

**Underground Coal Mining Information
Of the Illinois State Geological Survey
For the Areas of the
500-600 Blocks of E. Main, West Frankfort, Illinois
&
40 acres Defined as NE $\frac{1}{4}$ of the NE $\frac{1}{4}$ of Section 23 of
Township 7 South, Range 2 East of 3rd Principal Meridian**

By

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For

Mr. Jerry Eader
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Unit District 168

June 2012

500 & 600 Blocks of E. Main Street, West Frankfort, Illinois

The 500 & 600 E. Main Street blocks in West Frankfort, Illinois are not undermined according to the mine maps held at the Illinois State Geological Survey (The state's official repository for mine maps is the Office of Mines and Minerals). The nearest mining is one block north and one block south of the current high school property at 500-600 E. Main Street. Detailed mine maps exist for both mines in the area which include detailed street right of way and parcel boundaries on the mine maps. To the north of the school property is the Peabody Coal Company, Peabody No. 19 Mine and to the south is the Old Ben Coal Corporation, Old Ben No. 8 Mine.

Peabody Coal Company, Peabody No. 19 Mine

To the north of the school property, the closest underground coal mine is the Peabody Coal Company, Peabody No. 19 Mine which operated under various companies and names from 1904 to 1936 (see appendix). The mine map that is available is dated March 23, 1932, which is about 4 years before the last reported coal production in June 1936. This map shows the southern boundary of a production panel which is just north of the right of way of E. St. Louis Street to be the nearest part of this mine to school property. This panel is about 60 to 70 feet north of the centerline of E. St. Louis Street as shown by the street right of way lines on the mine map. This mine operated in the Herrin No. 6 Coal seam which is listed as 9 to 11 feet thick for this Peabody mine. Notes for this mine (see appendix) state that shale roof was soft and rather bad and generally 3 feet of the top of the coal seam (top coal) was left unmined to protect the roof. The floor is noted as gray sandy shale. The Peabody mine map has survey elevations for the top of rails at the mouth of this panel and mine entry heights noted on the map. The top of rail elevations at the mouth of the panel are 127.6 and 126.9 feet, with the top of rail elevation being 100 feet at the shaft bottom and the elevation at the shaft being -112 feet (mean sea level). Therefore 212 feet is subtracted from the rail elevations found on the mine map to produce the elevation of the rail at the surveyed locations in the mine as shown on the mine map. The elevation of the rail (floor) at the mouth of this panel is therefore about -85 feet (mean sea level). The production panel east of the one just north of the school property shows elevation measurements further south in the panel and the coal elevation rises about 10 feet higher. According to the notes on the mine map, mining height in the closest panel is 7 feet 6 inches through most of the panel and is the measurement closest to the school property. Using a surface elevation of 400 feet above mean sea level, the depth to the top of the mine in the panel is about 470 to 480 feet below the ground surface. The nearest part of the mine to the school property is about 495 feet north of the sidewalk on E. Poplar Street (Figure 1) or the edge of mining is over 1 times the depth to the mine or greater than an angle of draw of 45 degrees (see coal mine subsidence - figure 7).

Old Ben Coal Corporation, Old Ben No. 8 Mine

To the south of the school property, the closest underground coal mine is the Old Ben Coal Corporation, Old Ben No. 8 Mine, which operated under various companies and names from 1910 to 1952 (see appendix). The final mine map shows the northern boundary of a production panel of the mine nearest the school property to be just south of the right of way of E. Oak Street. This panel is about 60 to 70 feet south of the centerline of E. Oak Street as shown by the street and parcel lines on the mine map. This mine operated in the Herrin No. 6 Coal seam which is listed as 8.5 to 10 feet thick for this Old Ben Mine. Notes for this mine (see appendix) state that

the roof is massive shale which falls readily and 18 to 24 inches of coal was left up to protect the shale. The floor is soft and heaves when wet. The Old Ben mine map does not have elevations noted throughout the mine, but the elevation at the production shaft shows the coal to be about 50 feet higher than at the Peabody No. 19 Mine shaft and only 23 feet higher than in the Peabody production panel nearest the school. The nearest part of this mine to the school property is a mine production panel which is about 425 feet south of the sidewalk in front of the school on E. Main Street (Figure 1) or the edge of mining is close to 0.9 times the depth to the mine or greater than an angle of draw of 41 degrees (see coal mine subsidence – figure 7).

