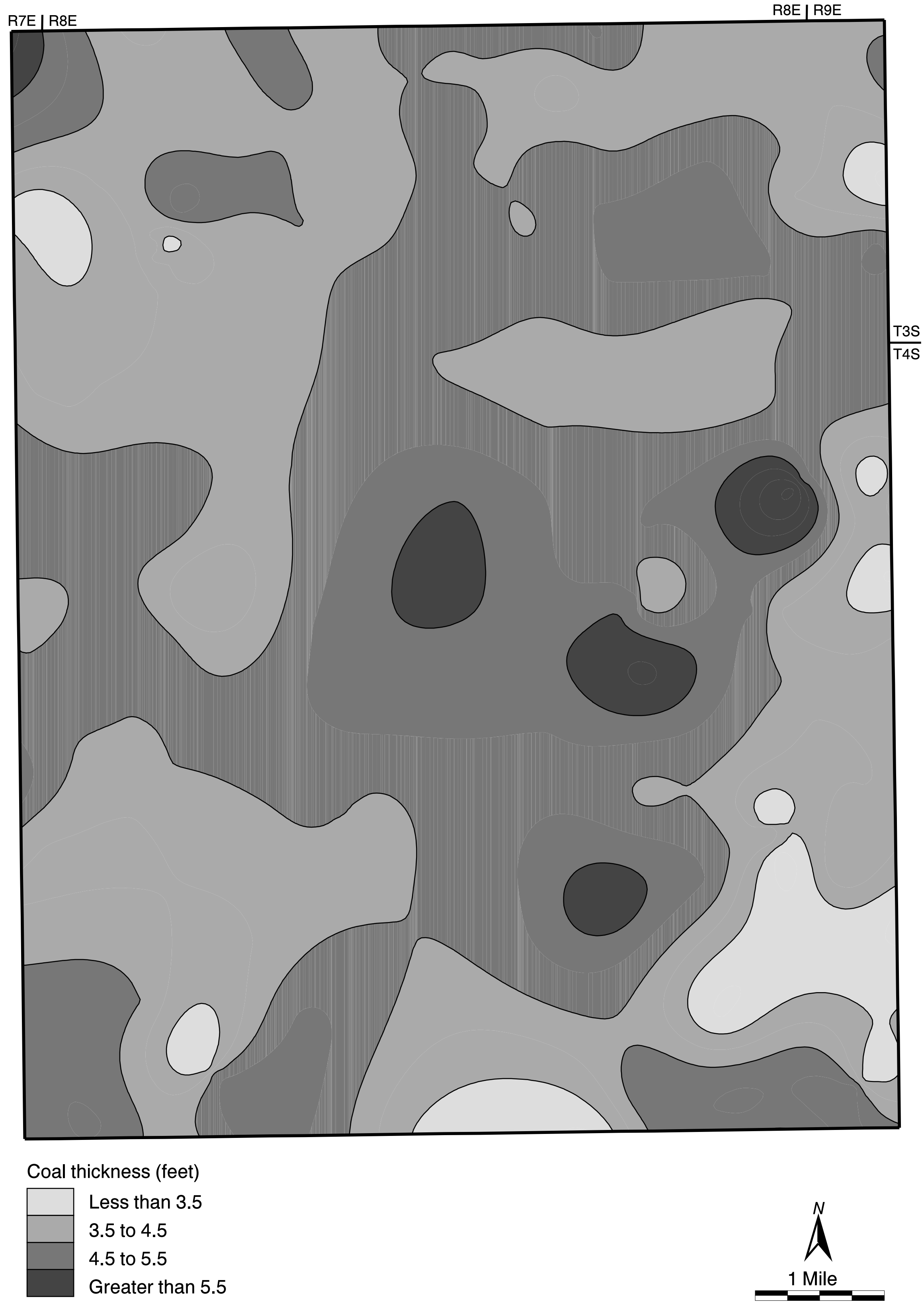


Figure 46 Thickness of the Herrin Coal, Springerton Quadrangle.

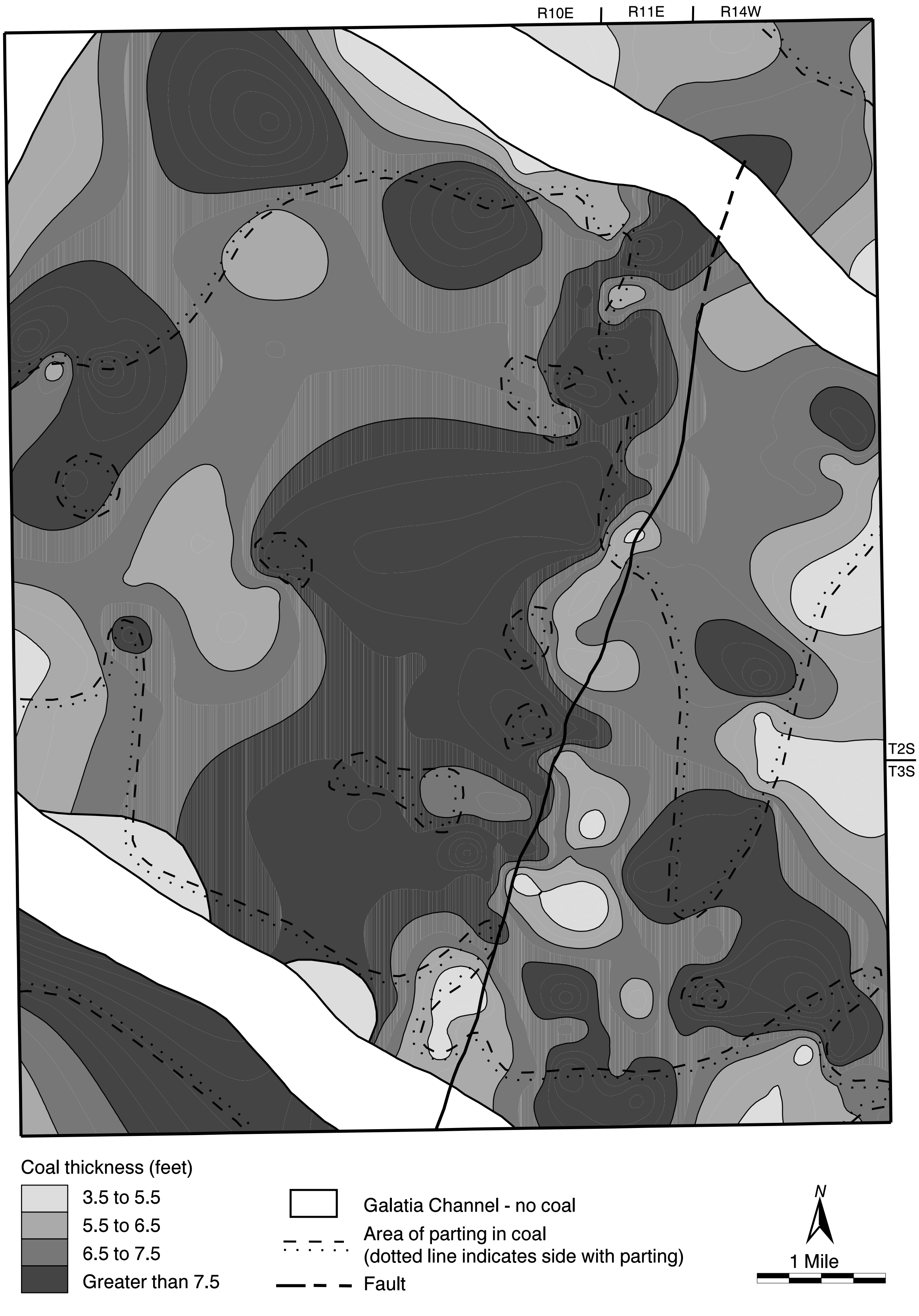


Figure 47 Thickness of the Springfield Coal, Albion South Quadrangle.

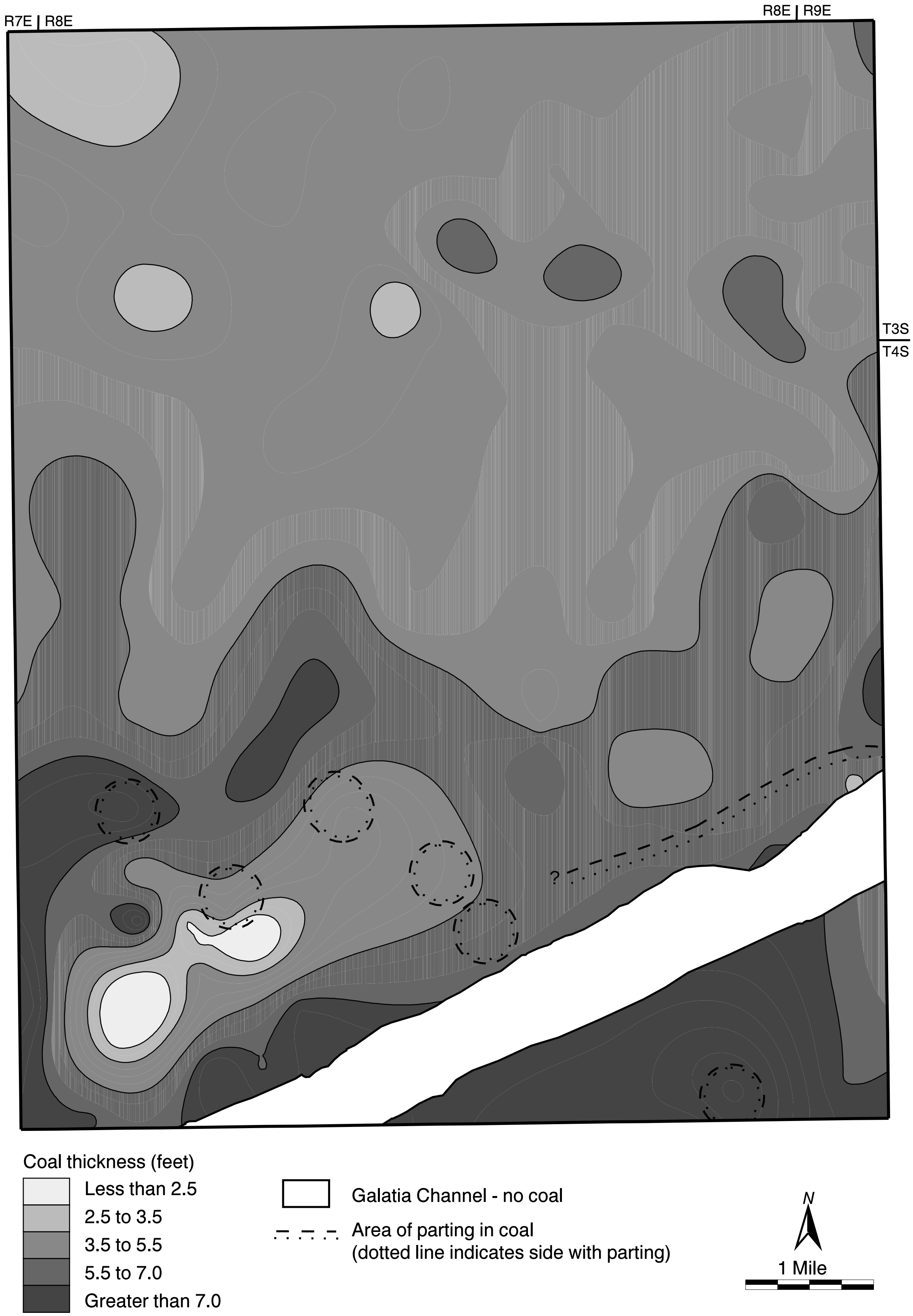


Figure 48 Thickness of the Springfield Coal, Springerton Quadrangle.

Figure 49 Thickness of the Dykersburg Shale, Albion South Quadrangle.

