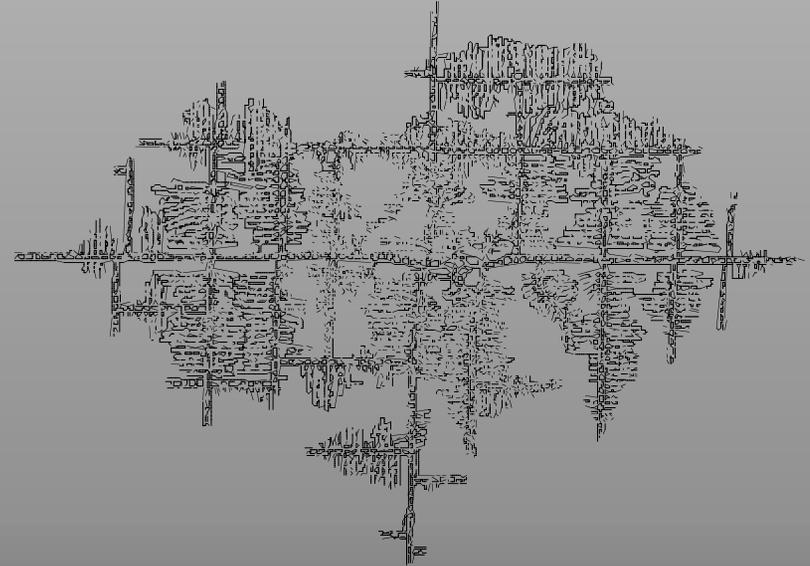




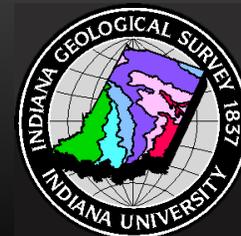
CMIS

Indiana Coal Mine
Information System



**-An integrated Geographic
Information System and
Database Management System**

Presented by:
Licia Weber
September, 2003



Basic History of CMIS

I) Initial phase (1981-1985)

- Mapped underground and surface coal mines on USGS 7.5 minute quadrangle maps.
- Compiled associated tabular data into SIR database.

II) GIS phase (1985-1999)

- Digitized spatial data compiled on quad maps and integrated into ESRI's ArcInfo GIS.
- Migrated tabular data to Dbase

III) Current phase (2000 - present)

- Refinement of the system
- Dissemination of information

Coal Mine Distribution

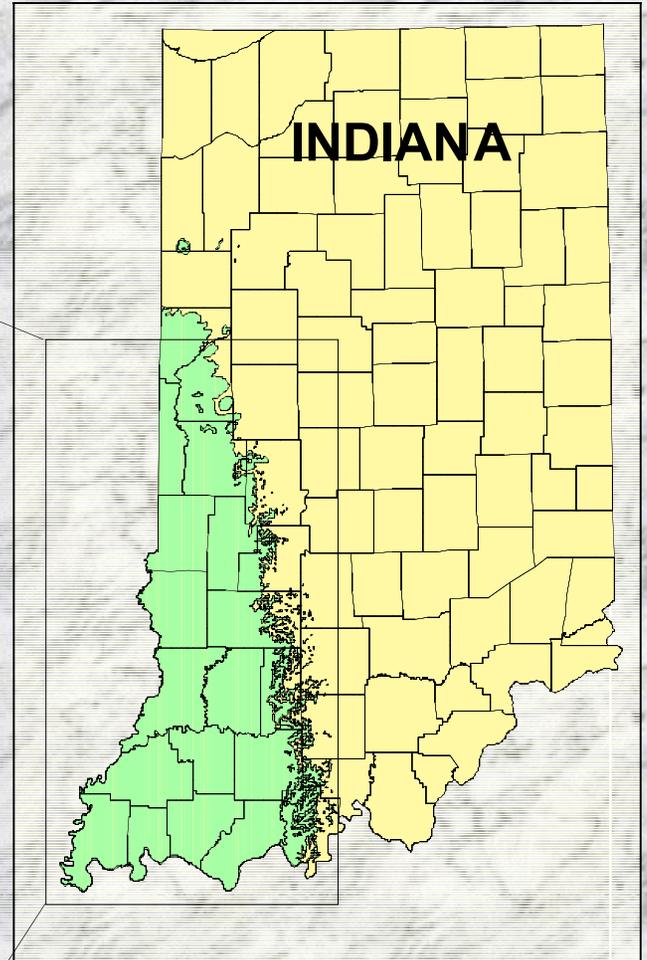
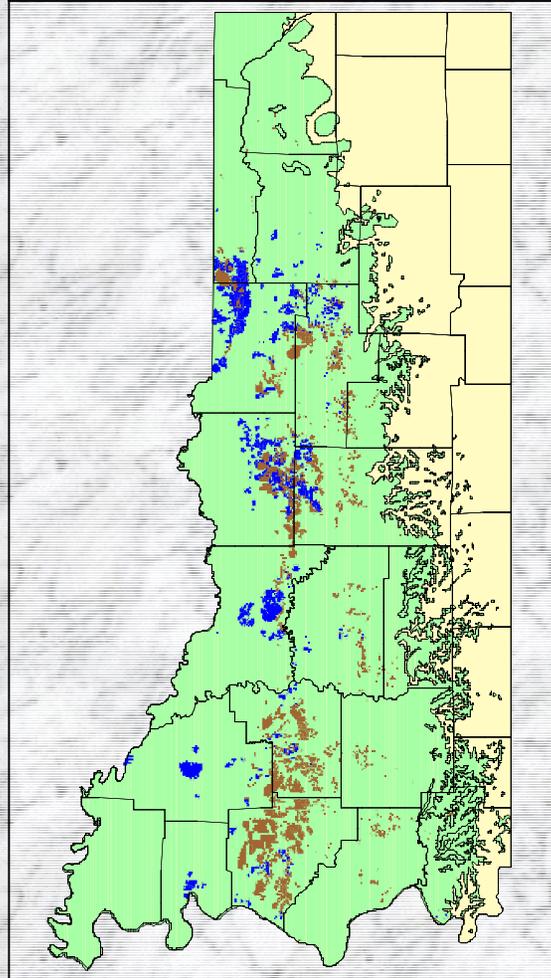
Southwestern Indiana



2,110 Underground
Mines



1,917 Surface Mines



Indiana's Coal Mine Information System:

I) Mapping Coal Mines – the early years

 **CMIS**
Indiana Coal Mine
Information System



Indiana Mine Data Compilation



+ Sources of Underground Coal Mine Data

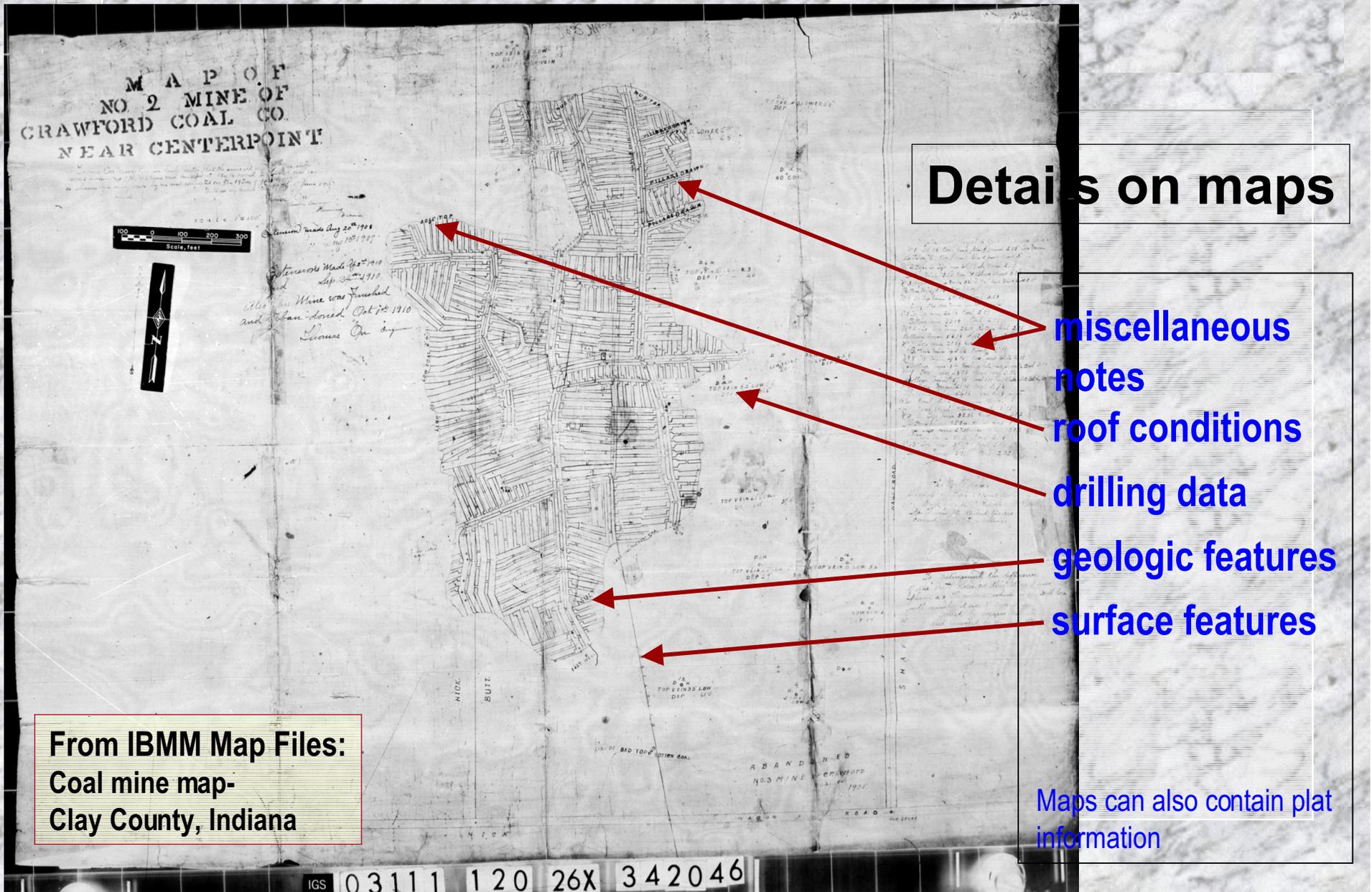
-Indiana Bureau of Mines and Mining

- Historic and current underground mine maps

-Indiana Geological Survey Files

- Coal Mine Card Catalog
- Geologists Field Maps
- Misc. Coal Company Maps
- Coal Related Publications

Initial Mapping Phase: UG Coal Mines

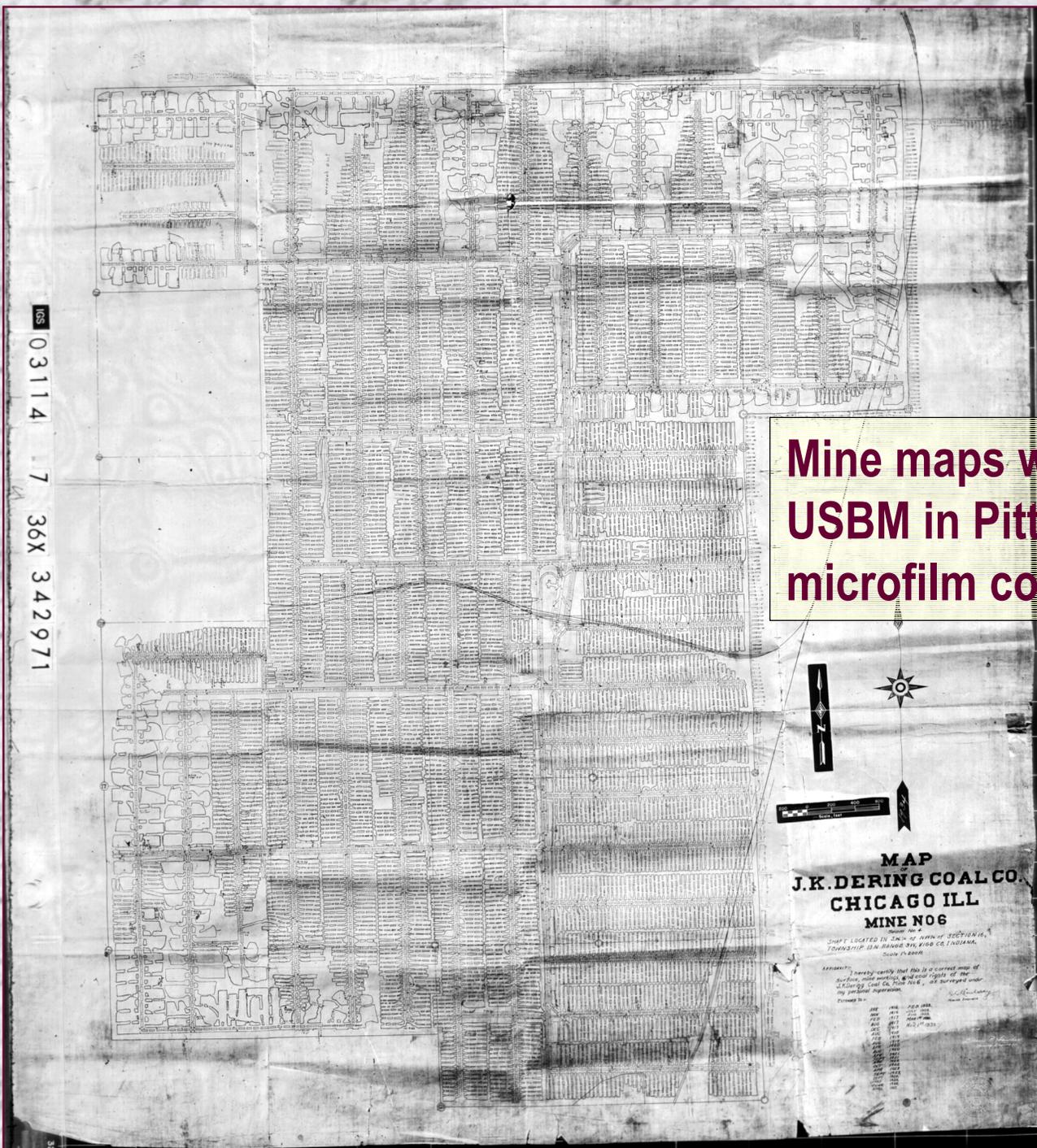


Details on maps

- miscellaneous notes
- roof conditions
- drilling data
- geologic features
- surface features

**From IBMM Map Files:
Coal mine map-
Clay County, Indiana**

Maps can also contain plat information



Mine maps were photographed by USBM in Pittsburgh to produce microfilm copies of maps.

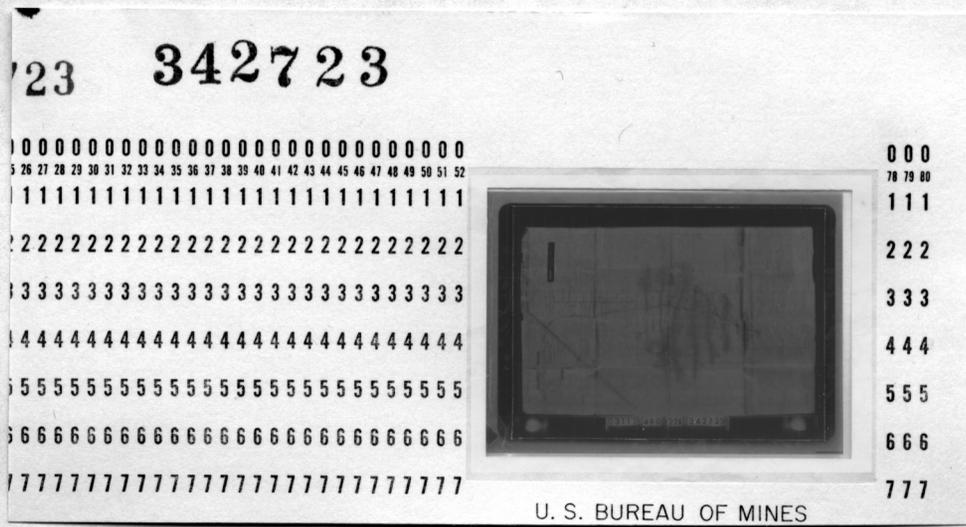
**MAP
J.K. DERING COAL CO.
CHICAGO ILL
MINE NO 6**

Scale No. 6
SHAFT LOCATED TO THE N. W. CORNER OF SECTION 10,
TOWNSHIP 15 N. RANGE 31 E. MISS CO. INDIANA.
Scale 1:25,000

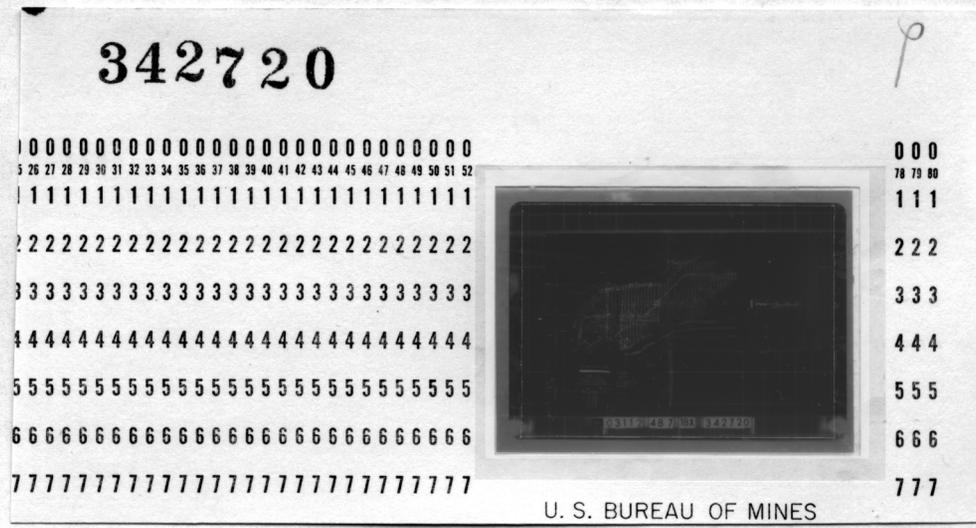
APPROVED: I hereby certify that this is a correct map of
surface and workings, and coal rights of the
J.K. Dering Coal Co. Mine No. 6, as surveyed under
my personal supervision.