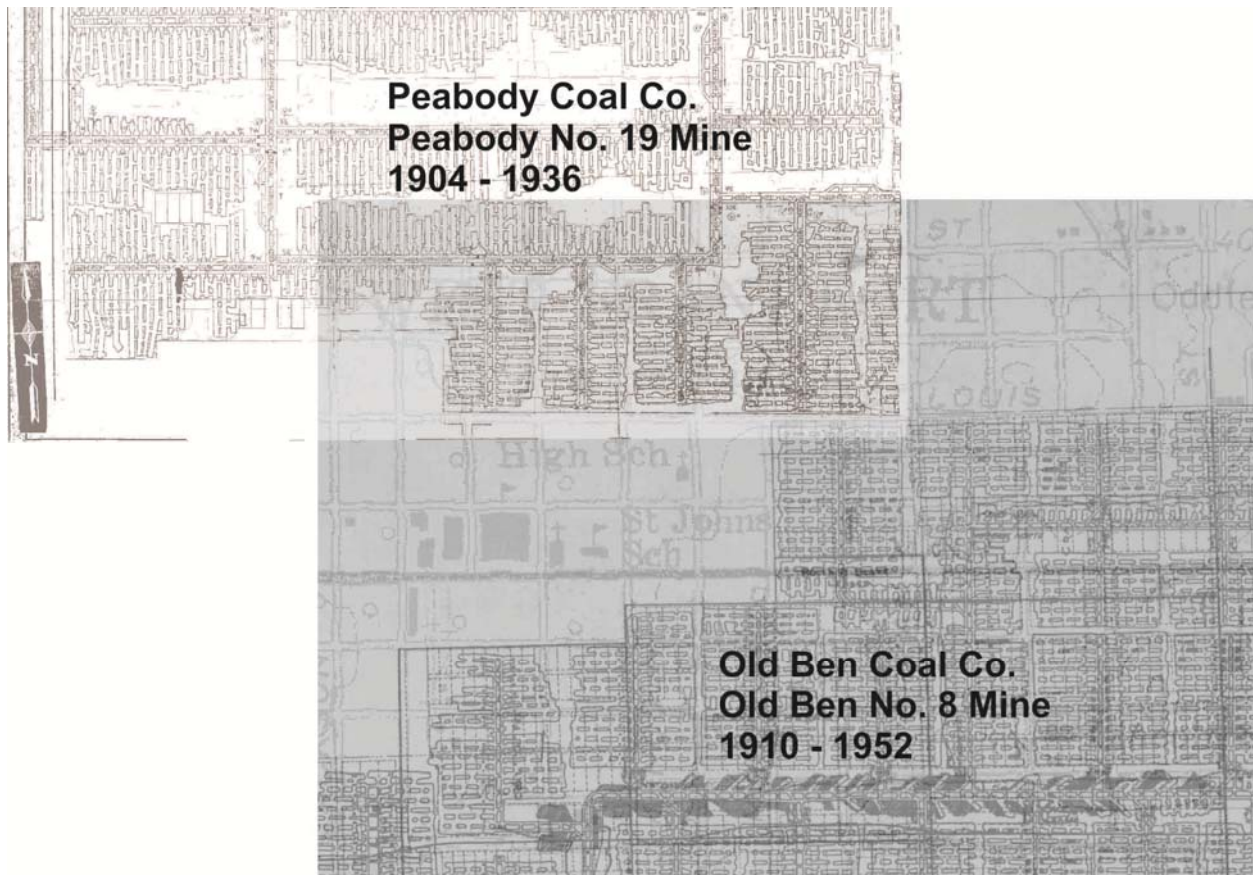


Figure 1. Parts of mine maps of underground coal mines closest to 500-600 E. Main Street, West Frankfort High School property are superimposed on a topographic map. Mine maps superimposed using topographic map features – combined images NOT for use for scaling distances. Both mine maps have details of street right of way boundaries and some parcels along with section lines used for overlay alignment. Old Ben mine map also shows pillar or parts of pillars where coal was removed by the hatched lines drawn on the pillars or in the areas of the barrier pillars between the submains and the production panels. Removal of coal from these barrier pillars along the mains or submains would have been performed when this part of the mine was completed for mining and abandoned.

NE quarter of NE quarter of Section 23 – 40 acre site

This 40 acre site according to available mine maps, has underground coal mines along the northern boundary, northern half of the western boundary, partial panel coming into the northern

half of the eastern boundary and western half of the southern boundary and mine panels under the southeastern part and a few submain entryways under the middle of the site.

The Southern Illinois Coal Co., Southern Illinois No. 21 Mine (also known as the Interstate Coal Company) operated in the Herrin No. 6 Coal seam at a depth of about 490 feet below the ground surface in this 40 acre site (Figure 2). A detailed mine map available is dated May 15, 1937 which is about 7 months before the end of coal production in this mine which reported the last production in December 1937 and is titled, Interstate Coal Company, No. 21 Mine. The mine map covering the 40 acre site and for the western side of the mine in section 23 shows short, open ended rooms drawn on the map usually indicating that mining is still progressing or abandoned at or near that stage of mining. The mine map shows several areas of a squeeze (floor failure-see appendix) and caved area in sections 24 and 23 respectively.

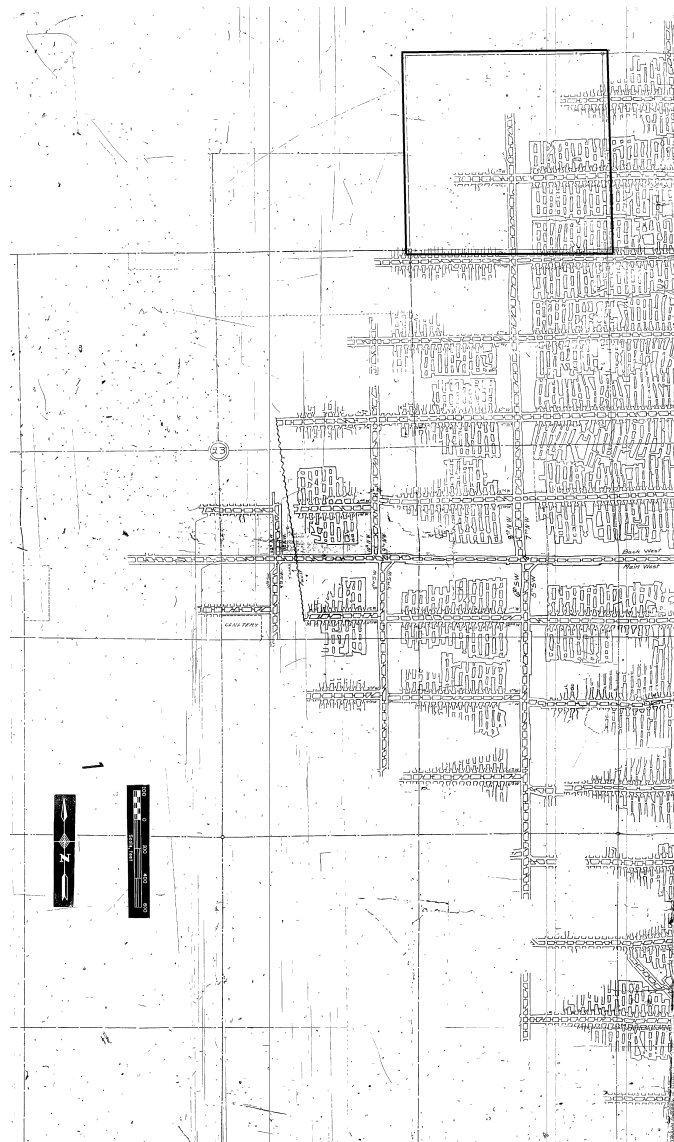


Figure 2. The Interstate Coal Company, No. 21 Mine (Southern Illinois Coal Co., Southern Illinois No. 21 Mine) map showing the 40 acre site outlined. The map of this end of the mine, shows open ended short rooms usually indicating mining is still progressing or was abandoned. Rooms could be longer depending on the mine's practice of when updates were applied to the map and how final an update was provided before abandoning the area.