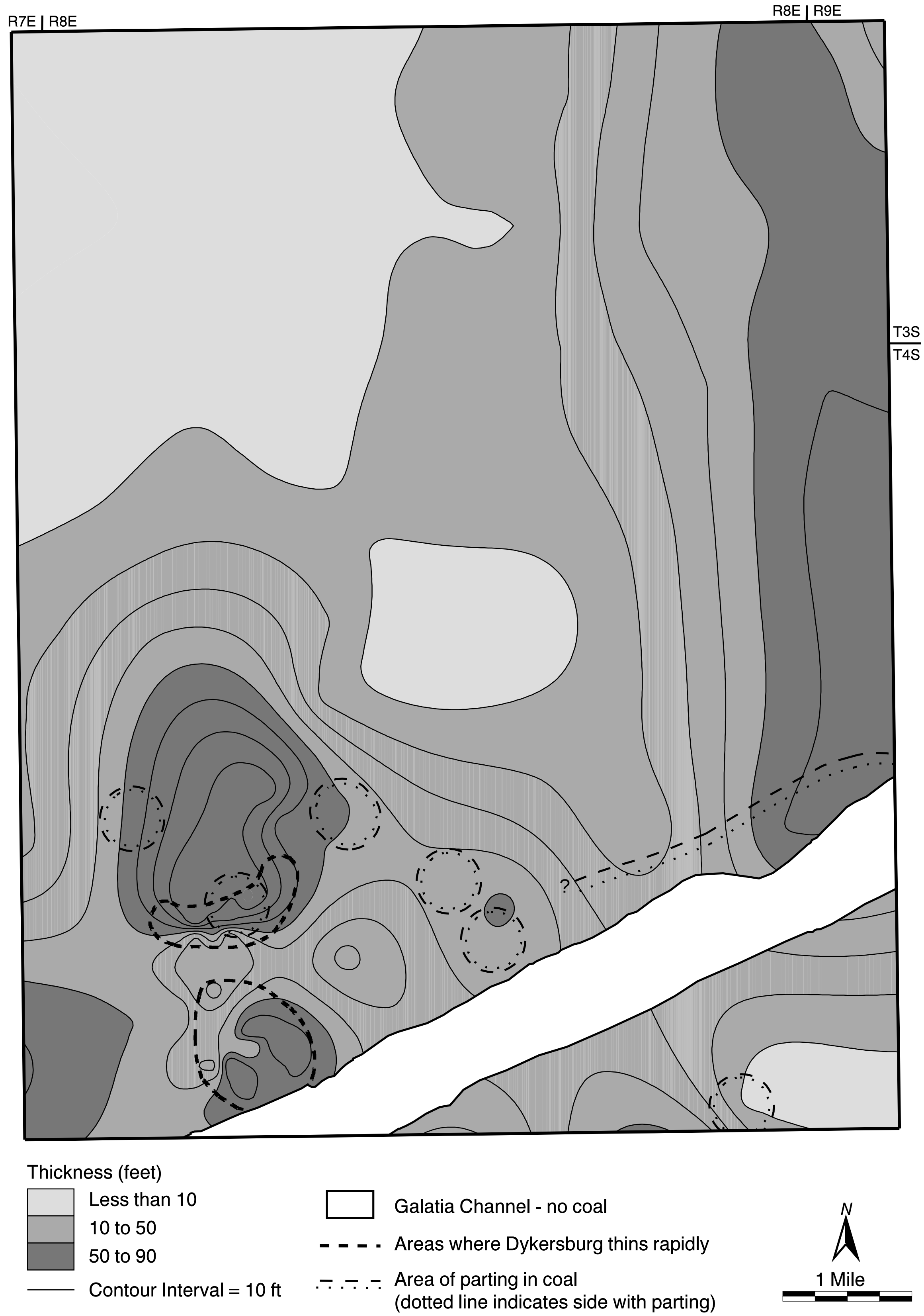


Figure 50 Thickness of the Dykersburg Shale, Springerton Quadrangle.

Figure 51 Thickness of the Lower Dekoven Coal, Springerton Quadrangle.

Figure 52 Thickness of the Davis Coal, Springerton Quadrangle.

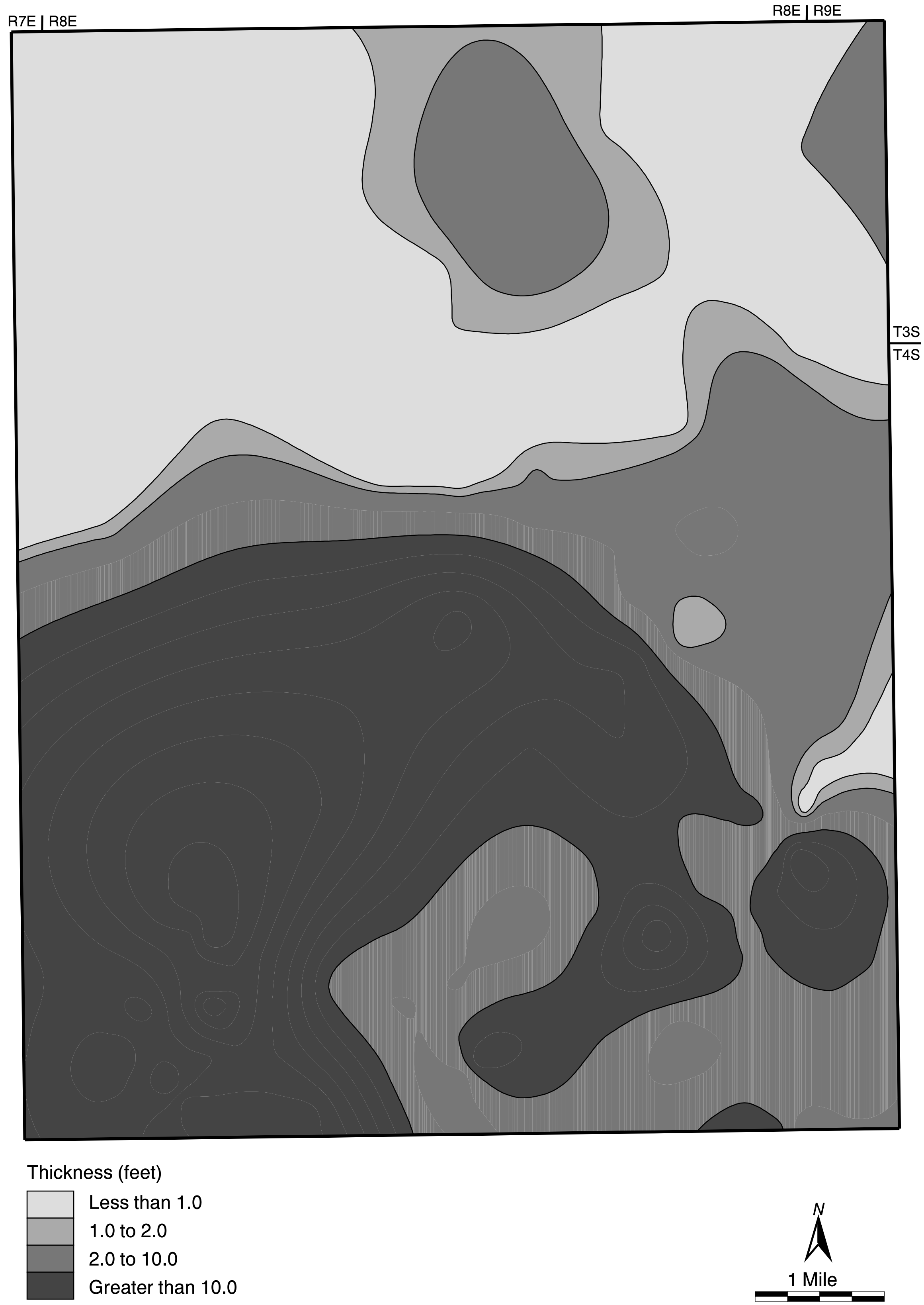


Figure 53 Thickness of the interval between the Lower Dekoven and Davis Coals, Springerton Quadrangle.

Figure 54 Yield of clean coal per ton of material mined, Lower Dekoven and Davis Coals, Springerton Quadrangle.

Available Coal Of the 725 million tons of original resources in the Albion South Quadrangle, 55% (401 million tons) is available for mining (table 6, fig. 55). This includes 39 million tons (5%) that are in areas with closely-spaced oil wells. Technological factors account for 43% of the restrictions and land use for about 2%. Results from the Springerton Quadrangle are somewhat similar. Of the 901 million tons of original resources, 74% (679 million tons) is available, including 9% (77 million tons) that is in areas of closely-spaced oil wells (table 7, fig. 56). Technological factors account for 23% of the restrictions and land use for about 2%.

The availability of the Herrin Coal differs sharply between the two quadrangles: only 25% remains available in the Albion South versus 94% remaining in the Springerton (figs. 57 and 58). The amount of available coal in areas of closely-spaced wells is 2% and 9% of total resources, respectively. Land use restrictions are about 2% in both quadrangles, but technological restrictions affect 72% of the Herrin Coal in the Albion South Quadrangle and only 4% of the coal in the Springerton Quadrangle. The Albion South Quadrangle has three restrictions that are not present in the Springerton: conditions adjacent to the channel, other areas with Anvil Rock Sandstone closely overlying the coal, and the fault zone restrict 10%, 4%, and 4% of the resources, respectively. More importantly, the position of these restrictions to one another, together with thinning of the coal immediately to the north of the quadrangle and the presence of a very large field of closely-spaced wells to the east, separates 49% of the Herrin resources (161 million tons) into blocks that are unsuitable in size and geometry for efficient mining. Conversely, the only technological restriction on the Herrin Coal in the Springerton Quadrangle is seam thickness.

The availability of the Springfield Coal was similar in the two quadrangles: 75% available in Albion South and 80% in Springerton (figs. 59 and 60). The amount of available Springfield Coal in areas of closely-spaced wells is 8% and 6% of total resources, respectively. The difference in percent available is primarily due to the fault and the longer length of the Galatia Channel in Albion South. Land use restrictions affect 2% of total resources in both quadrangles.

The availability of the Davis Coal in the Springerton Quadrangle is 47% of the original resources of 237 million tons (fig. 61). About one quarter of these available resources (11% of original resources) lie in areas with closely-spaced wells. Technological restrictions, primarily thin coal, account for 51% of the restrictions. The Lower Dekoven Coal is available in the northern third of the quadrangle, where 19 million tons can be mined with the available Davis. This includes 4 million tons of Lower Dekoven that are in areas with closely-spaced wells.

Table 6 Availability of coal resources for mining in the Albion South Quadrangle; thousands of tons and (percent of original resources). Note: all resources are underground minable.

	Herrin	Springfield	Total
Original	286,581	438,257	724,838
Available	67,511 (24)	295,030 (67)	362,541 (50)
Available with conditions*	5,483 (2)	33,657 (8)	39,140 (5)
Land use restriction	6,079 (2)	6,500 (1)	12,579 (2)
Technological restriction	207,581 (72)	103,070 (24)	310,578 (43)
Land use restrictions			
Towns	4,219 (1)	3,349 (1)	7,568 (1)
Cemeteries	1,553 (<1)	2,553 (<1)	4,106 (<1)
Church or school	306 (<1)	598 (<1)	905 (<1)
Technological restrictions			
Near fault	10,698 (4)	21,662 (5)	32,360 (4)
Near channel	28,735 (10)	68,242 (16)	96,977 (13)
Poor roof conditions	10,580 (4)	1,657 (<1)	12,237 (2)
Block size	151,564 (53)	8,968 (2)	160,532 (22)
Coal <42" thick	5,931 (2)	2,541 (<1)	8,471 (1)

*Available coal within areas of closely-spaced oil wells

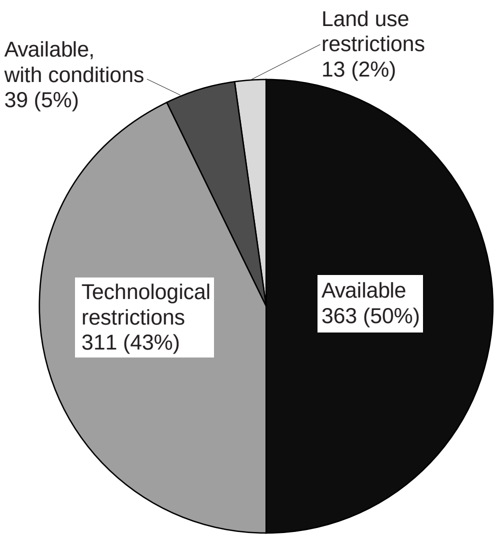


Figure 55 Availability of coal resources, Albion South Quadrangle; millions of tons and (percent of original resources).

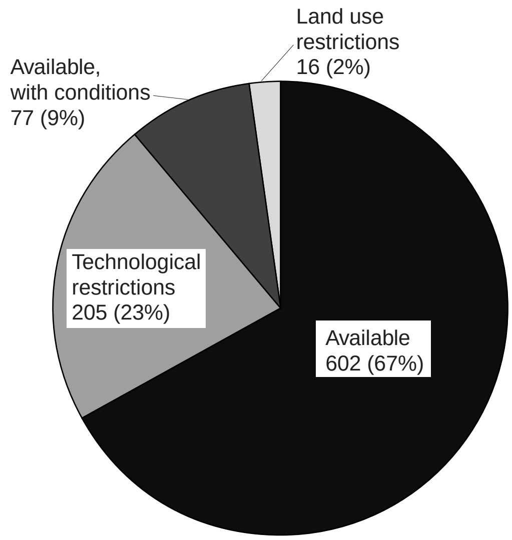


Figure 56 Availability of coal resources, Springerton Quadrangle; millions of tons and (percent of original resources).