- Surveyed by: J.K. Dering
- | | | | |
|---------|---------|---------|---------|
| SEE | THE | FOR | THE |
| NO. 1 | NO. 1 | NO. 1 | NO. 1 |
| NO. 2 | NO. 2 | NO. 2 | NO. 2 |
| NO. 3 | NO. 3 | NO. 3 | NO. 3 |
| NO. 4 | NO. 4 | NO. 4 | NO. 4 |
| NO. 5 | NO. 5 | NO. 5 | NO. 5 |
| NO. 6 | NO. 6 | NO. 6 | NO. 6 |
| NO. 7 | NO. 7 | NO. 7 | NO. 7 |
| NO. 8 | NO. 8 | NO. 8 | NO. 8 |
| NO. 9 | NO. 9 | NO. 9 | NO. 9 |
| NO. 10 | NO. 10 | NO. 10 | NO. 10 |
| NO. 11 | NO. 11 | NO. 11 | NO. 11 |
| NO. 12 | NO. 12 | NO. 12 | NO. 12 |
| NO. 13 | NO. 13 | NO. 13 | NO. 13 |
| NO. 14 | NO. 14 | NO. 14 | NO. 14 |
| NO. 15 | NO. 15 | NO. 15 | NO. 15 |
| NO. 16 | NO. 16 | NO. 16 | NO. 16 |
| NO. 17 | NO. 17 | NO. 17 | NO. 17 |
| NO. 18 | NO. 18 | NO. 18 | NO. 18 |
| NO. 19 | NO. 19 | NO. 19 | NO. 19 |
| NO. 20 | NO. 20 | NO. 20 | NO. 20 |
| NO. 21 | NO. 21 | NO. 21 | NO. 21 |
| NO. 22 | NO. 22 | NO. 22 | NO. 22 |
| NO. 23 | NO. 23 | NO. 23 | NO. 23 |
| NO. 24 | NO. 24 | NO. 24 | NO. 24 |
| NO. 25 | NO. 25 | NO. 25 | NO. 25 |
| NO. 26 | NO. 26 | NO. 26 | NO. 26 |
| NO. 27 | NO. 27 | NO. 27 | NO. 27 |
| NO. 28 | NO. 28 | NO. 28 | NO. 28 |
| NO. 29 | NO. 29 | NO. 29 | NO. 29 |
| NO. 30 | NO. 30 | NO. 30 | NO. 30 |
| NO. 31 | NO. 31 | NO. 31 | NO. 31 |
| NO. 32 | NO. 32 | NO. 32 | NO. 32 |
| NO. 33 | NO. 33 | NO. 33 | NO. 33 |
| NO. 34 | NO. 34 | NO. 34 | NO. 34 |
| NO. 35 | NO. 35 | NO. 35 | NO. 35 |
| NO. 36 | NO. 36 | NO. 36 | NO. 36 |
| NO. 37 | NO. 37 | NO. 37 | NO. 37 |
| NO. 38 | NO. 38 | NO. 38 | NO. 38 |
| NO. 39 | NO. 39 | NO. 39 | NO. 39 |
| NO. 40 | NO. 40 | NO. 40 | NO. 40 |
| NO. 41 | NO. 41 | NO. 41 | NO. 41 |
| NO. 42 | NO. 42 | NO. 42 | NO. 42 |
| NO. 43 | NO. 43 | NO. 43 | NO. 43 |
| NO. 44 | NO. 44 | NO. 44 | NO. 44 |
| NO. 45 | NO. 45 | NO. 45 | NO. 45 |
| NO. 46 | NO. 46 | NO. 46 | NO. 46 |
| NO. 47 | NO. 47 | NO. 47 | NO. 47 |
| NO. 48 | NO. 48 | NO. 48 | NO. 48 |
| NO. 49 | NO. 49 | NO. 49 | NO. 49 |
| NO. 50 | NO. 50 | NO. 50 | NO. 50 |
| NO. 51 | NO. 51 | NO. 51 | NO. 51 |
| NO. 52 | NO. 52 | NO. 52 | NO. 52 |
| NO. 53 | NO. 53 | NO. 53 | NO. 53 |
| NO. 54 | NO. 54 | NO. 54 | NO. 54 |
| NO. 55 | NO. 55 | NO. 55 | NO. 55 |
| NO. 56 | NO. 56 | NO. 56 | NO. 56 |
| NO. 57 | NO. 57 | NO. 57 | NO. 57 |
| NO. 58 | NO. 58 | NO. 58 | NO. 58 |
| NO. 59 | NO. 59 | NO. 59 | NO. 59 |
| NO. 60 | NO. 60 | NO. 60 | NO. 60 |
| NO. 61 | NO. 61 | NO. 61 | NO. 61 |
| NO. 62 | NO. 62 | NO. 62 | NO. 62 |
| NO. 63 | NO. 63 | NO. 63 | NO. 63 |
| NO. 64 | NO. 64 | NO. 64 | NO. 64 |
| NO. 65 | NO. 65 | NO. 65 | NO. 65 |
| NO. 66 | NO. 66 | NO. 66 | NO. 66 |
| NO. 67 | NO. 67 | NO. 67 | NO. 67 |
| NO. 68 | NO. 68 | NO. 68 | NO. 68 |
| NO. 69 | NO. 69 | NO. 69 | NO. 69 |
| NO. 70 | NO. 70 | NO. 70 | NO. 70 |
| NO. 71 | NO. 71 | NO. 71 | NO. 71 |
| NO. 72 | NO. 72 | NO. 72 | NO. 72 |
| NO. 73 | NO. 73 | NO. 73 | NO. 73 |
| NO. 74 | NO. 74 | NO. 74 | NO. 74 |
| NO. 75 | NO. 75 | NO. 75 | NO. 75 |
| NO. 76 | NO. 76 | NO. 76 | NO. 76 |
| NO. 77 | NO. 77 | NO. 77 | NO. 77 |
| NO. 78 | NO. 78 | NO. 78 | NO. 78 |
| NO. 79 | NO. 79 | NO. 79 | NO. 79 |
| NO. 80 | NO. 80 | NO. 80 | NO. 80 |
| NO. 81 | NO. 81 | NO. 81 | NO. 81 |
| NO. 82 | NO. 82 | NO. 82 | NO. 82 |
| NO. 83 | NO. 83 | NO. 83 | NO. 83 |
| NO. 84 | NO. 84 | NO. 84 | NO. 84 |
| NO. 85 | NO. 85 | NO. 85 | NO. 85 |
| NO. 86 | NO. 86 | NO. 86 | NO. 86 |
| NO. 87 | NO. 87 | NO. 87 | NO. 87 |
| NO. 88 | NO. 88 | NO. 88 | NO. 88 |
| NO. 89 | NO. 89 | NO. 89 | NO. 89 |
| NO. 90 | NO. 90 | NO. 90 | NO. 90 |
| NO. 91 | NO. 91 | NO. 91 | NO. 91 |
| NO. 92 | NO. 92 | NO. 92 | NO. 92 |
| NO. 93 | NO. 93 | NO. 93 | NO. 93 |
| NO. 94 | NO. 94 | NO. 94 | NO. 94 |
| NO. 95 | NO. 95 | NO. 95 | NO. 95 |
| NO. 96 | NO. 96 | NO. 96 | NO. 96 |
| NO. 97 | NO. 97 | NO. 97 | NO. 97 |
| NO. 98 | NO. 98 | NO. 98 | NO. 98 |
| NO. 99 | NO. 99 | NO. 99 | NO. 99 |
| NO. 100 | NO. 100 | NO. 100 | NO. 100 |

APERTURE CARD – 40mm negative of original company mine map (produced in 1980).