The Orient No. 2 Coal mine detailed mine map shows a similar mining pattern in the 40 acre site but with lines closing the rooms and AD 1927 written at the end of the submains now also showing closed lines (Figure 3). The Southern Gem Coal Corporation which owned the mine up to 1926 (idle during 1925 & 1926) appears to have sold it to the Brewerton Coal Company (Brewerton No. 21 mine) which started operations in 1927 (history of mine name changes in appendix). The Orient No. 2 mine operated in the Herrin No. 6 Coal seam from 1922 to 1960. It mined in section 13 up against the northern border of Southern Illinois No. 21 mine in section 24. There are also connected submain entries across this entire ¾ mile long common boundary between the two mines (Figure 4).

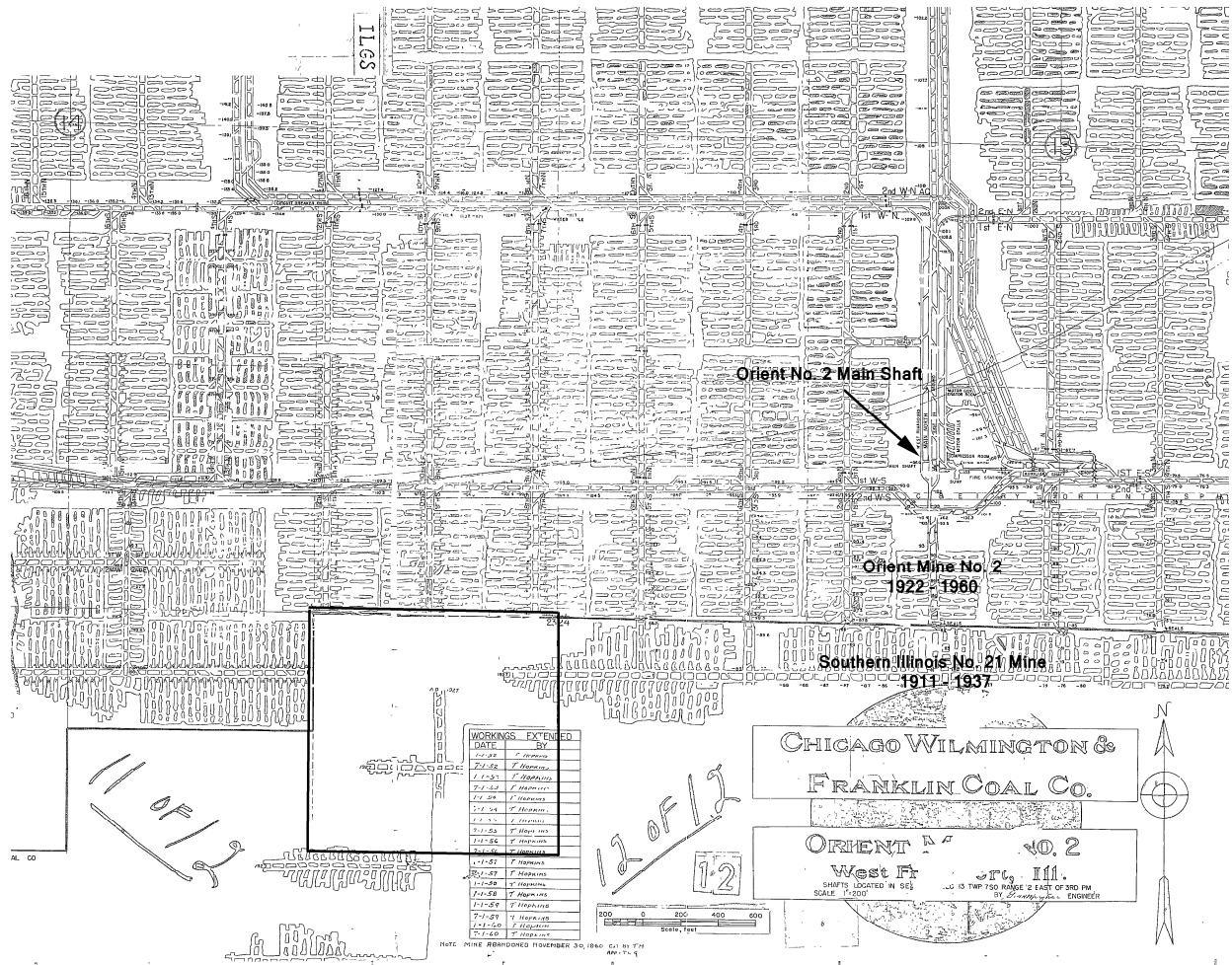


Figure 3. Orient No. 2 Coal mine detailed mine map shows a similar mining pattern in the 40 acre site (outlined) with lines closing the rooms and AD 1927 written at the end of the closed with lines submains and shortened panels (rooms) at the SW corner of the 40 acre site. Orient mine map also shows pillar or parts of pillars where coal was removed by the hatched lines drawn on the pillars.