Table 7 Availability of coal resources for mining in the Springerton Quadrangle; thousands of tons and (percent of original resources). Note: all resources are underground minable.

	Herrin	Springfield	L. Dekoven	Davis	Total
Original	301,602	329,855	32,560 **	236,774	900,792
Available	257,163 (85)	244,640 (74)	14,929 (46)	85,520 (36)	602,252 (67)
Available with conditions*	26,682 (9)	19,466 (6)	4,487 (14)	26,475 (11)	77,110 (9)
Land use restriction	5,280 (2)	5,554 (2)	47 (<1)	5,082 (2)	15,963 (2)
Technological restriction	12,478 (4)	60,195 (18)	13,097 (40)	119,696 (51)	205,467 (23)
Land use restrictions					
Towns	3,444 (1)	3,575 (1)	- -	3,616 (2)	10,635 (1)
Cemeteries	1,492(<1)	1,679(<1)	- -	1,237(<1)	4,408(<1)
Church or school	344(<1)	300(<1)	47(<1)	229(<1)	920(<1)
Technological restrictions					
Partings	- -	8,782 (3)	- -	- -	8,782 (1)
Near channel	- -	39,305(12)	- -	- -	39,305 (4)
Poor roof conditions	- -	3,099 (1)	- -	- -	3,099(<1)
Block size	1,684(<1)	2,571 (1)	- -	18,017 (8)	22,272 (3)
Coal <42" thick	10,794 (4)	6,438 (2)	13,097(40)	101,680(43)	132,009(15)

*Available coal within areas of closely-spaced oil wells.

**The original resources of the Lower Dekoven include all coal greater than 2.3 ft thick (13,145 thousand tons) plus coal less than 2.3 feet thick that can be mined in combination with the Davis Coal. None of the resources greater than 2.3 feet thick are available for mining. All of the available resources are less than 2.3 ft thick and can be mined only in combination with the Davis Coal.

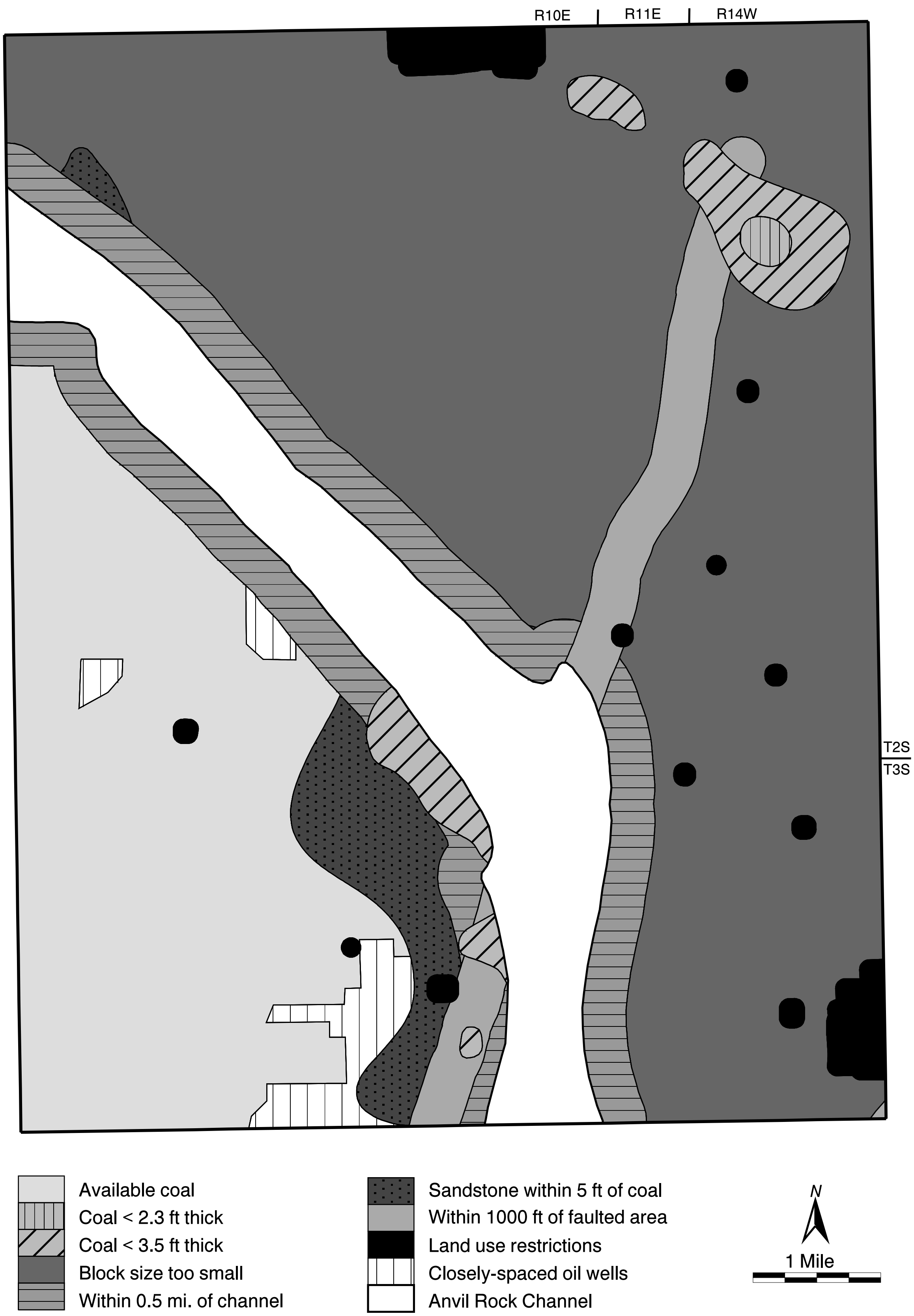


Figure 57 Availability of the Herrin Coal for underground mining, Albion South Quadrangle.

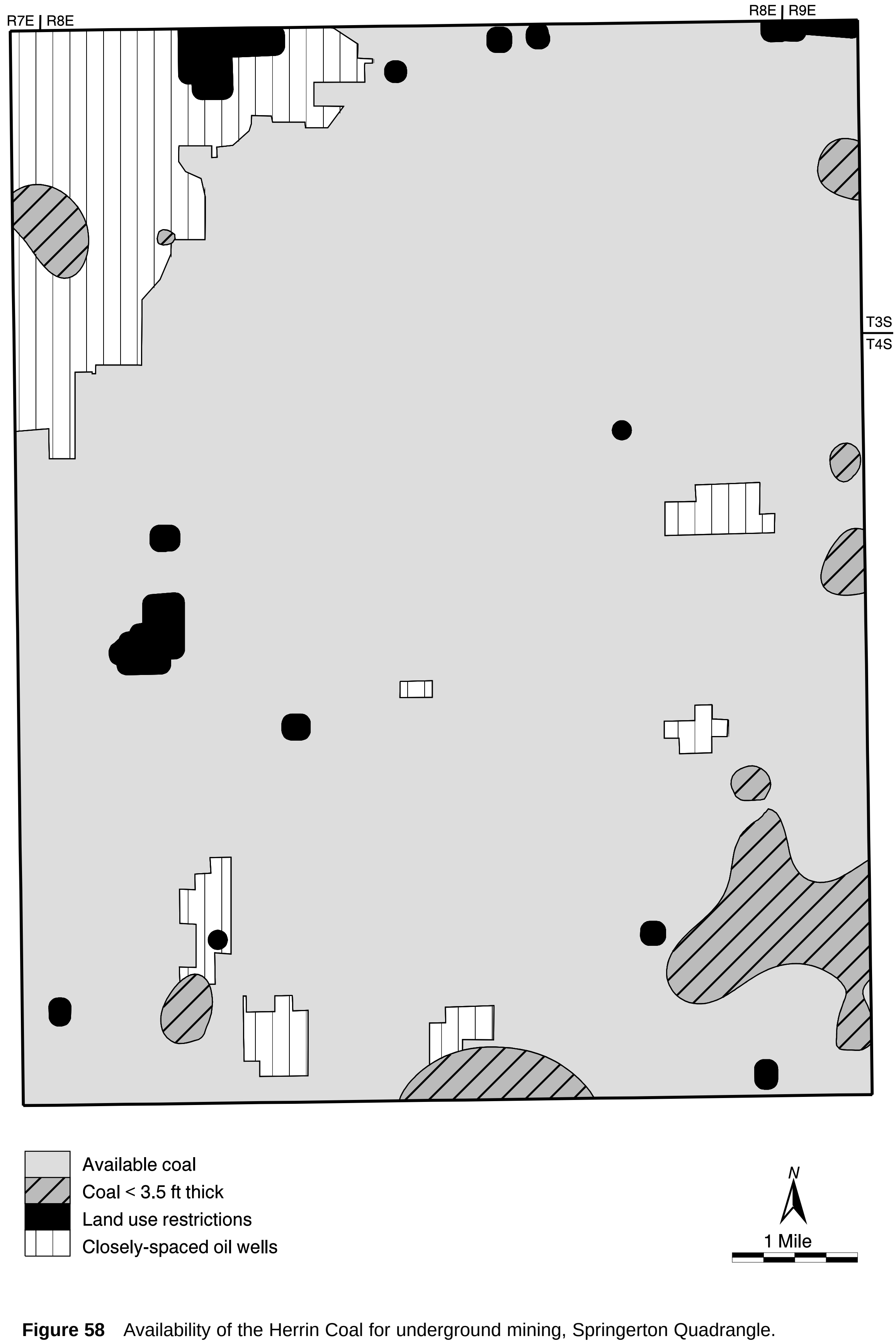


Figure 58 Availability of the Herrin Coal for underground mining, Springerton Quadrangle.

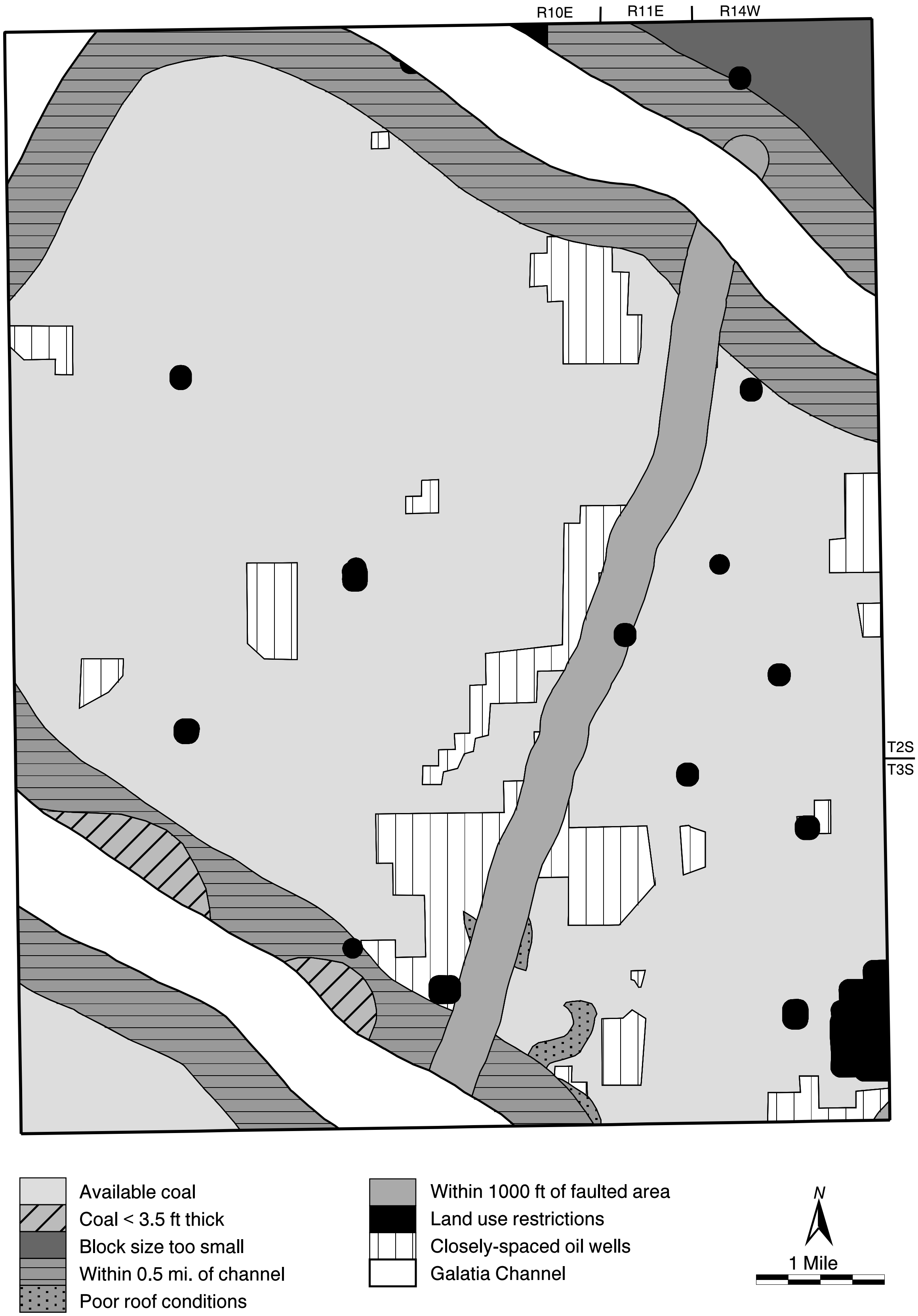


Figure 59 Availability of the Springfield Coal for underground mining, Albion South Quadrangle.