- 1.) 8.5 x 11 prints were made from these film images
- 2.) Mine outline was digitized from the print and scaled by computer to 1:24,000
- 3.) The mine outline was plotted by hand on paper USGS quadrangle maps.



Results of initial Underground and Surface coal mine mapping & data compilation



- + Produced a set of 97 quadrangle maps (1:24,000) showing locations of underground mines.
- + Produced a set of 115 quadrangle maps (1:24,000) showing locations of surface mines.
- + Produced sets of county maps (1:63,360) showing locations of surface mines and underground mines.
- + Created database of tabular data using SIR software.

II) Creating the Coal Mine Information System GIS



INITIAL EFFORTS:

- + **Used ESRI's ArcInfo**
Designed structure for the CMIS GIS
- + **Digitized mine outlines and entry locations plotted on USGS quad maps, and entered selected mine data into the associated attribute tables.**
- + **Migrated tabular data to Dbase (compatible with ArcInfo).**

CURRENT DATA STANDARDS:

- + **Metadata** - based on the Federal Geographic Data Committee Standard for Geospatial Metadata requirements.
- + **Coordinate system** - Universal Transverse Mercator (UTM) map projection, North American Datum (NAD) 83 - U.S. Geological Survey (USGS) standards for surface coordinates.

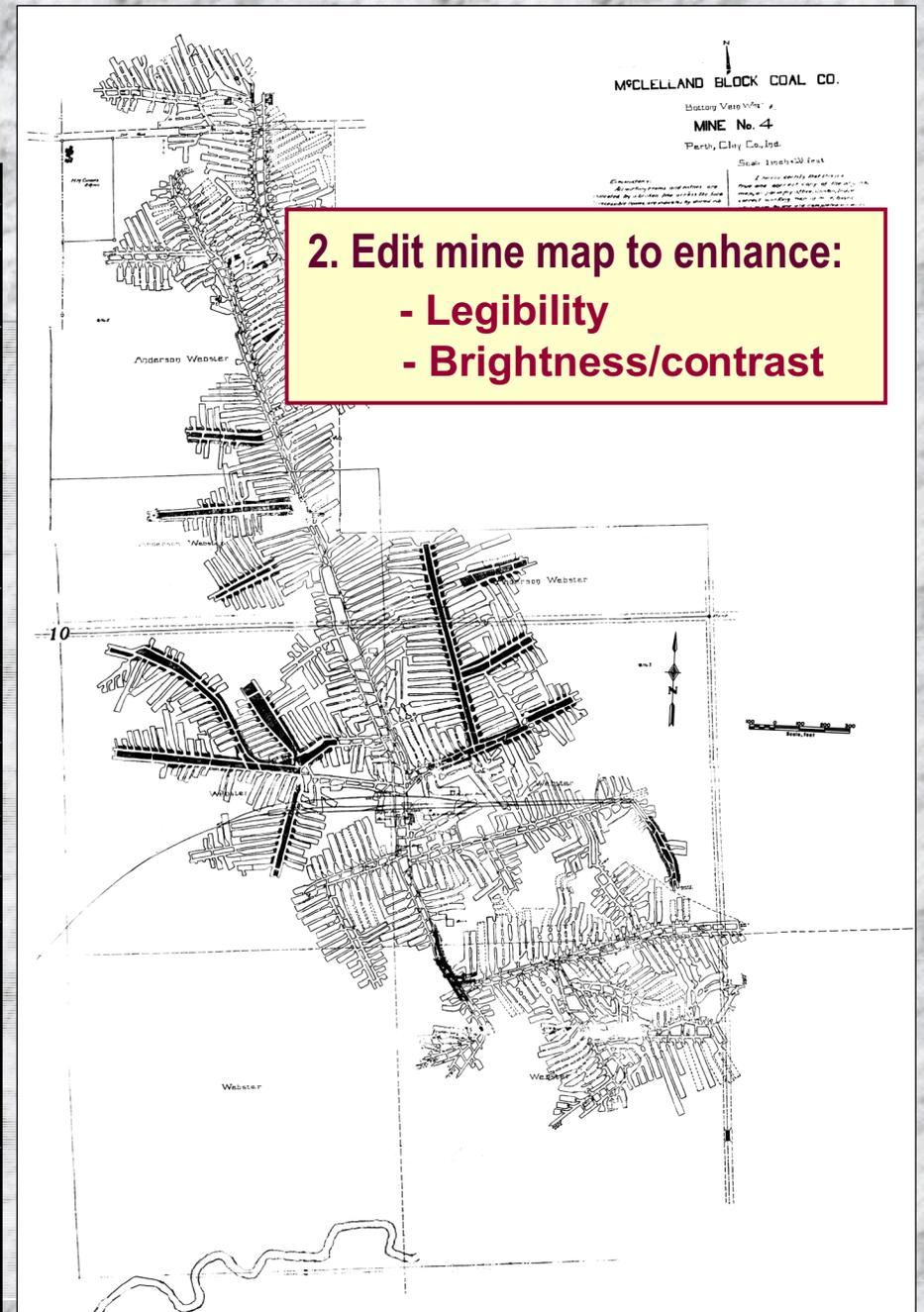
1. Scan mine map film image

-create high resolution .tif image



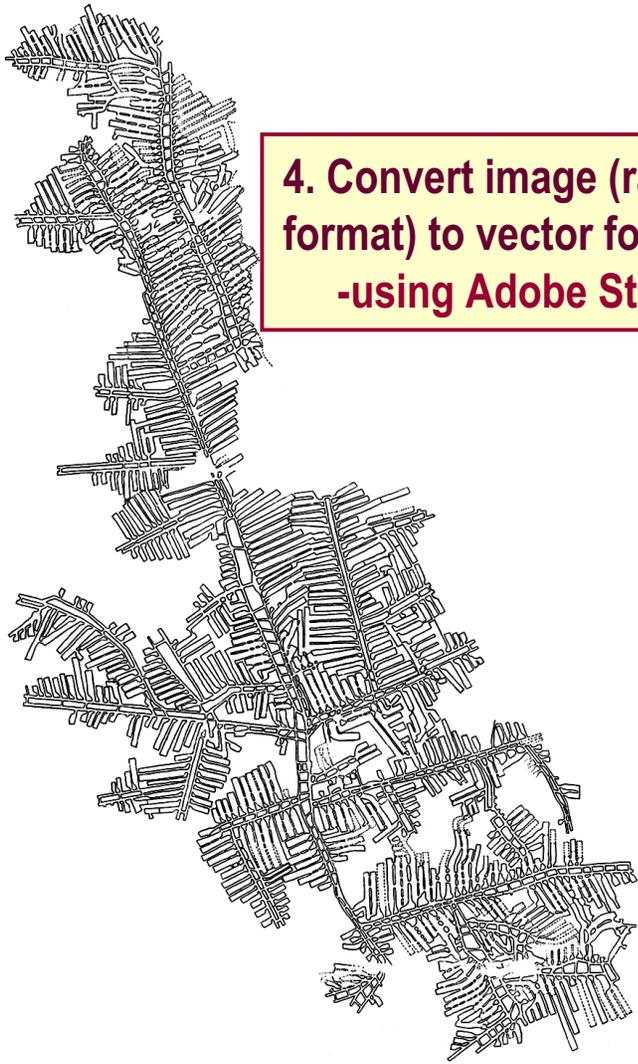
2. Edit mine map to enhance:

- Legibility
- Brightness/contrast



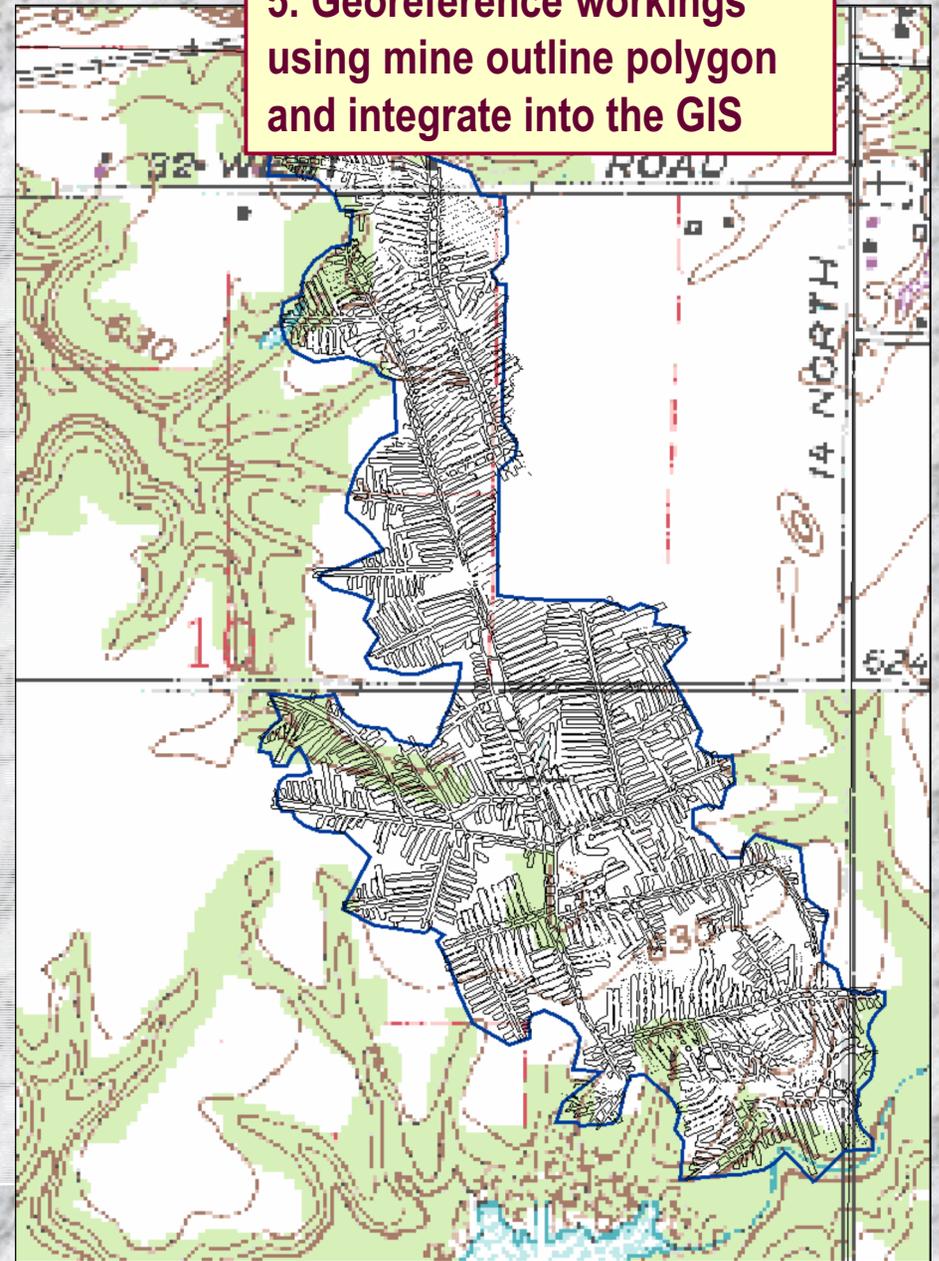
3. Prepare map for conversion to vector format

- Erase all lines on map that are not part of mine workings



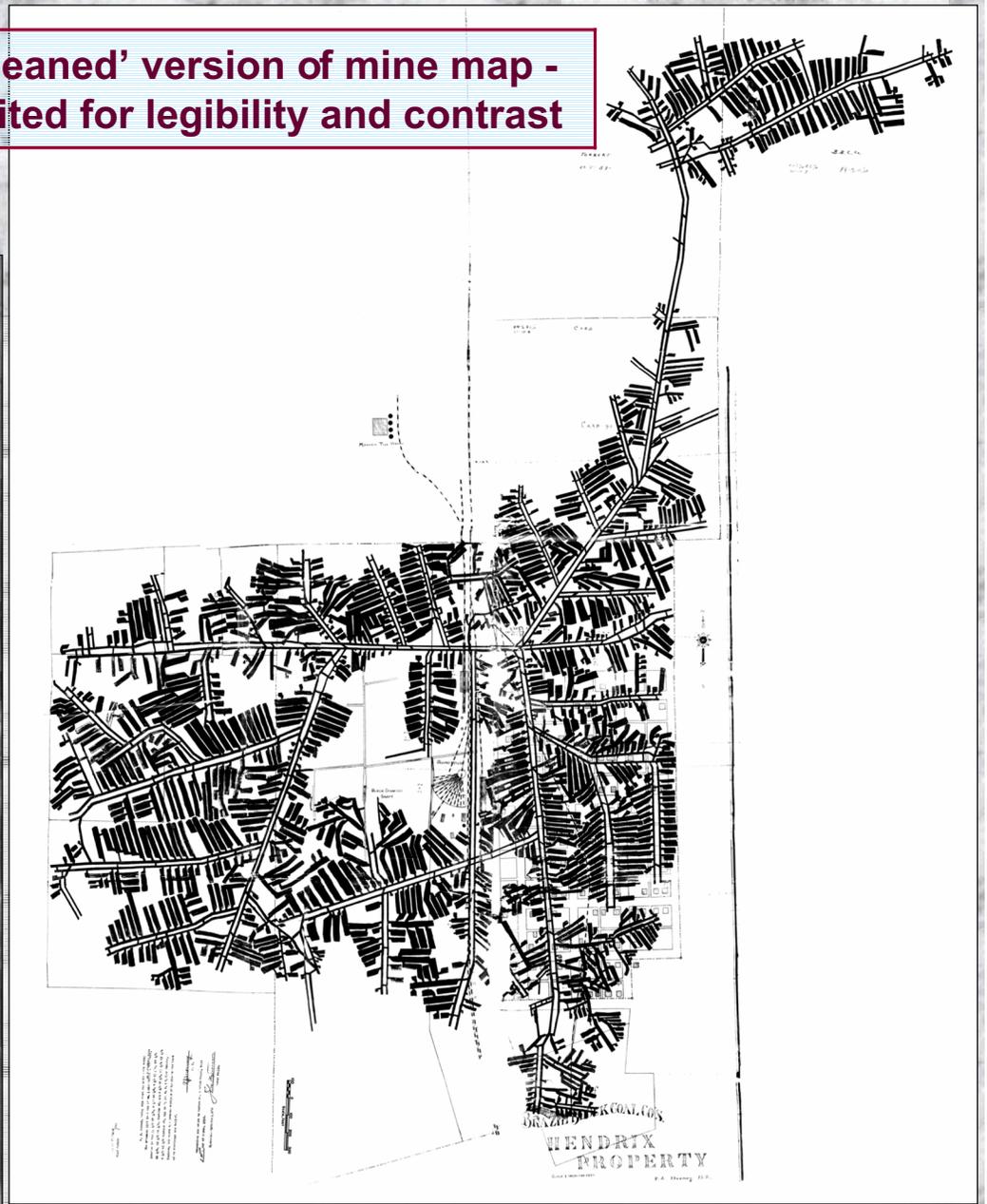
4. Convert image (raster format) to vector format -using Adobe Streamline