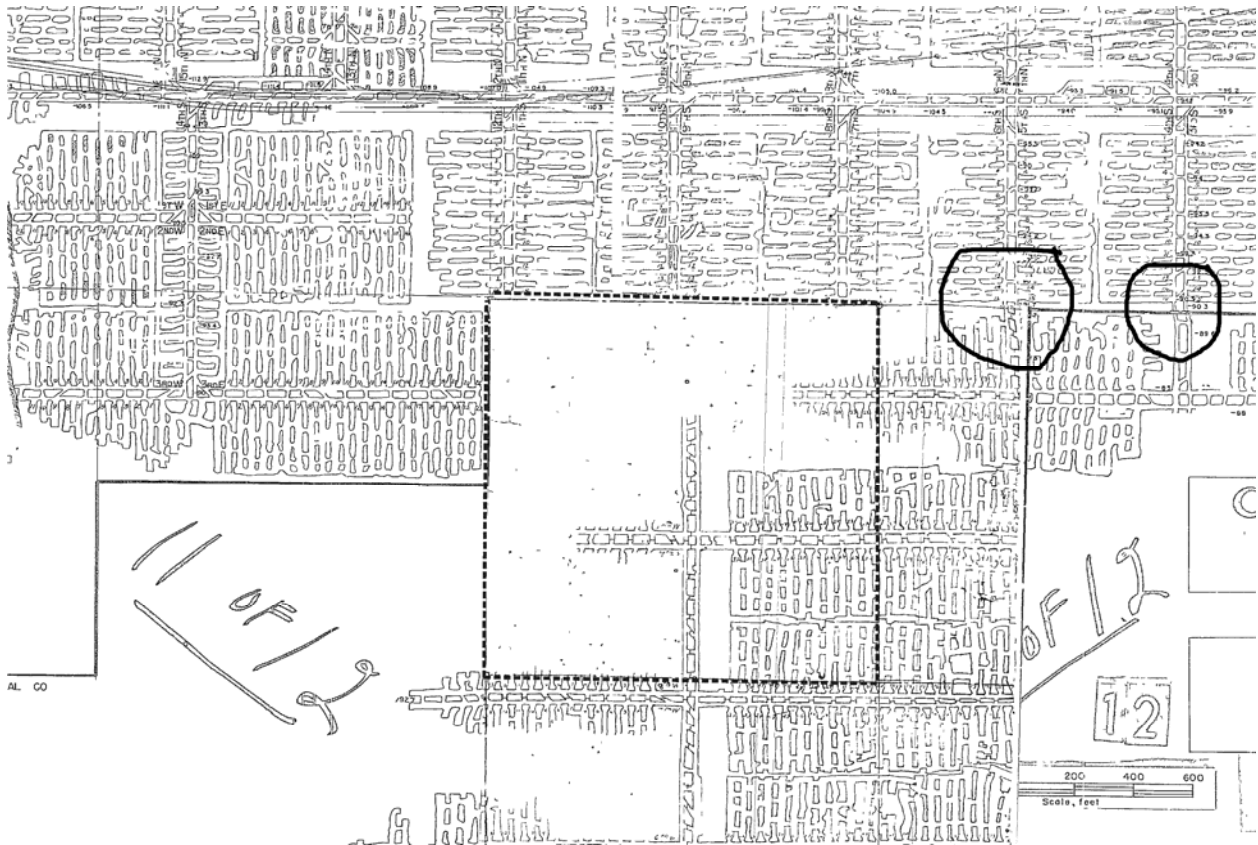


Figure 4. Southern Illinois No. 21 mine map for 40 acre site added to the Orient No. 2 mine map. Circled areas are two of the seven sites where the Orient mine connected entryways across the boundary between the two mines. All these entries on the Orient mine map are shown to be sealed across the boundary area between the two mines.

The 40 acre site is nearly surrounded by mine production panels or mined areas wide enough if they become unstable, could produce subsidence at the ground surface within the 40 acre site. The two parallel entries for submains or haulageways by themselves are probably two small across to produce subsidence at the surface if the pillars fail, but pillars as shown and as standard practice in the submains are much larger and more stable than the pillars in the production panels. One of the questions is; did any further mining occur along these shortened submains and shortened rooms of the incomplete panels? It is a concern that the Orient Mine with its main shaft within about 800 feet (Figure 3) of the Southern Illinois mine had connections to the Southern Illinois No. 21 mine close to this 40 acre site and the Orient mine continued to operate for 23 more years after the “abandonment” of the Southern Illinois No. 21 mine. Mines usually do not connect through to other mines because of the added threat of gas or water to deal with from another mine complex.

Another source of general information is the “Preliminary Report on Subsidence Investigation Franklin County, Illinois” by J.C. Quade for Federal Land Bank of St. Louis (1934). These were reports and investigations of mine outlines, severance rights, and subsidence locations for the purpose of establishing loans for property depending on land conditions (Figure 5). This map shows agreement, IN 1934, with the outline of the mine maps presented above. Also this map shows that each of the four mines discussed in this report, did have reported coal mine subsidence with their mining methods and mine plans.