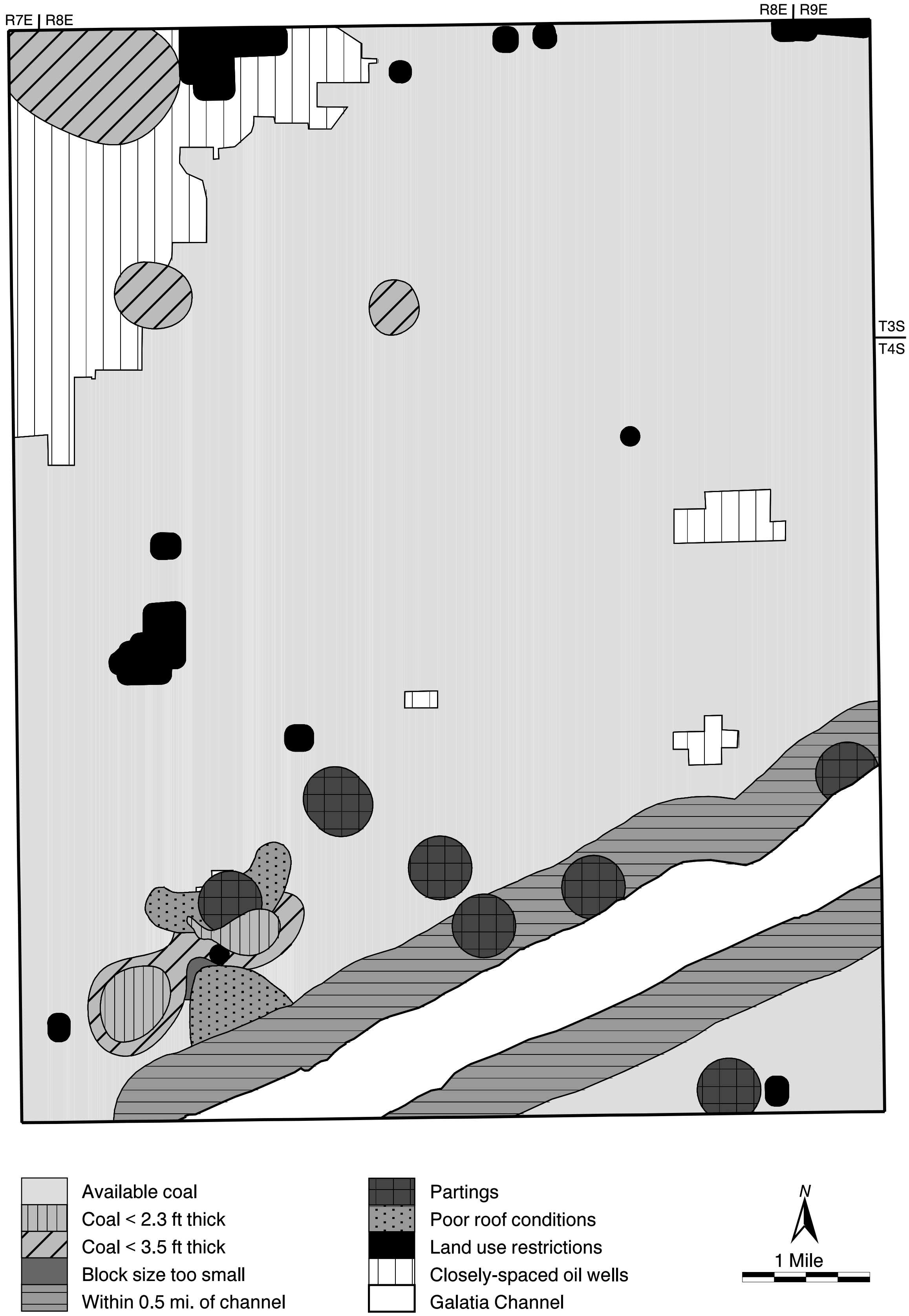


Figure 60 Availability of the Springfield Coal for underground mining, Springerton Quadrangle.

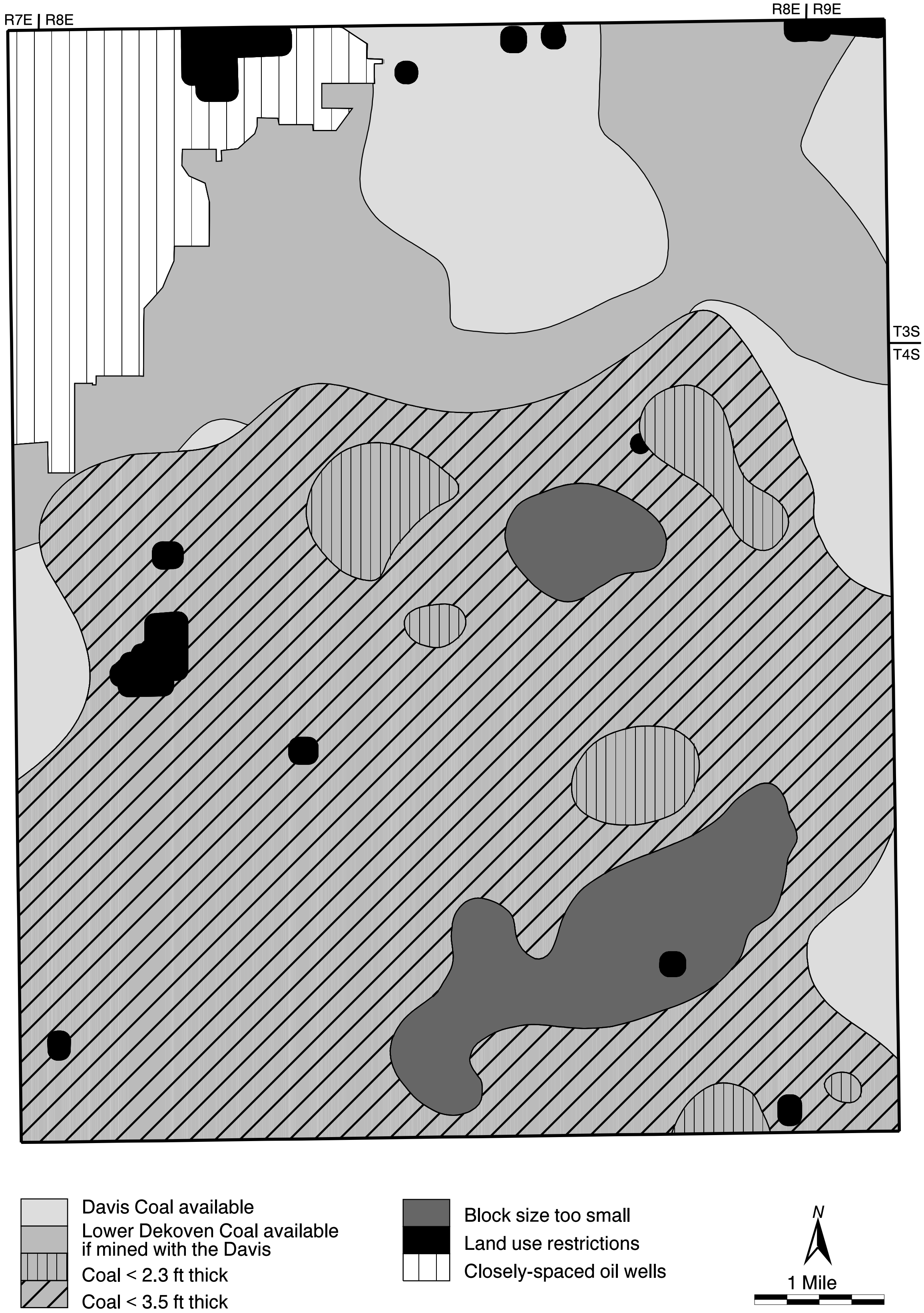


Figure 61 Availability of the Davis and Lower Dekoven Coals for underground mining, Springerton Quadrangle.

Availability of Coal in the Snyder-West Union Quadrangle, East-Central Illinois

The Snyder-West Union study area is representative of some of the mining conditions associated with the Danville, Jamestown, Springfield, and Seelyville Coals on the east side of the Illinois coal field (fig. 62). The study area is a quadrangle-sized area consisting of the south half of the Snyder Quadrangle and the north half of the West Union Quadrangle. These boundaries were selected to match the distribution of available data.

The Snyder-West Union Quadrangle is a rural area of farmland, pasture, and small woodlands. The town of West Union (1990 population: < 100) is in the southeast quarter of the study area (fig. 63). Other than the town and numerous small rural cemeteries, there are no man-made obstacles to underground mining.

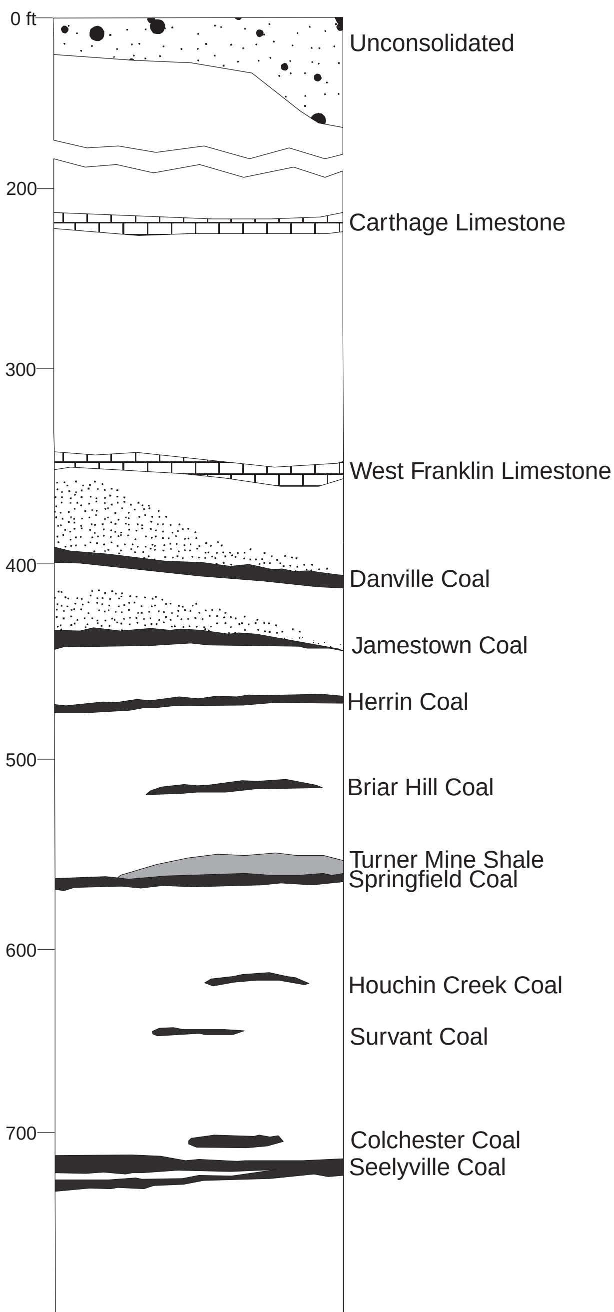


Figure 62 Selected stratigraphic units, Snyder-West Union Quadrangle.

Geology and Coal Resources The Snyder-West Union Quadrangle is on the eastern shelf of the Illinois Basin. The major coal seams in this part of the basin rise gently eastward toward their outcrops about 30 miles to the east in Indiana. The resources in this quadrangle are divided rather evenly among four seams: Danville, Jamestown, Springfield, and Seelyville. Resources of the Herrin and Survant Coals are present in the east-central part of the basin, but these coals are not well developed in the study area. The Danville Coal, the uppermost coal of interest, lies 300 to 550 feet below the surface (fig. 64), and the Seelyville Coal, the lowest mapped resource, lies 610 to 870 feet deep.