5. Georeference workings using mine outline polygon and integrate into the GIS



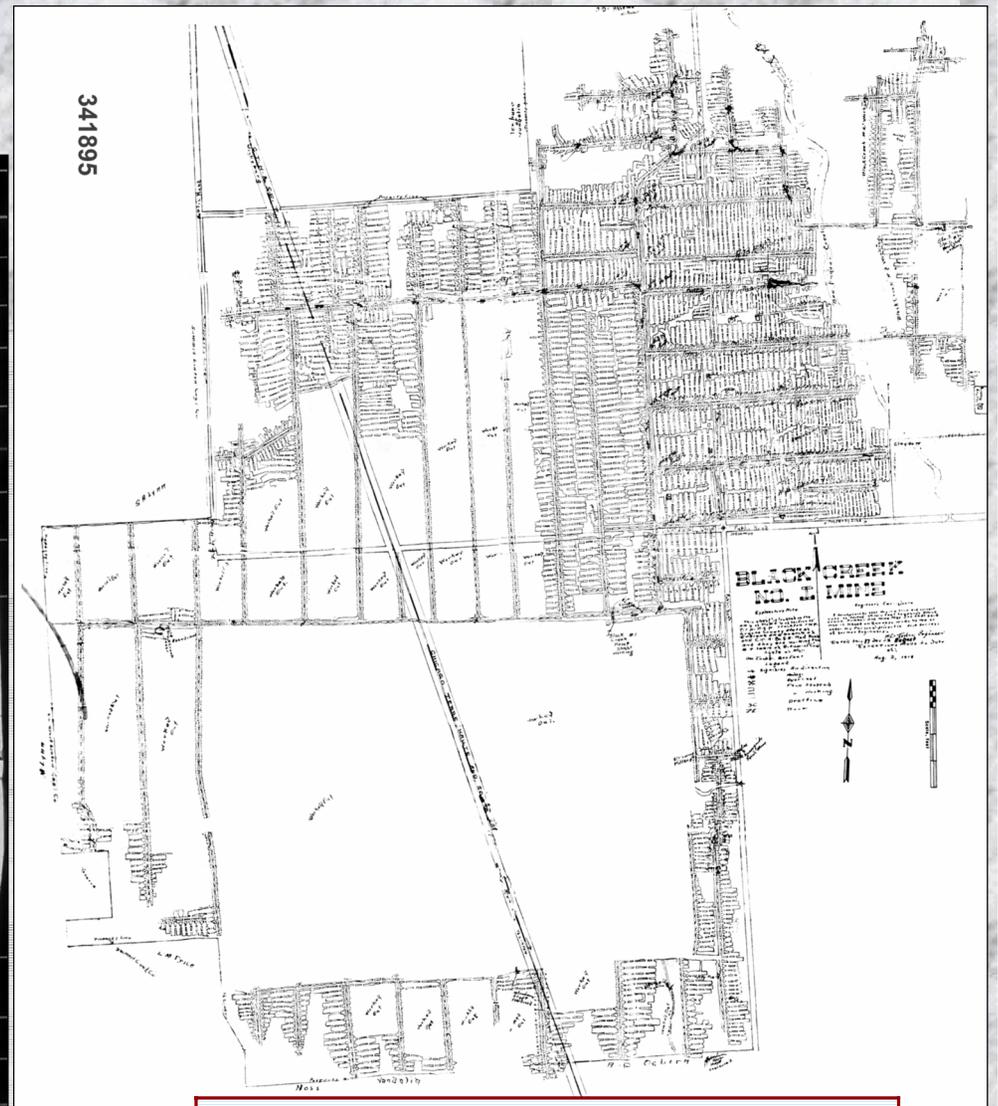
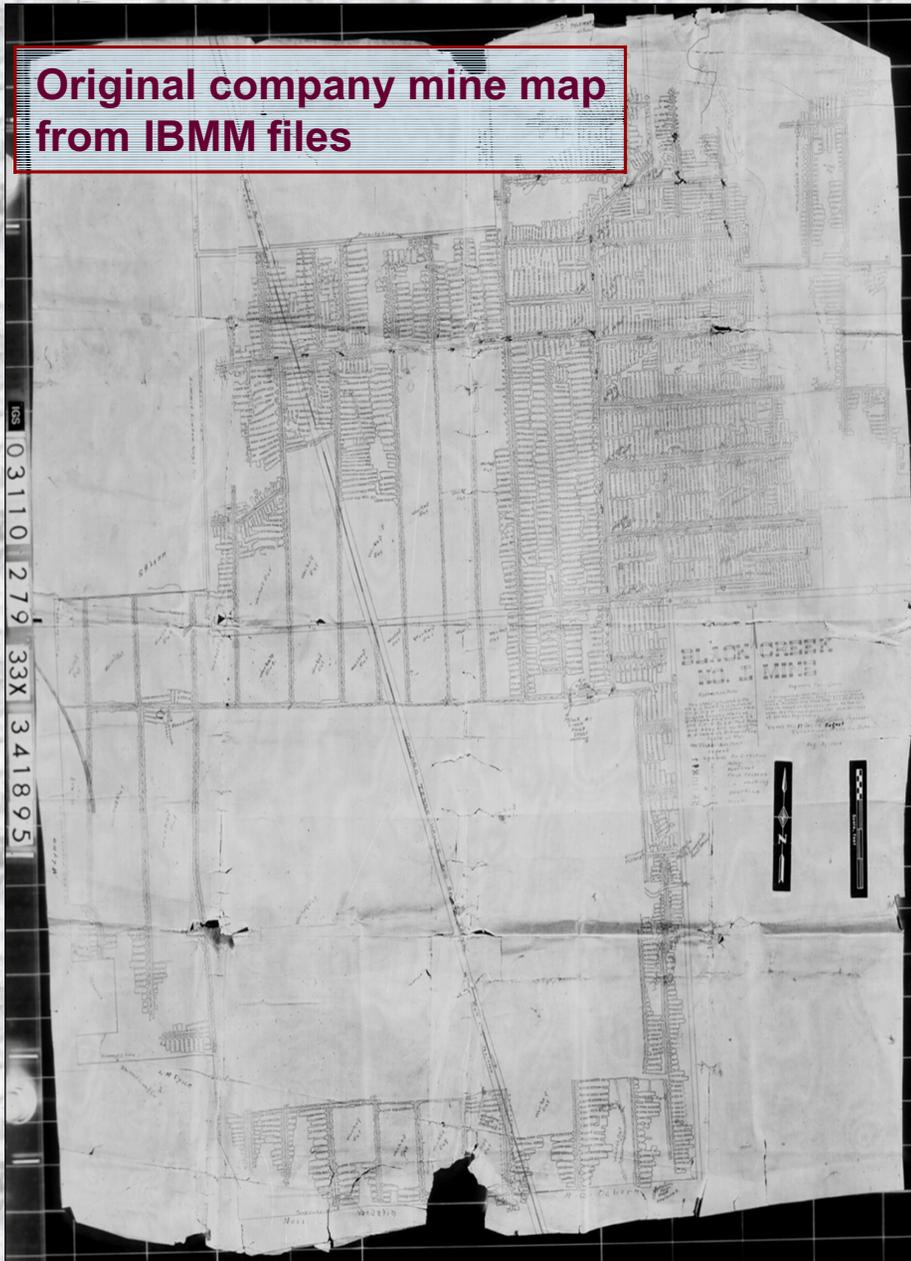
**'Cleaned' version of mine map -
edited for legibility and contrast**

**Original company mine
Map from IBMM files**



1889 Coal Mine Map

Original company mine map
from IBMM files



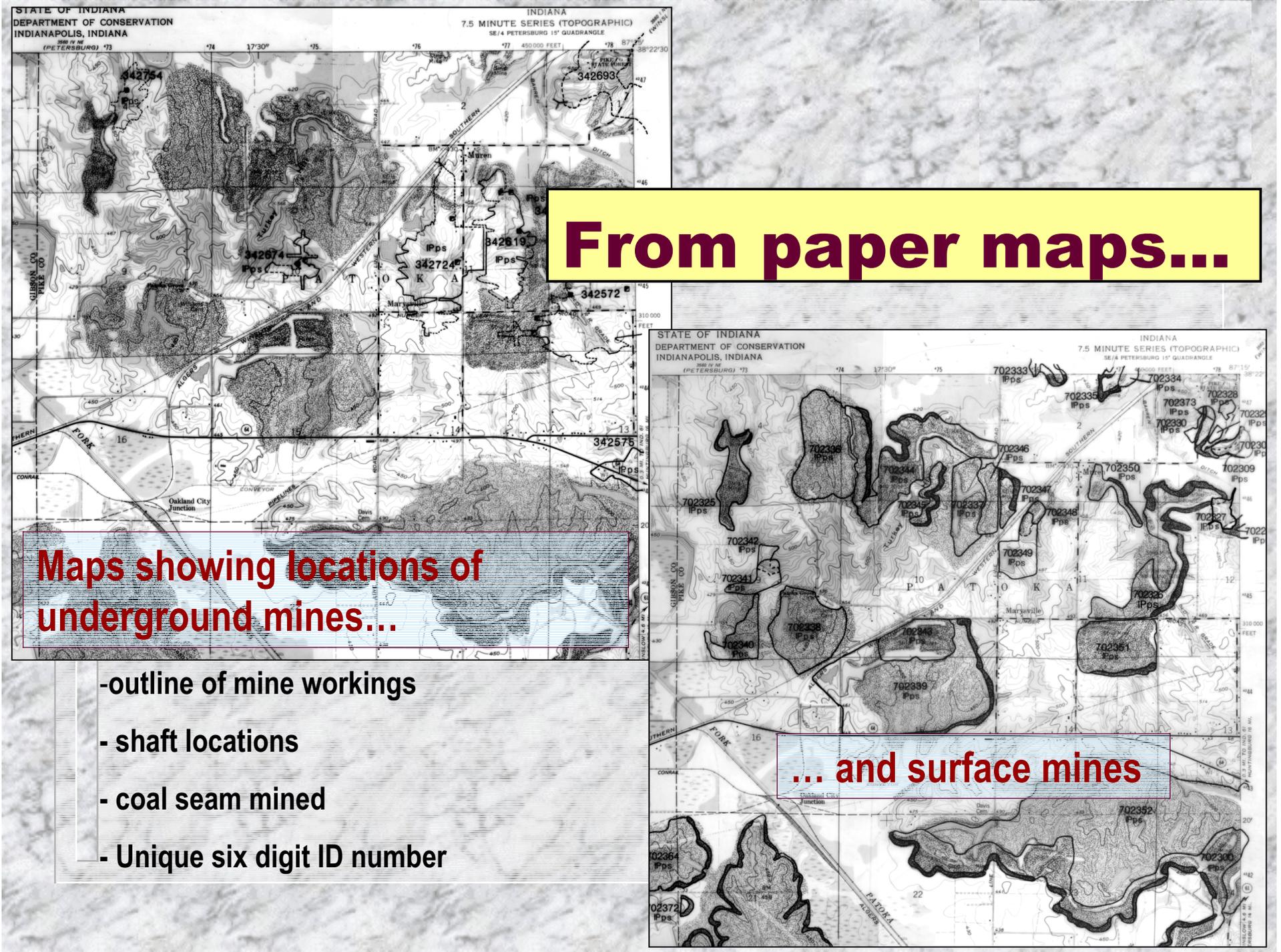
'Cleaned' version of mine map –
Edited for legibility and contrast

From paper maps...