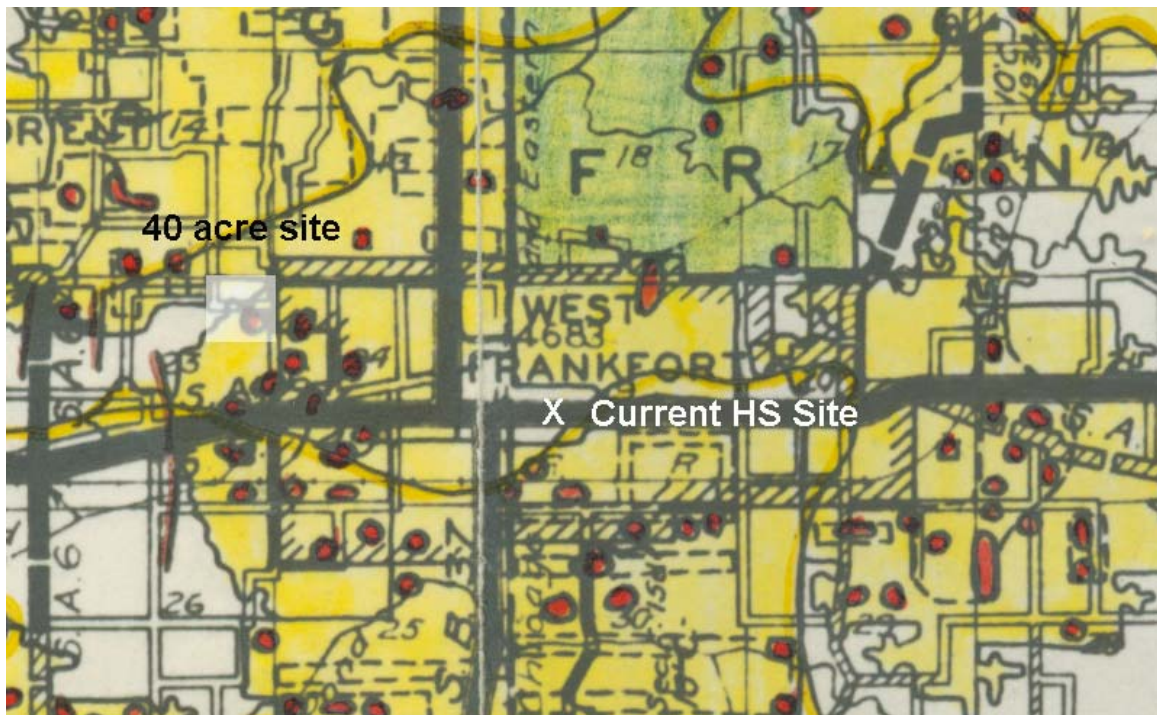


Figure 5. Part of map from the “Preliminary Report on Subsidence Investigation Franklin County, Illinois” by J.C.Quade for Federal Land Bank of St. Louis (1934). These were reports and investigations of mine outlines, severance rights, and subsidence locations (in red) – also red squares are shaft locations. 40 acre site in section 23 and current high school general locations noted on the map.

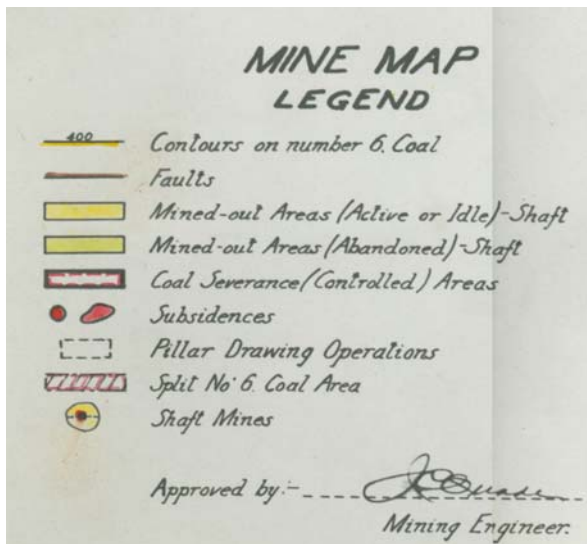


Figure 6. Legend for map shown in Figure 5. Pillar drawing operations is where pillars were “robbed” or removed or partially removed. Depending on the areal size of the pillar robbing operation, it could result in collapse and subsidence on the ground surface.

Coal Mine Subsidence

Considering that coal mine subsidence on the ground surface reaches outside of the outline of the unstable mine area (Figure 7), the 40 acre site can potentially be impacted from 7 different production panels and 5 or 6 of them are not within the 40 acres. Using an angle of draw of 0.6

times the depth (about 30 degrees), leaves an area of about 200-300 x 600-700 feet outside the influence of the mine production panels – IF one assumes that there was no more mining than is shown on the mine maps. Even the use of backfilling on a section of a production panel on the 40 acre property may only triple that potentially unaffected area – again – IF no other mining occurred than what is shown on the mine maps. Angle of draw information for subsidence events associated with abandoned mines is provided by compiled case histories in Illinois presented in Bauer and Hunt (1982). In that publication figure 16 shows a wide range of locations for specific surface subsidence features in relation to the edge of the mine in the subsurface. Some of this wide range of locations is a product of inaccuracies of locating the edge of the mine in relation to the surface with mine maps that have limited surveyed surface boundaries. This results in using large angles of draw for room-and-pillar mine plans which may be far outside of true location of “zero” downward movement from a coal mine subsidence event.