The thickness of the Danville Coal varies from 1.5 to 4.5 feet over distances of less than one mile (fig. 65). The coal is attractive because of its low sulfur content (as low as 0.4% as-received basis). The Danville Coal has never been mined in this area of Illinois. The coal has been mined extensively to the east in Indiana and to the north in Edgar and Vermilion Counties.

This quadrangle lies on the northern edge of the known minable resources of the Jamestown Coal (fig. 66). The coal is almost 7 feet thick in the southeast quarter of the study area, thins to less than a foot in the northern quarter of the quadrangle, and is thin or absent north of the quadrangle (fig. 67). The Jamestown Coal lies 15 to 40 feet below the Danville Coal (fig. 68). Its equivalent, the Hymera Coal in Indiana, has been mined extensively in surface and underground mines in that state (Harper 1994), but the Jamestown Coal has never been mined in Illinois.

The interval between the Danville and Jamestown Coals consists of interbedded shale, siltstone, and sandstone. Mining engi-

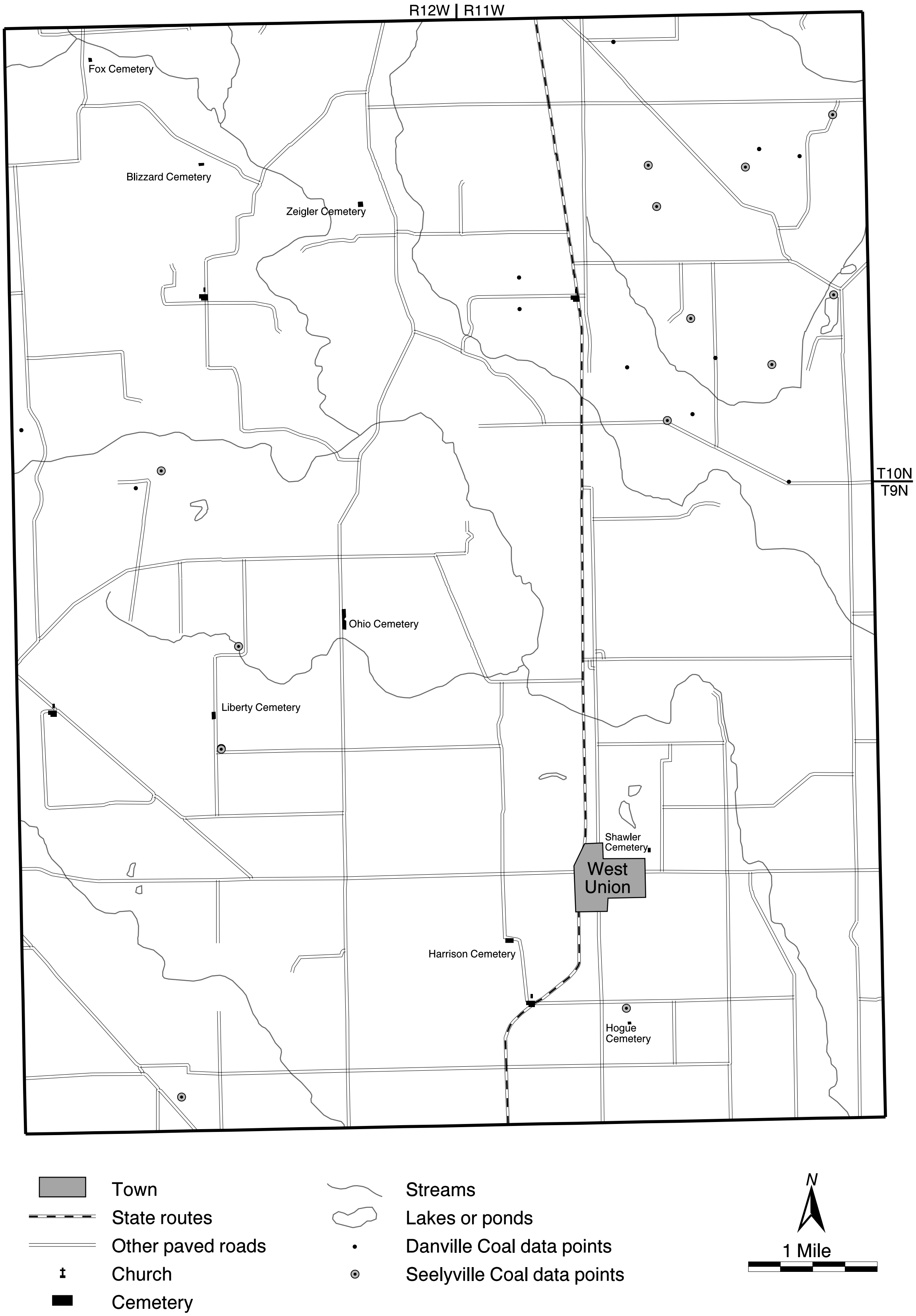


Figure 63 Surface features, Snyder-West Union Quadrangle.

Figure 64 Depth of the Danville Coal, Snyder-West Union Quadrangle.

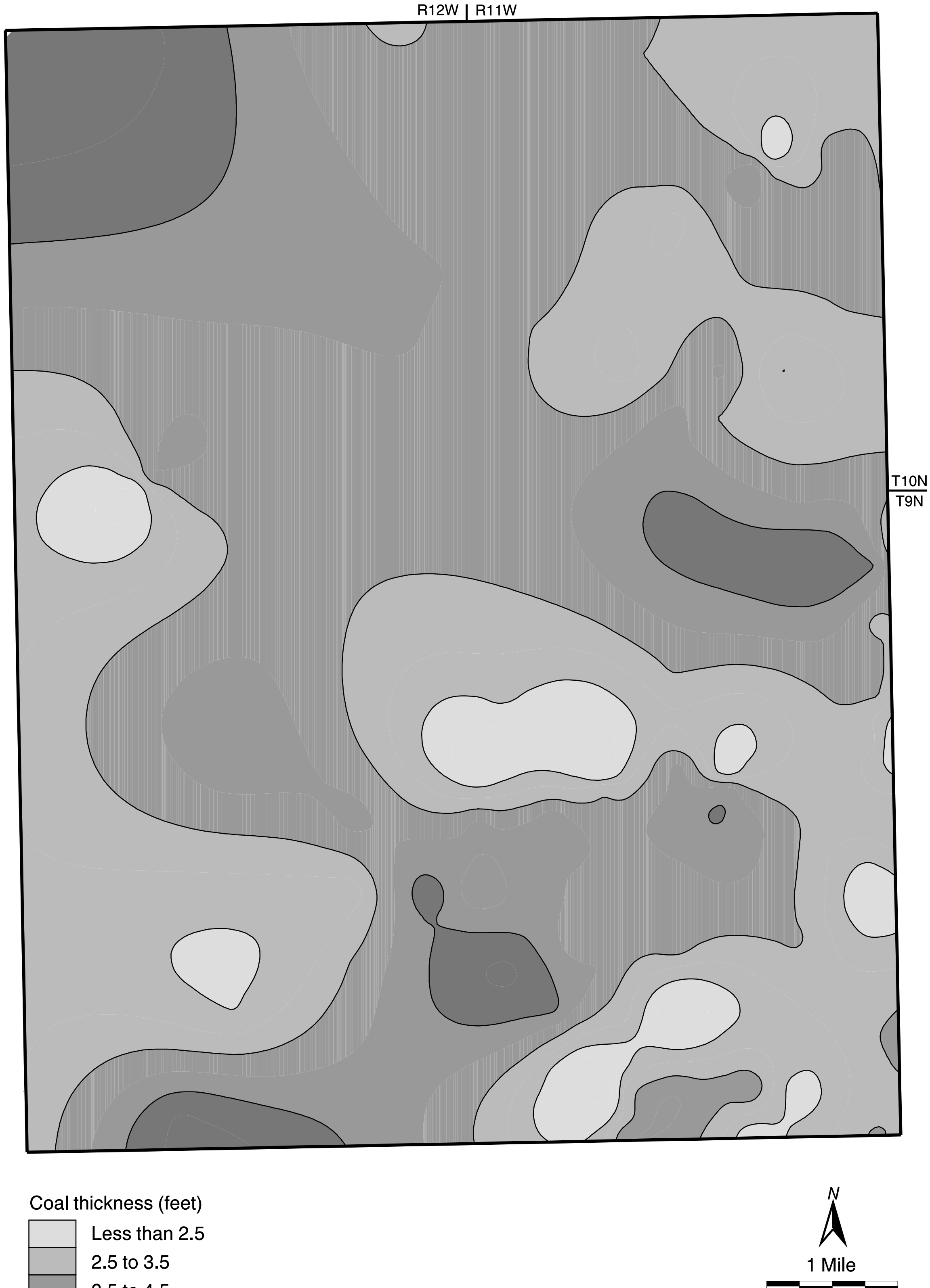


Figure 65 Thickness of the Danville Coal, Snyder-West Union Quadrangle.

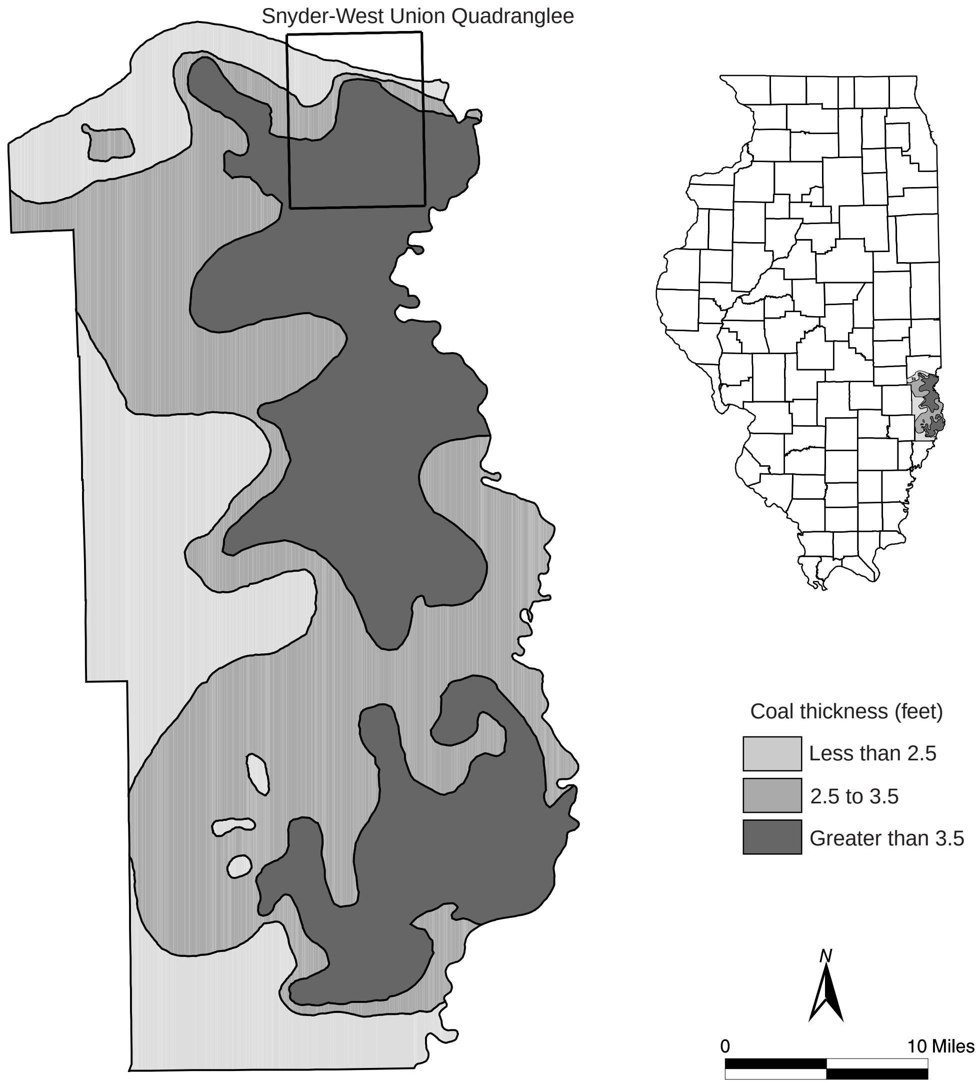


Figure 66 Extent of the Jamestown Coal, east-central Illinois (from Treworgy and Bargh, 1984b).

neers believe that the thickness and relative weakness of these strata make it unlikely that both the Danville and Jamestown Coals can be mined at the same location. Because of the significantly lower sulfur content of the Danville Coal, we assume that where the Danville is greater than 3.5 feet thick, it will be mined instead of the Jamestown.