Maps showing locations of underground mines...

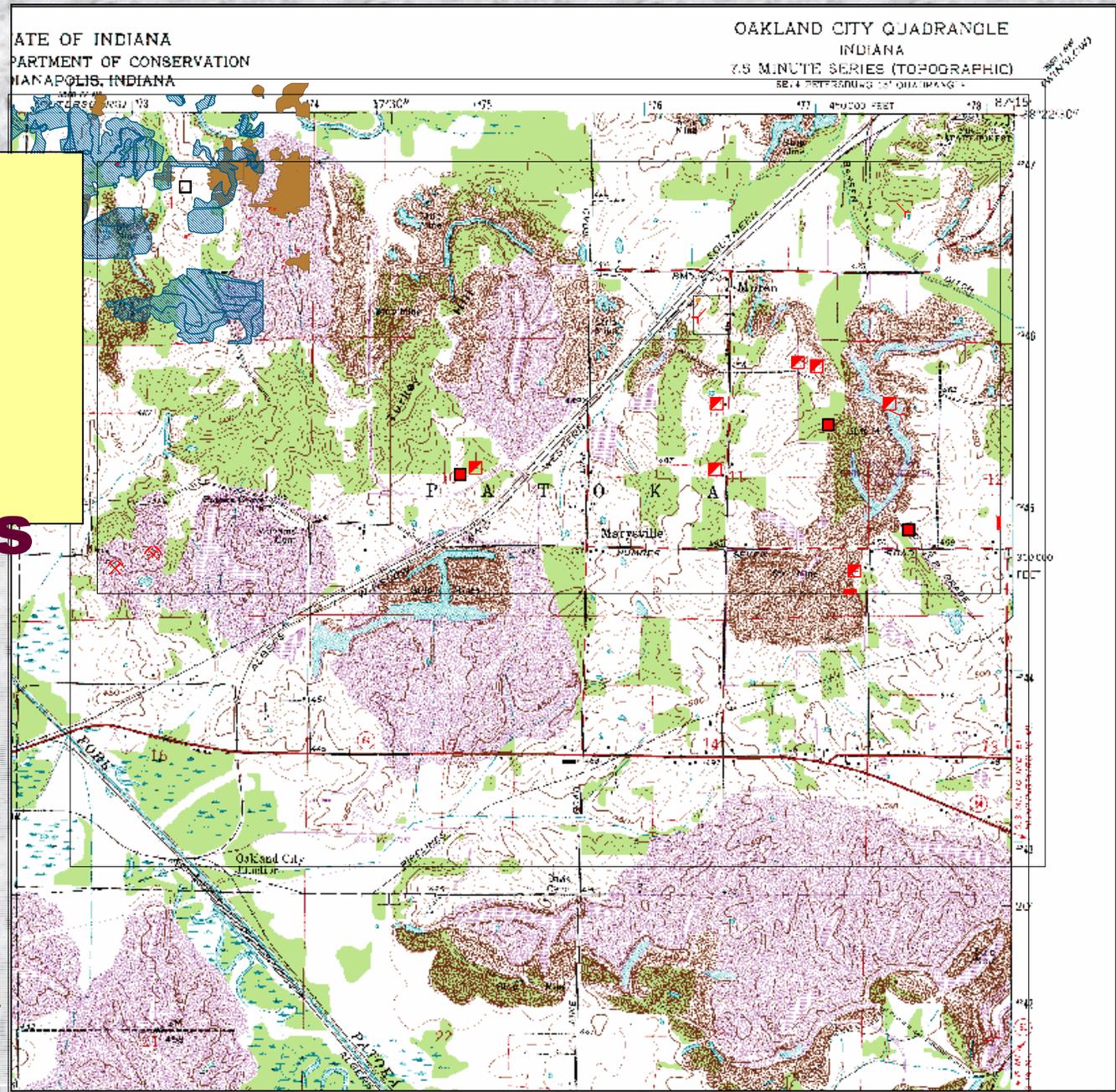
- outline of mine workings
- shaft locations
- coal seam mined
- Unique six digit ID number

... and surface mines



**...to GIS,
and digital
capabilities**

- querying capabilities
- site specific maps and data retrievals
- functional links to tabular data



CMIS COMPONENTS: Coal Mine Datasets

Current Software:

ESRI ArcInfo 8.x – ArcMap

- vector based mine outlines and workings
- raster based workings and quadrangle maps



Underground mine outline

Mine entrances



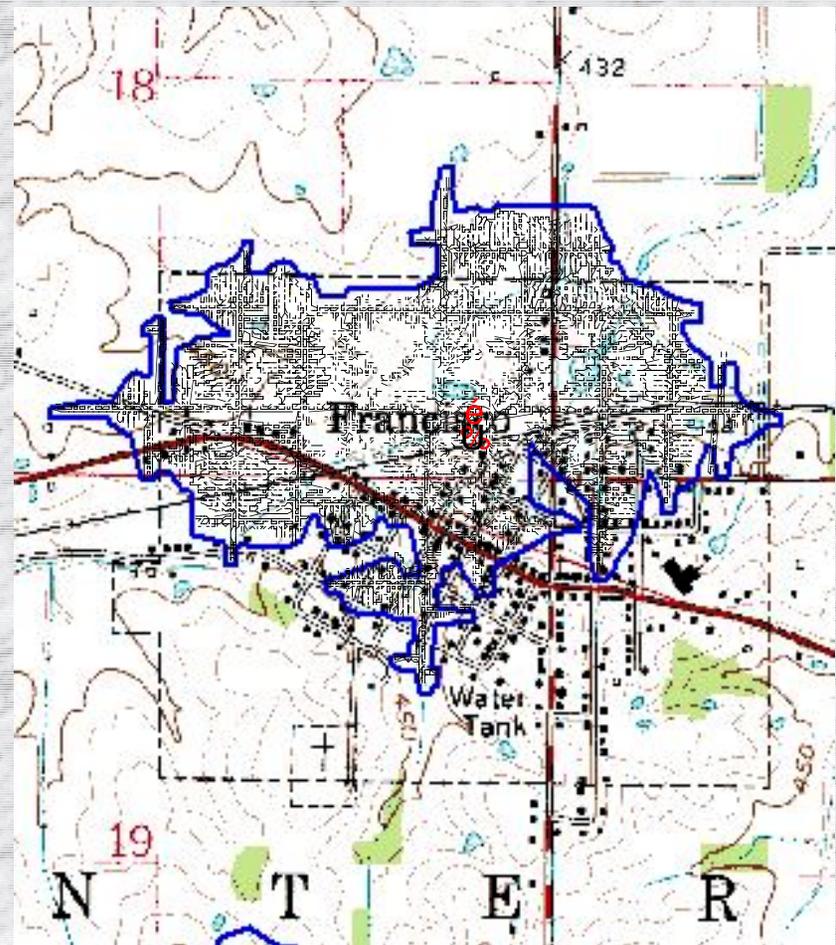
Hoist Shaft



Air Escape Shaft



Underground mine workings



Database Management System Data Storage in GIS



EXTERNAL DATABASE REPORT

COAL MINE INFORMATION SYSTEM
Main Data Sheet

MINE NUMBER
800550
Underground

MINE NAME HISTORY

Mine Name	Start	End
Westphalia No. 4	1934	1939
Westphalia	1920	1934
Clara	1917	1920
Fourth Vein	1001	9009

START DATE

MIN	Start	MAX	MIN	End	MAX
1917	1917	1917	1939	1939	1939

END DATE

OWNERSHIP HISTORY

Company Name	Start	End
Knox County Fourth Vein Coal Co.	1920	1939

OPERATIONS

Coal Removal Method	Shaft
Removal Equipment	Machine
Transportation Type	Railroad
Preparation Method	Mine run

COUNTIES

County Name	Primary
Knox	Yes

QUADRANGLE

Quad Name	Primary
Plainville	Yes

TRS LOCATION

Twp	Dir	Rng	Dir	SecType	Sec	Quarters
5	N	7	W	Sec.	19	
5	N	7	W	Sec.	20	
5	N	7	W	Sec.	29	
5	N	7	W	Sec.	30	
5	N	8	W	Sec.	24	
5	N	8	W	Sec.	25	
5	N	7	W	Sec.	30	SE NW NW

COAL GEOLOGY

Coal Seam/Member	Depth (ft)	Thick (ft)	Roof Lith	Floor Lith	Original Correlation
Survant Coal	222	4.8	UNKNOWN	UNKNOWN	CO-4 PCM

COMMENTS

Date	Comments
3/31/1999	Mine may have been known as Fourth Vein Mine (reported as such in Coal Trade Reports from 1926-1936).