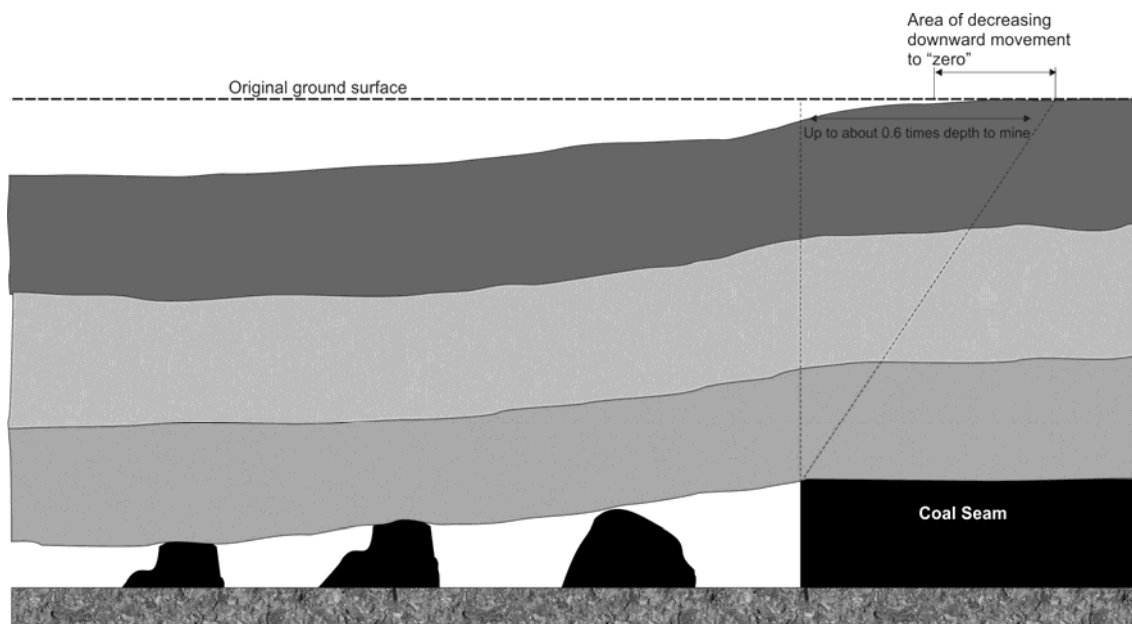


Figure 7. Diagram showing vertical section from ground surface to a coal mine with collapsed coal pillars causing downward movement of the ground surface; coal mine subsidence. Diagram also shows area affected on the ground surface outside of the edge of mining to a point defined by no more downward movement. The angle between the two dotted lines, one vertical at edge of mining and one to the “zero” downward movement is called the angle of draw. This can also be presented by a multiplying factor times the depth to the mine. Zero downward movement is usually considered to be 0.03 feet. Near surface soil elevations fluctuate because of weather and the varying amount of water plants/trees use.

Summary

The 500-600 E. Main blocks are not undermined according to detailed mine maps and the edges of nearest mining is horizontally a distance equal to 0.9 to 1.0 times the depth to the mine from the 500-600 E. Main properties. This is well outside of the area of influence from a subsidence event that may occur caused by a pillar or floor failure in the mine right up to the edge of mining closest to the properties. This safe distance is based on case histories of subsidence events associated with Illinois abandoned coal mines. The mine maps associated with this site are very

detailed in showing and the mine boundaries following street right of way and parcel boundaries which are not all associated with section lines.

The 40 acre site is nearly completely surrounded by mine production panels and is undermined by production panels in the southeastern quarter. Any failures in any of these panels nearest and surrounding the 40 acre property could produce subsidence well into the property. Assuming all the panels could pose a threat of subsidence and using an angle of draw of 30 degrees would roughly define an area of only about 200-300 x 600-700 feet potentially unaffected. There is also a question based on several reasons as to if the mine maps available for this 40 acres are showing the final mining; they may but questions exist. To determine if areas are undermined and their lateral extent for any production panels coming off the now mapped two sets of submains in this area by just using drill hole information by itself may be cost prohibitive. A few lines of boreholes could easily determine if the two submains were extended but this only checks a part of the mine map and gives no information on production panel(s) extent which would be the areas responsible for potential subsidence. Crosshole radar, sending waves between two instrumented distance boreholes that go down through the coal seam could cover larger areas (spacing of boreholes about 225-250 feet). Some consulting companies are using this technique for this particular purpose. It is beyond the scope of this report to present all the possible investigation plans and techniques to determine if this area is mined any further than what the available mine maps show. It is also beyond the scope to present various backfilling ideas to assure large stable areas within the 40 acre site.

Reference

Bauer, R. A., and S. R. Hunt. 1982. Profile, strain, and time characteristics of subsidence from coal mining in Illinois. Proceedings Workshop on Surface Subsidence Due to Underground Mining, p. 207-219.

Appendix

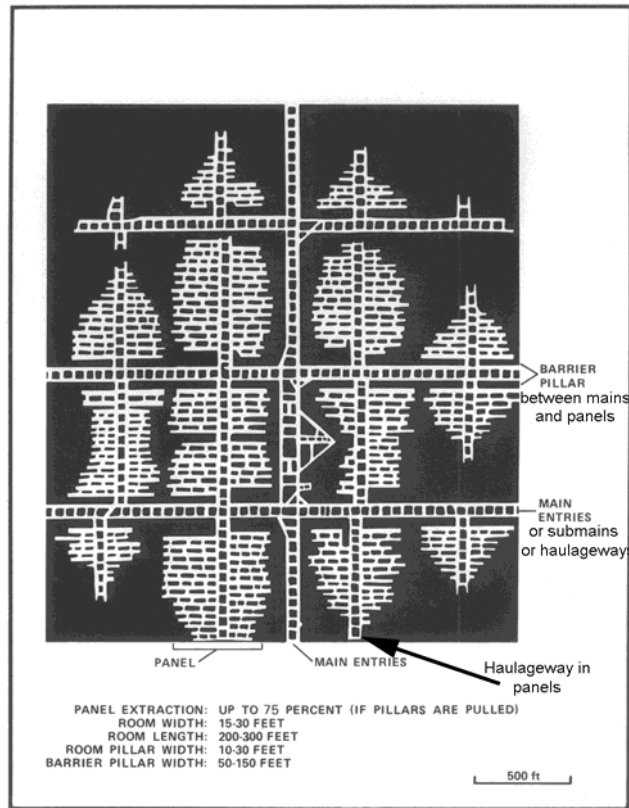
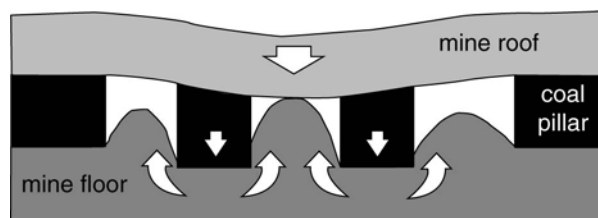
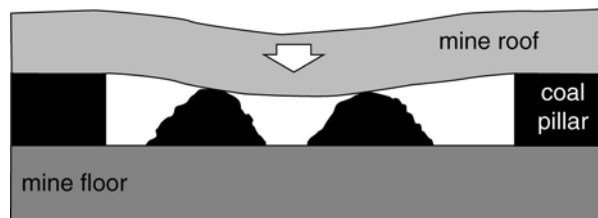


Diagram (plan view) showing similar mining plan as mines in area and names of features used in report.

Two modes of failure in coal mines leading to coal mine subsidence



Floor failure also known as a squeeze when the pillars are pushed downward into the soft floor.