The Springfield Coal lies 90 to 110 feet below the Jamestown Coal. It ranges from less than 2.5 to about 5 feet thick (fig. 69). The coal has not been mined in this area of Illinois, but has been extensively mined to the east in Indiana, where it lies closer to the surface.

The Seelyville Coal lies 150 to 175 feet below the Springfield Coal. The coal commonly has one or more partings a few inches to several feet thick. The partings occur in the lower half of the bed in the west central portion of the quadrangle and in the upper half in the southern portion of the quadrangle. Total bed thickness is in excess of ten feet in some areas, but total coal thickness is less than 7 feet (fig. 70). The coal may locally be partially or totally eroded by ancient channels that were contemporaneous with, or deposited shortly after, the Seelyville peat swamp. The yield of clean coal that can be expected from mining this seam in the quadrangle is commonly less than 65% (fig. 71).

Figure 67 Thickness of the Jamestown Coal, Snyder-West Union Quadrangle.

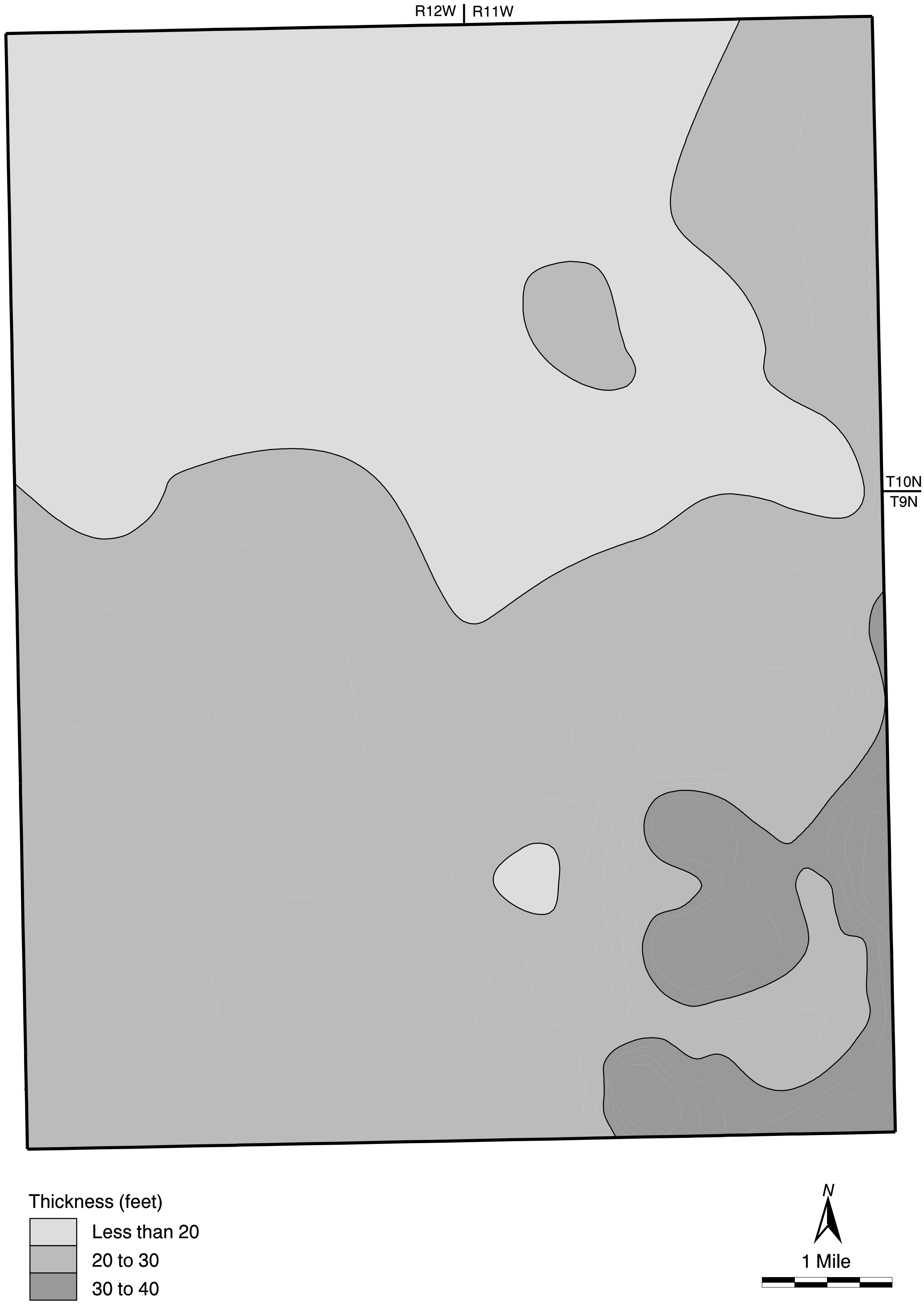


Figure 68 Thickness of the interval between the Danville and Jamestown Coals, Snyder-West Union Quadrangle.

Figure 69 Thickness of the Springfield Coal, Snyder-West Union Quadrangle.

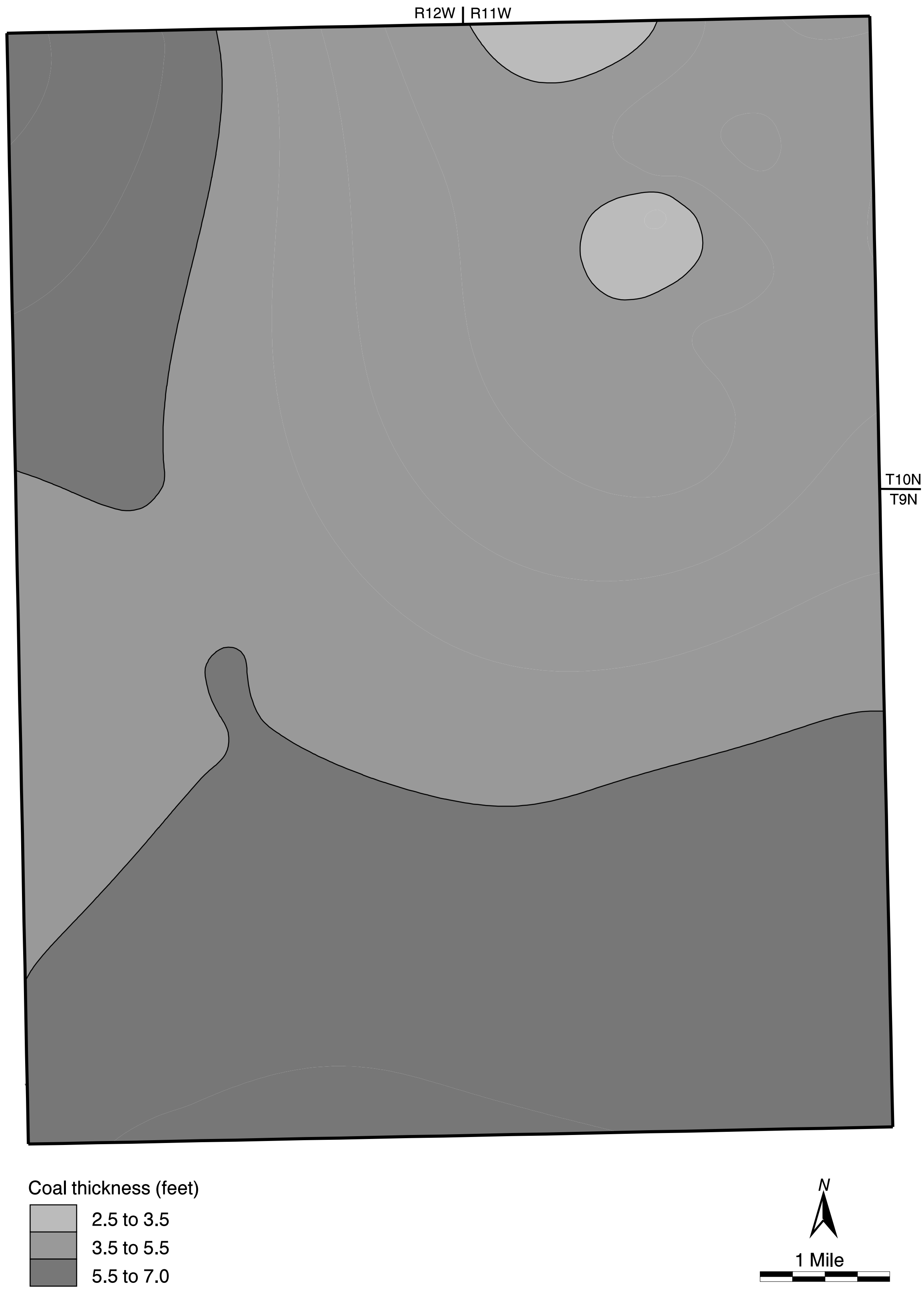


Figure 70 Thickness of the Seelyville Coal, Snyder-West Union Quadrangle.

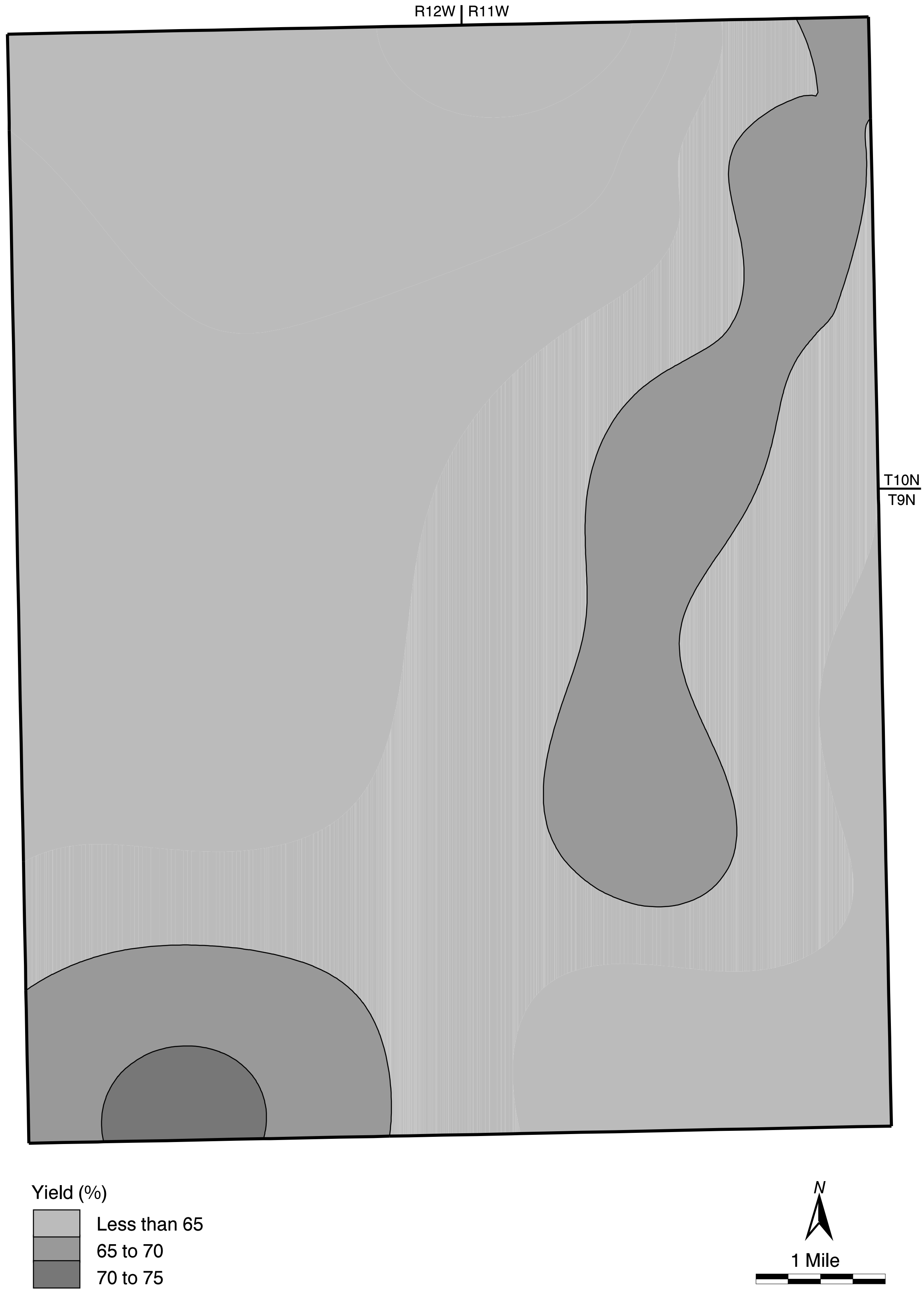


Figure 71 Yield of clean coal per ton of material mined, Seelyville Coal, Snyder-West Union Quadrangle.