The Illinois State Geological Survey West Frankfort quadrangle map showing the outlines for the coal mines and the full directory with information on each mine can be found at:

<http://www.isgs.illinois.edu/maps-data-pub/coal-maps/topo-mines/west-frankfort.pdf>

The following pages are the directory front page and the four pages with mine information from the directory for the four mines discussed in this report.

A general source of information about subsidence in Illinois can be found in the publication:

<http://www.isgs.illinois.edu/research/pdf-files/c569.pdf>

DIRECTORY OF COAL MINES IN ILLINOIS 7.5-MINUTE QUADRANGLE SERIES WEST FRANKFORT QUADRANGLE FRANKLIN COUNTY

Cheri Chenoweth & Alan R. Myers



Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
2002
REVISED 2004

PART II DIRECTORY OF MINES IN THE WEST FRANKFORT QUADRANGLE

MINE SUMMARY SHEETS

A summary sheet on the geology and production history of each mine in the West Frankfort Quadrangle is provided. These summary sheets are arranged numerically by mine index number. Consult Part I for a complete explanation of the data listed in the summary sheet.

Mine Index 51

Peabody Coal Company, Peabody No. 19 Mine

Type: Underground Total mined-out acreage shown: 1,915

SHAFT, SLOPE, DRIFT or TIPPLE LOCATIONS

Type	County	Township-Range	Section	Quarters-Footage
Main shaft	Franklin	7S 3E	18	Center SE SW
Air shaft	Franklin	7S 3E	18	1100 FSL, 2050 FWL

GEOLOGY

Seam(s) Mined	Depth (ft)	Thickness (ft)			Mining Method
		Min	Max	Ave	
Herrin	500	9.0	11.0	10.0	RPP

Geologic Problems Reported: The mine had gas problems; eight people were killed in four explosions between 1907 and 1925. One or two small faults were reported. The shale roof was soft and projected into the coal in several places as rolls. Generally 3 feet of top coal was left to protect the roof. Sulfur balls were scattered through the coal.

PRODUCTION HISTORY

Company	Mine Name	Years	Production (tons)
Dering Coal Company	Dering No. 11	1904-1908	659,781
Brazil Block Coal Company	Brazil Block No. 11	1908-1911	808,654
Dering Coal Company	Dering No. 11	1911-1915	967,681
Producer's Coal Company	Producer's No. 19	1915-1916	254,826
By-Products Coal Corporation	By-Products No. 19	1916-1922	1,668,873
Industrial Coal Company	Industrial No. 19	1922-1927	2,928,714
Peabody Coal Company	Peabody No. 19	1927-1936	<u>4,844,040</u>
			12,132,479

Last reported production: June 1936

SOURCES OF DATA

Source Map	Date	Original Scale	Digitized Scale	Map Type
Microfilm, document 351419	7-1936	1:2400	1:2813	Final
Microfilm, document 351435	6-30-1954	1:4800	1:9931	Secondary source

Annotated Bibliography (data source, brief description of information)

Coal Reports - Production, ownership, years of operation, geologic problems.

Directory of Illinois Coal Mines (Franklin County) - Mine names, mine index, ownership, years of operation.

ENR Document 85/01 - Mining method.

Mine notes (Franklin County) - Mine type, shaft locations, seam, depth, thickness, geologic problems.

Microfilm map, document 351419, reel 03136, frames 54-62 - Shaft locations, mine outline, mining method.

Microfilm map, document 351435, reel 03136, frames 103, 104, map of Old Ben No. 15 (mine index 482) - Mine outline (west extension).

Mine Index 143**Old Ben Coal Corporation, Old Ben No. 8 Mine**

Type: Underground Total mined-out acreage shown: 4,270

SHAFT, SLOPE, DRIFT or TIPPLE LOCATIONS

Type	County	Township-Range	Section	Quarters-Footage
Main shaft (10'x18')	Franklin	7S 2E	25	625 FNL, 200 FEL
Air shaft (9'x16')	Franklin	7S 2E	25	NW NE NE
Auxiliary shaft	Franklin	7S 3E	31	1650 FNL, 125 FWL - nwswnw

GEOLOGY

Seam(s) Mined	Depth (ft)	Thickness (ft)			Mining Method
		Min	Max	Ave	
Herrin	440-472			8.5-10.0	RPP *

* Some areas of HER are shown on the source map; room pillars and some barrier pillars were removed in various parts of the mine.

Geologic Problems Reported: Gas explosions killed 36 men in four accidents between 1921 and 1947. The main roof was massive shale that fell readily. Generally 18 to 24 inches of top coal was left up to protect the roof. Only one fault was noted, with a throw of a few inches, and a few small slips were reported. The underclay was soft and heaved readily. The source map showed northwest-southeast trending faults in the southern part of the mine. Throw on these faults was commonly 1 foot, and did not greatly interfere with the mining pattern, but some faults had throws of up to 9 feet, and resulted in some inaccessible areas where the coal was not mined.

PRODUCTION HISTORY

Company	Mine Name	Years	Production (tons)
Wilmington Star Mining Company	Wilmington Star No. 8	1910-1911	39,946
Ohio Valley Mining Company	Ohio Valley	1911-1913	814,304
Old Ben Coal Corporation	Old Ben No. 8	1913-1952	<u>30,930,704</u> 31,784,954

Last reported production: February 1952

SOURCES OF DATA

Source Map	Date	Original Scale	Digitized Scale	Map Type
Company map	2-27-1952	1:4591	1:4591	Final

Annotated Bibliography (data source, brief description of information)

Coal Reports - Production, ownership, years of operation, shaft sizes, depth, thickness, geologic problems.

Directory of Illinois Coal Mines (Franklin County) - Mine names, mine index, ownership, years of operation.

ENR Document 85/01 - Mining method.

Mine notes (Franklin County) - Mine type, shaft locations, seam, depth, geologic problems.

Company map, ISGS map library, Old Ben Archive Collection - Mine outline, shaft locations, mining method, geologic problems.