Available Coal Of the 1,027 million tons of coal in the quadrangle, 42% (432 million tons) is available for mining (table 8, fig. 72). As noted earlier, all of these resources are believed to have chlorine contents in excess of 0.5%. Due to the severely limited market for such coals, we are designating the available resources as “available, but with quality limitations.” Technological restrictions, including partings, interburden, block size, and seam thickness, restrict 57% of the resources and land use restricts 1% of the resources.

Of the 231 million tons of Danville Coal resources, 69% is available for mining (fig. 73). The major restriction is seam thickness. About 29% of the resources is less than 3.5 feet thick. All other restrictions are less than 1% of resources. The lack of known technological restrictions for this coal may be due to the limited experience with mining the Danville Coal in this area.

Of the 218 million tons of Jamestown Coal resources, 42% (91 million tons) is available for mining (fig. 74). Most of the Jamestown resources are restricted because of the interburden between them and the overlying Danville Coal. If the Danville Coal were not mined, an additional 89 million tons would be available, and bring the total available to 78% of original resources. Coal thickness is the second greatest restriction on availability of this seam. Land use restricts about 1% of the resources.

Almost 75% of the 243 million tons of Springfield Coal resources is available for mining (fig. 75). Coal thickness accounts for 23% of the restrictions and block size about 2% of restrictions.

None of the 335 million tons of Seelyville Coal is available for mining (fig. 76). Partings cause the yield of clean coal to fall below 65% for 81% of the resources. Block size restricts an additional 18% of the resources.

Table 8 Availability of coal resources for mining in the Snyder-West Union Quadrangle; thousands of tons and (percent of original resources). Note: all resources are underground minable.

	Danville	Jamestown	Springfield	Seelyville	Total
Original	230,514	218,201	243,131	335,355	1,027,200
Available w/ conditions*	159,401 (69)	90,959 (42)	181,398 (74)	0 (0)	431,758 (42)
Land use restriction	1,783 (1)	2,249 (1)	1,593 (1)	2,665 (1)	8,290 (1)
Technological restriction	69,330 (30)	124,992 (57)	60,141 (25)	332,689 (99)	587,152 (57)
Land use restrictions					
Towns	1,280 (1)	1,852 (1)	1,112 (<1)	1,962 (1)	6,206 (1)
Cemeteries	424 (<1)	326 (<1)	411 (<1)	599 (<1)	1,761 (<1)
Church or school	79 (<1)	71 (<1)	70 (<1)	103 (<1)	323 (<1)
Technological restrictions					
Partings	- -	- -	- -	271,823 (81)	271,823 (27)
Interburden	- -	110,592 (51)	- -	- -	110,592 (11)
Block size	1,808 (1)	2,617 (1)	3,971 (2)	60,867 (18)	69,263 (7)
Coal <42" thick	67,522 (29)	11,784 (5)	56,169 (23)	- -	135,475 (13)

*Available, but with quality limitations. All resources are believed to have a chlorine content in excess of 0.5%.

CONCLUSIONS

This study provided new insights on the factors that restrict the availability of coal for mining and confirmed findings from previous quadrangle studies.

• Situations discovered in several quadrangles demonstrate the need to refine or subdivide the category of "available" resources in order to distinguish resources that are readily available from those that meet all known technical and legal criteria, but have significant negative characteristics that substantially limit their likelihood of development. These negative characteristics include potential land use conflicts (Peoria West), areas with numerous closely-spaced oil wells (Albion South and Springerton), and unfavorable coal quality (Snyder-West Union).

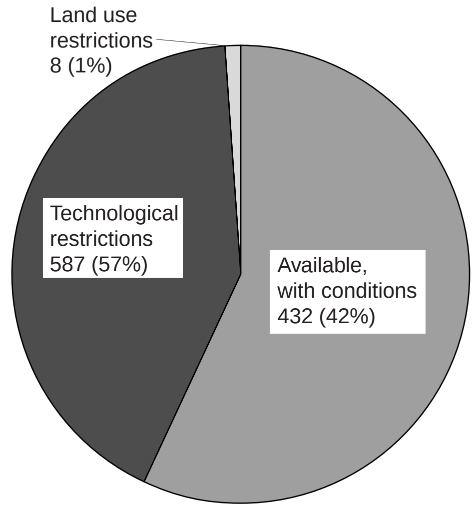


Figure 72 Availability of coal resources, Snyder-West Union Quadrangle; millions of tons and (percent of original resources).

• Restrictions to mining newly identified in this report include mining conditions in the Herrin Coal associated with the Anvil Rock Sandstone, in the Springfield Coal associated with partings and the Dykersburg Shale, and along the Wabash Valley Fault Zone.

• As noted in previous studies, underground minable resources of the Herrin Coal in the southern part of the state generally have a high availability.

• Opportunities for mining the Lower Dekoven Coal in combination with the Davis Coal are identified.

• Due to the thickness and composition of interburden, mining of the Danville Coal in east-central Illinois will preclude mining of the Jamestown Coal or vice versa.

• Significant resources of Seelyville Coal may be unavailable for mining due to partings.

• The availability of a small, but significant portion of resources depends on their being surface mined in combination with overlying or underlying seams.

The available resources in the Peoria West Quadrangle meet the state's legal criteria for distance from roads and dwellings. However, the area is checkered with rural subdivisions, many of them new and growing. None of the companies that we interviewed about this quadrangle were willing to acquire reserves in this area because of the potential for local opposition to mining or interference with mining operations (e.g. complaints about dust, truck traffic, or blasting), and the long term exposure to liability for subsidence. Although delineation of such areas is more subjective than other restrictions identified in these studies, failing to identify situations such as this could seriously misrepresent the available resources.

Large areas of the Albion South and Springerton Quadrangles contain closely-spaced oil wells. Companies mining in similar areas have demonstrated that wells can be successfully plugged or mining plans altered to mine between wells. However, these measures increase the cost of mining and/or limit the use of high-extraction mining techniques. Resources in such areas, although technically available for mining, will be avoided in favor of lower cost resources. Such avoidance will in some cases result in sterilization of coal resources that lie above oil fields when coal on either side of the field is mined.

All of the available coal in the Snyder-West Union Quadrangle is believed to have a chlorine content in excess of 0.5%. Because the market for coal with this quality is severely limited and there has been no mining in Illinois of resources with this high of a chlorine content, these resources are classified as "available with quality limitations".

Study of the Albion South Quadrangle identified, for the first time in this series, mining conditions that restrict the availability of the Herrin Coal where the Anvil Rock Sandstone lies within 5 feet of the top of

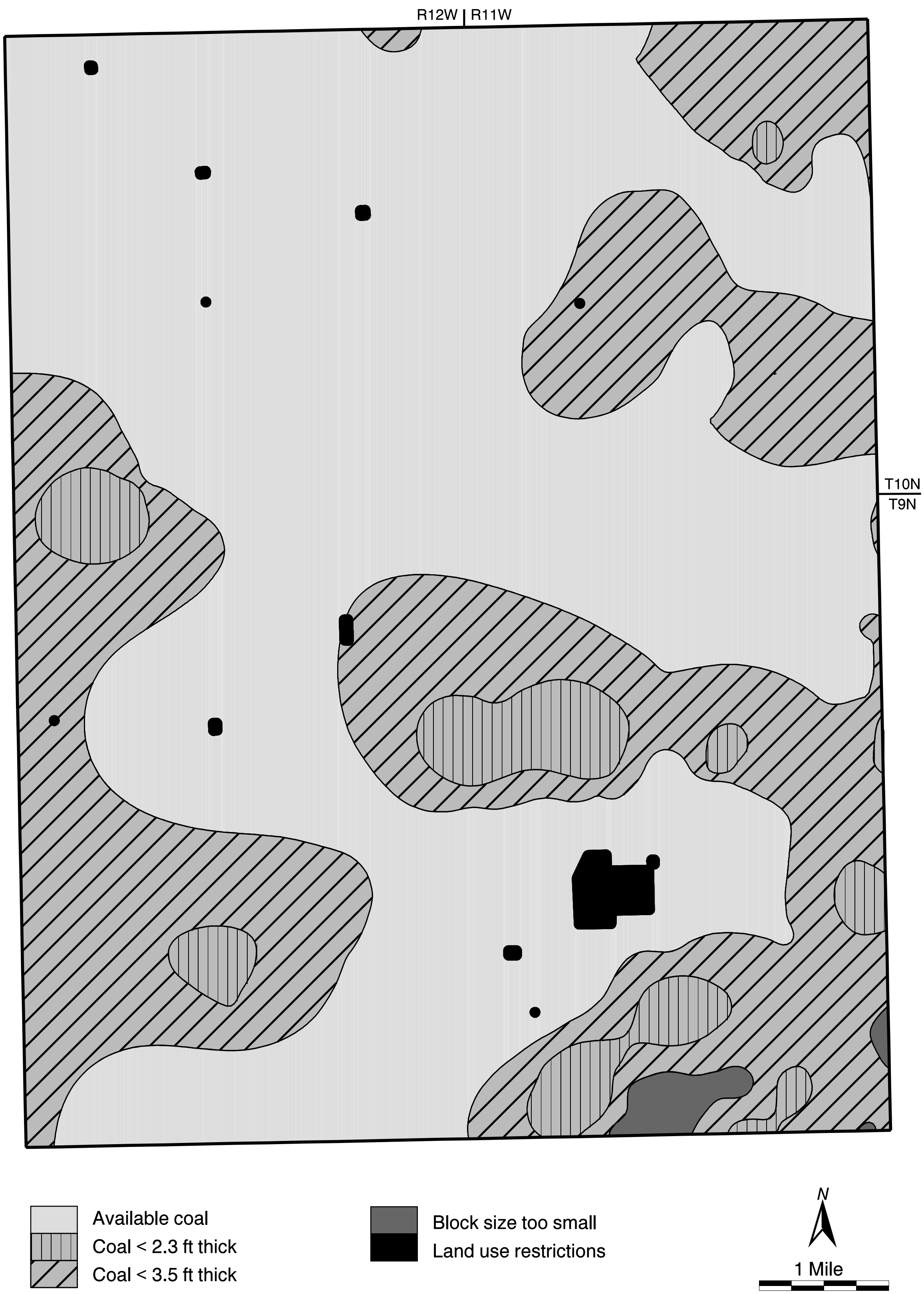


Figure 73 Availability of the Danville Coal for underground mining, Snyder-West Union Quadrangle.

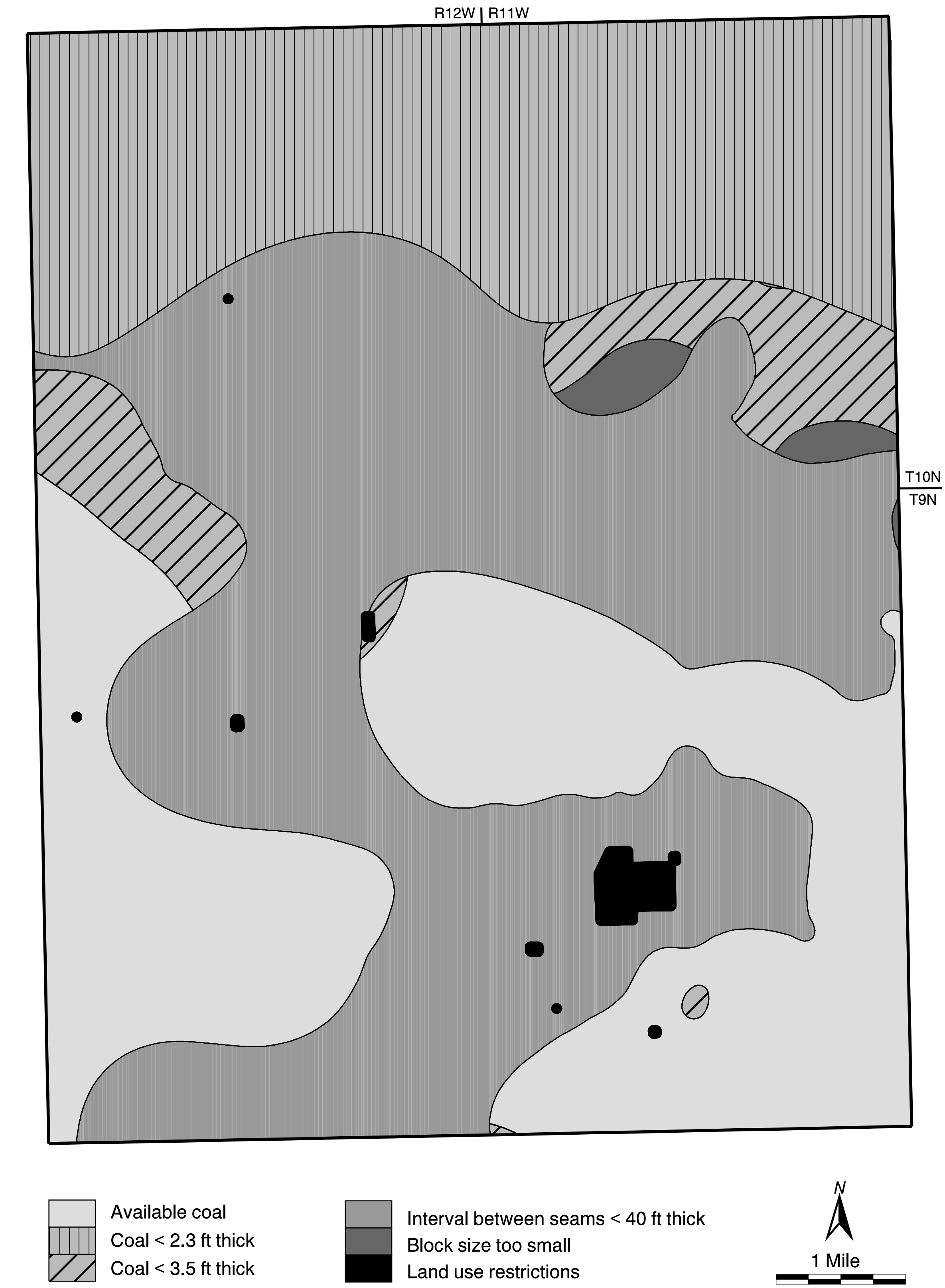


Figure 74 Availability of the Jamestown Coal for underground mining, Snyder-West Union Quadrangle.

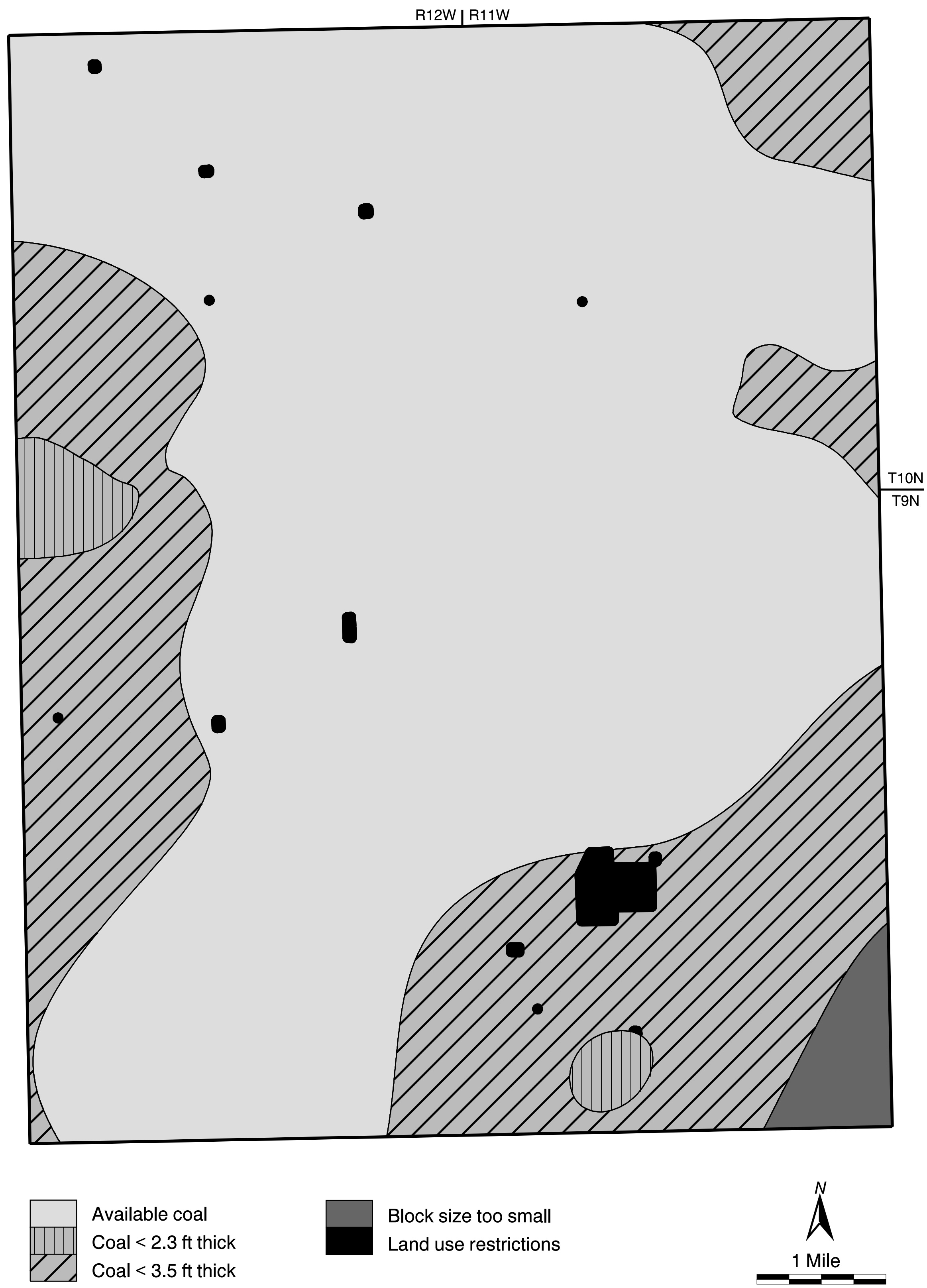


Figure 75 Availability of the Springfield Coal for underground mining, Snyder-West Union Quadrangle.

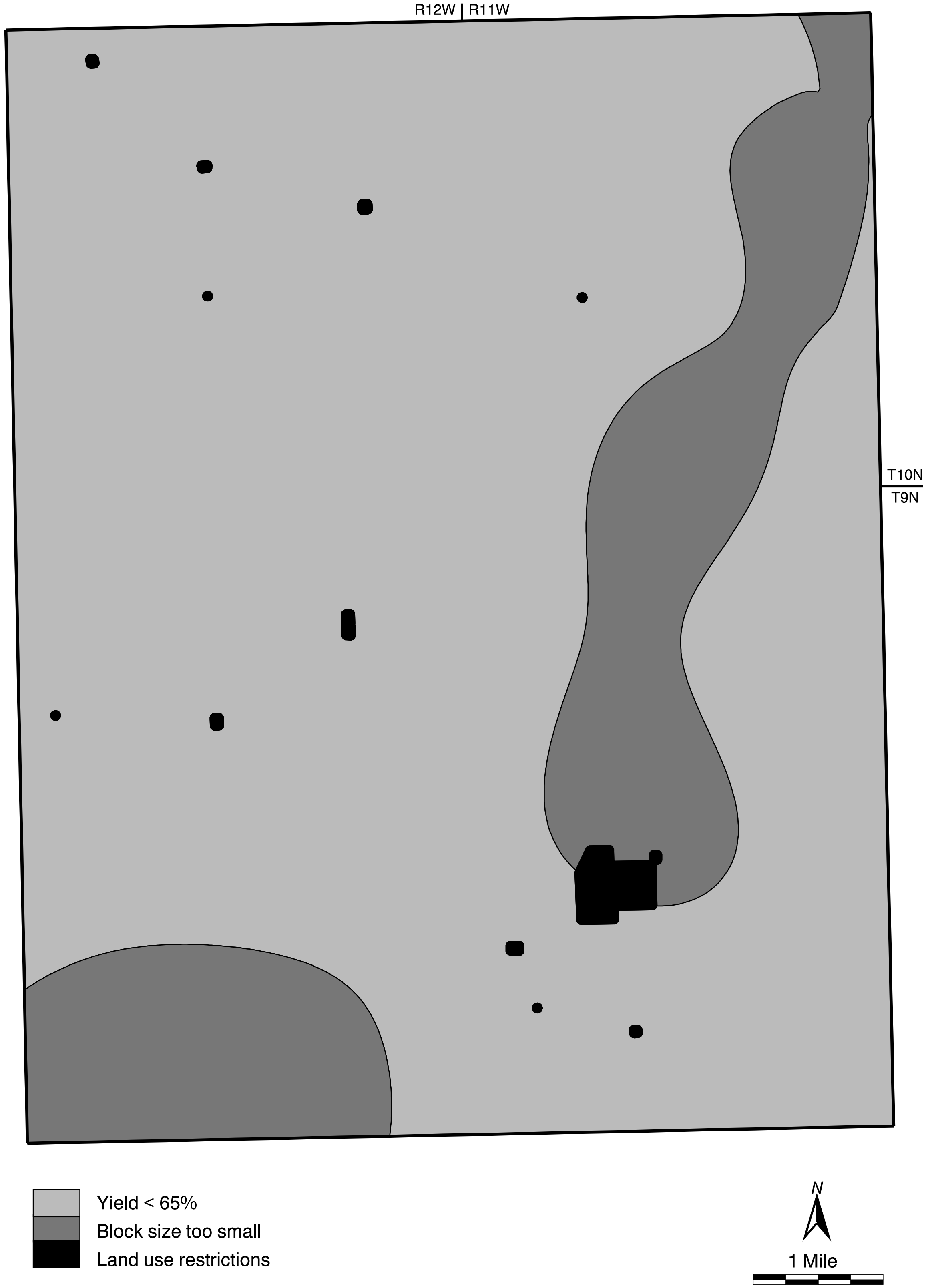


Figure 76 Availability of the Seelyville Coal for underground mining, Snyder-West Union Quadrangle.

the coal. Poor roof conditions and inflows of water are encountered in these areas. These conditions are commonly found within about 1,800 feet of areas where the Herrin Coal has been eroded by channels filled by the Anvil Rock Sandstone, but may be encountered in other areas as well. This study also found that coal within about 1,000 feet of the main fault traces of the Wabash Valley Fault System is commonly left unmined because of minor parallel faults, cross faults, and severe dips in seam elevation. In the Albion South Quadrangle, the effect of these features on the availability of the Herrin Coal was magnified by their proximity to one another as well as to areas of thin coal and large areas of closely-spaced oil wells. This combination of features results in relatively large blocks of Herrin Coal that are below the size required to support an underground mine at this depth. In areas away from the Anvil Rock Channel and Wabash Valley Fault System, such as in the Springerton Quadrangle, underground minable resources of the Herrin Coal have a relatively high availability. This is consistent with findings from previous studies of other quadrangles.

In the Springerton Quadrangle, thick partings (>4 ft) in the Springfield Coal were found to restrict mining of the coal. Even though either bench of coal was thick enough to mine alone, companies that have attempted to mine these benches report that the parting rock is too weak to permit mining of the lower bench and the pitch of the upper bench is commonly too steep to follow. Both the Albion South and Springerton Quadrangles contained areas where the Dykersburg Shale overlying the Springfield Coal thinned abruptly. Companies report that severe roof conditions are common in such areas and that mining is avoided.

Resources of the Lower Dekoven Coal normally are not considered available where they are too deep to surface mine because of their thickness (commonly < 3 ft). However, in the Springerton Quadrangle, the interval between the Lower Dekoven and the underlying Davis is thin enough over several square miles to allow underground mining of both seams together.

The interburden between the Danville and Jamestown Coals in the Snyder-West Union Quadrangle is too thin and weak to allow underground mining of both seams. Because the Danville Coal has a lower sulfur content it is assumed that this seam will be mined where it is at least 3.5 feet thick. The Jamestown Coal is therefore unavailable in these areas. This situation probably applies to most of the resources of the Jamestown Coal in east-central Illinois.

Significant resources of the Seelyville Coal may be unavailable for mining due to partings. Partings restricted 81% of the resources in the Snyder-West Union Quadrangle. This may be a worst-case situation for the Seelyville. However, in the Newton Quadrangle, where the Seelyville was thicker and had fewer partings, partings still restricted 12% of the resources (Treworgy et al. 1996b).

Some resources of the Danville, Herrin, and Springfield Coals in the Peoria West Quadrangle and the Herrin Coal in the Tallula Quadrangle are available only if surface mined in combination with underlying or overlying seams. Consequently, if underground mining is chosen for the lower seam, the overlying resources are no longer available for mining. Although underground mining is unlikely in either quadrangle due to other conditions, underground mining of the lower seams in adjacent quadrangles is a reasonable possibility. A similar situation was noted with resources in region 6 (Treworgy et al. 1997a).

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