Mine Index 433

Southern Illinois Coal Company, Southern Illinois No. 21 Mine

Type: Underground Total mined-out acreage shown: 1,107 Production indicates an additional 18 acres may have been mined after the map date.

SHAFT, SLOPE, DRIFT or TIPPLE LOCATIONS

Type	County	Township-Range	Section	Quarters-Footage
Main shaft (9.5'x17.5')	Franklin	7S 2E	24	SE NE SW
Air shaft (9.5'x14')	Franklin	7S 2E	24	SW NW SE

GEOLOGY

Seam(s) Mined	Depth (ft)	Thickness (ft)			Mining Method
		Min	Max	Ave	
Herrin	450-460	6.0	10.0	8.5-9.0	MRP

Geologic Problems Reported: Some squeezes occurred in the east half of SW 24-T7S-R2E; the SW SW part of 23-T7S-R2E has an area labeled "caved".

PRODUCTION HISTORY

Company	Mine Name	Years	Production (tons)
West Frankfort Coal Company	West, West Frankfort No. 1	1911-1919	2,926,185
Southern Gem Coal Corporation	Southern Gem No. 1	1919-1926 **	2,296,249
Brewerton Coal Company	Brewerton No. 21	1927-1932	1,520,700
West Frankfort Coal Company	West Frankfort No. 21	1933-1934	229,735
West Mine Coal Corporation	West No. 21	1935-1936 ***	64,958
Frankfort Coal Company	Frankfort No. 21	1936-1937	86,997
Southern Illinois Coal Company	Southern Illinois No. 21	1937-1937	<u>116,221</u> ****
			7,241,045

** Idle 1925 & 1926

*** Idle 1935

**** Production after map date; reported under the name Southern Illinois Coal Company; the map indicates the company operated as Interstate Coal Company, No. 21 Mine

Last reported production: December 1937

SOURCES OF DATA

Source Map	Date	Original Scale	Digitized Scale	Map Type
Microfilm, document 351425	5-15-1937	1:2400	1:4634	Not final
Microfilm, document 351435	6-30-1954	1:4800	1:9931	Secondary source

Annotated Bibliography (data source, brief description of information)

Coal Reports - Production, ownership, years of operation, shaft sizes, depth, thickness.

Directory of Illinois Coal Mines (Franklin County) - Mine names, mine index, ownership, years of operation.

ENR Document 85/01 - Mining method.

Mine notes (Franklin County) - Mine type, shaft locations, seam.

Microfilm map, document 351425, reel 03136, frames 78-88 - Shaft locations, mine outline, mining method, geologic problems.

Microfilm map, document 351435, reel 03136, frames 103, 104, map of Old Ben No. 15 Mine (mine index 482) - Mine outline (southwest).

Company map, ISGS map library, Old Ben Coal Company Archive Collection - Mine outline (southwest).

Mine Index 366

Orient Number Two Coal Company, Orient No. 2 Mine

Type: Underground Total mined-out acreage shown: 9,638 An additional 46 acres may have been mined after the map date.

SHAFT, SLOPE, DRIFT or TIPPLE LOCATIONS

Type	County	Township-Range	Section	Quarters-Footage
Main shaft	Franklin	7S 2E	13	NW SE SW
Auxiliary shaft	Franklin	7S 2E	13	NE SE SW
Shaft No. 3 (air)	Franklin	7S 2E	1	SE NE NW
Shaft No. 4 (motor)	Franklin	6S 2E	36	NE NE SW

GEOLOGY

Seam(s) Mined	Depth (ft)	Thickness (ft)			Mining Method
		Min	Max	Ave	
Herrin	480-500	8.0	12.5	9.0	HER

Geologic Problems Reported: An explosion in 1951 resulted in 119 men killed, ranking second only to the Cherry Mine fire (Bureau County, 1909) in number of deaths. The mine had been classified as gassy, and had additional safety procedures (rock dusting to alleviate combustible coal dust in the mine, certified examiners monitoring the mine prior to each shift, etc.) An exhaustive investigation of the cause of ignition was narrowed down to two possibilities: an electrical arc from the operation of a motor or personnel smoking underground. The methane gas had apparently migrated from abandoned workings. The roof was at least 40 feet of shale, and generally up to 19 inches of top coal was left to support this roof. Some calcite appeared as fracture filler, and some thin pyrite stringers were present in the top coal. Some small slips were present, but did not seriously affect mining. The northward dip of the bed and the presence of a few rolls required some grading to be performed. The floor consisted of 4 to 18 inches of underclay that heaved "readily but not far". The microfilm source map shows generally north-trending faults along the west side of the mine, part of the Rend Lake Fault System. In some cases, mining was not badly impacted, but in other areas, entries and rooms were truncated due to faulting.

PRODUCTION HISTORY

Company	Mine Name	Years	Production (tons)
Chicago, Wilmington & Franklin Coal Co.	New Orient, Orient No. 2	1922-1959	60,003,670
Orient Number Two Coal Company	Orient No. 2	1959-1960	810,507
Orient Number Two Coal Company	Orient No. 2	1960-1960	293,263 *
			61,107,440

* Production after map date

Last reported production: November 30, 1960

SOURCES OF DATA

Source Map	Date	Original Scale	Digitized Scale	Map Type
Microfilm, document 351453	7-1-1960	1:2400	1:5296	Not final
Company, 4103.F7 i5.1-63	1-1-1960	1:12000	1:12000	Not final

Annotated Bibliography (data source, brief description of information)

Coal Reports - Production, ownership, years of operation, depth, geologic problems.

Directory of Illinois Coal Mines (Franklin County) - Mine names, mine index, ownership, years of operation.

ENR Document 85/01 - Mining method.

Mine notes (Franklin County) - Mine type, shaft location, seam, depth, thickness, geologic problems.

Microfilm map, document 351453, reel 03136, frames 160-171 - Shaft locations, mine outline, mining method.

Company map, ISGS map library, 4103.F7 i5.1-63 - Shaft locations.