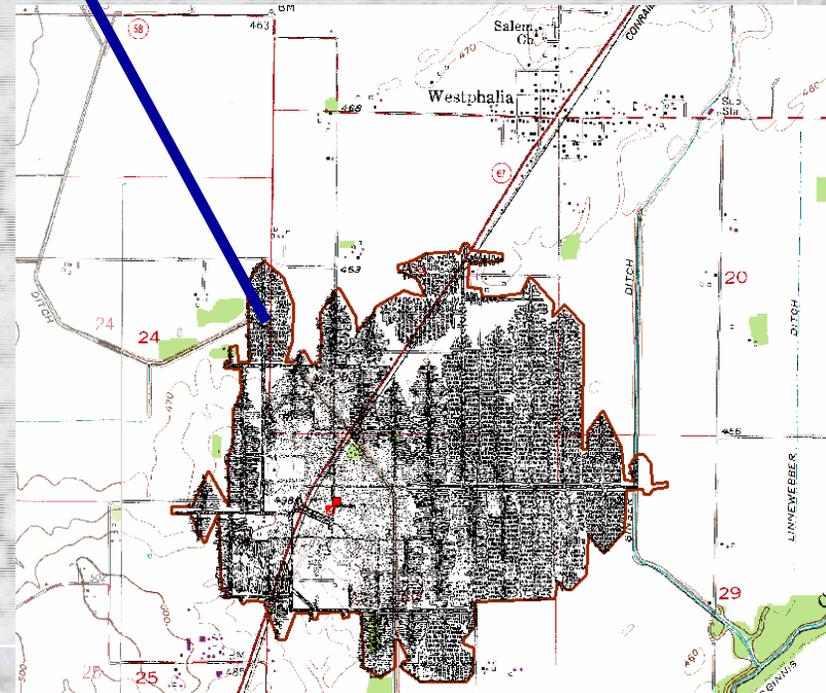
CITATIONS

Abbreviated Citation	Internal No	Digital
Data Card	2193	No
Data Card	2227	No

SPATIAL DATABASE (GIS attribute tables)

MINE NUMB	MAP NUMB	AREA	MINE_TYPE	YR_START
800550	342063	3209231	U	1917

MAP FEATURE



III) The Current Phase

With ESRI's new GIS capabilities, spatial and tabular data are made more accessible and manageable:

- **New geodatabase model**
- **Georeferencing tools** - Improve location accuracy and accessibility of spatial data by allowing the integration of raster images into GIS.
- **Internet Map Server (IMS) software**

ESRI's new Geodatabase Format

Introducing the Geodatabase...

- One file – not multiple complex files
- Continuous images – not tiled
- Simpler to design and manage
- More capabilities
- Open and standard
- Scalable

One place to store geographic and tabular data

Using ArcMap to locate and georeference mine maps

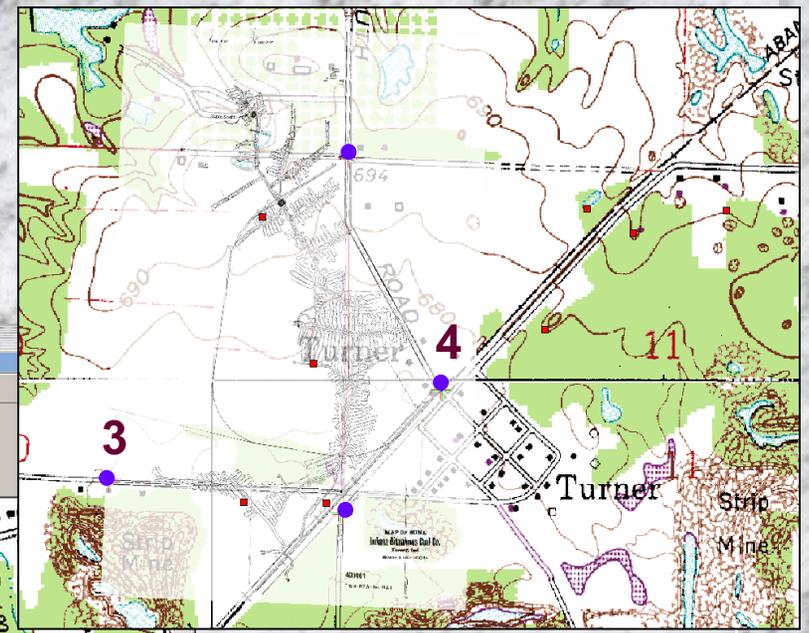
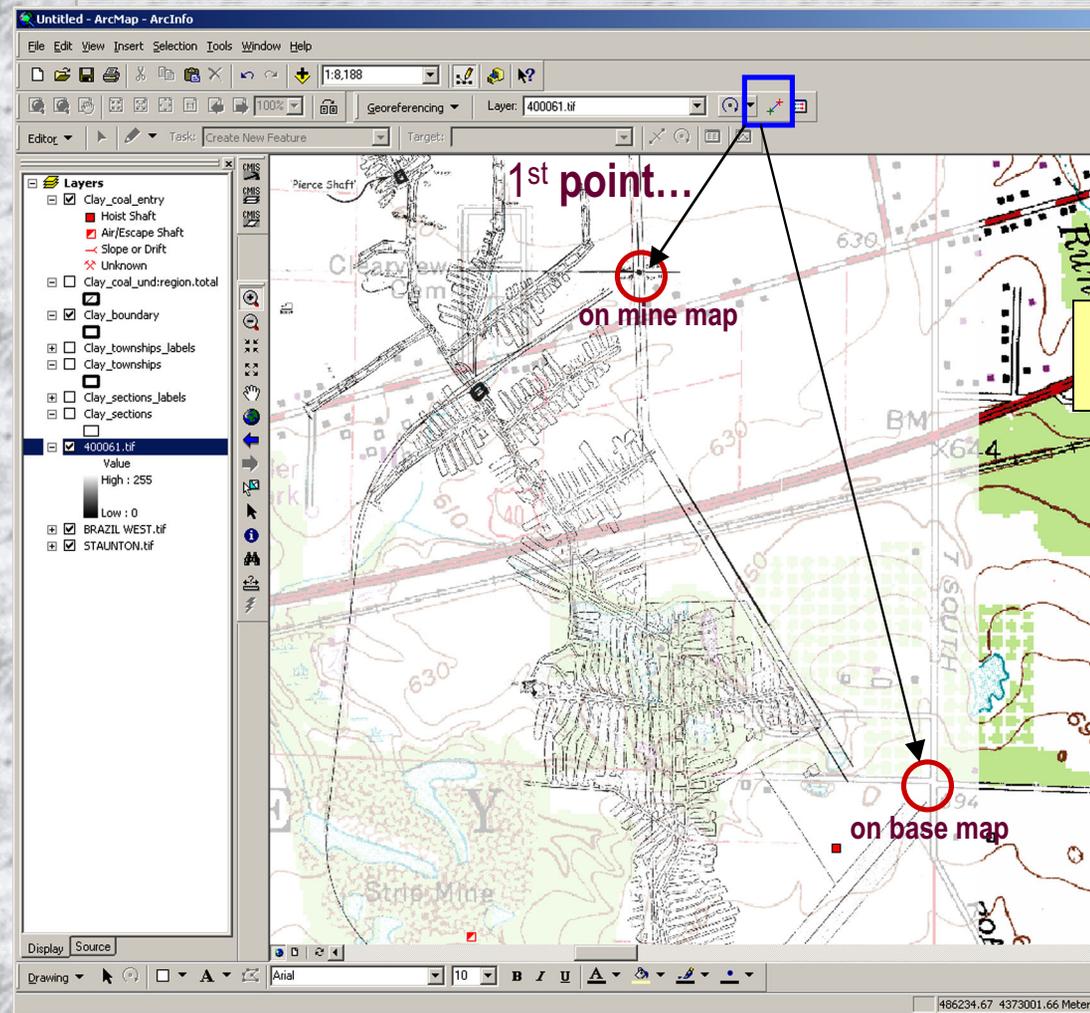
2. Using 'fit to image' command in Georeferencing pull down menu

1. Bring map image (.tif) into Arc Map

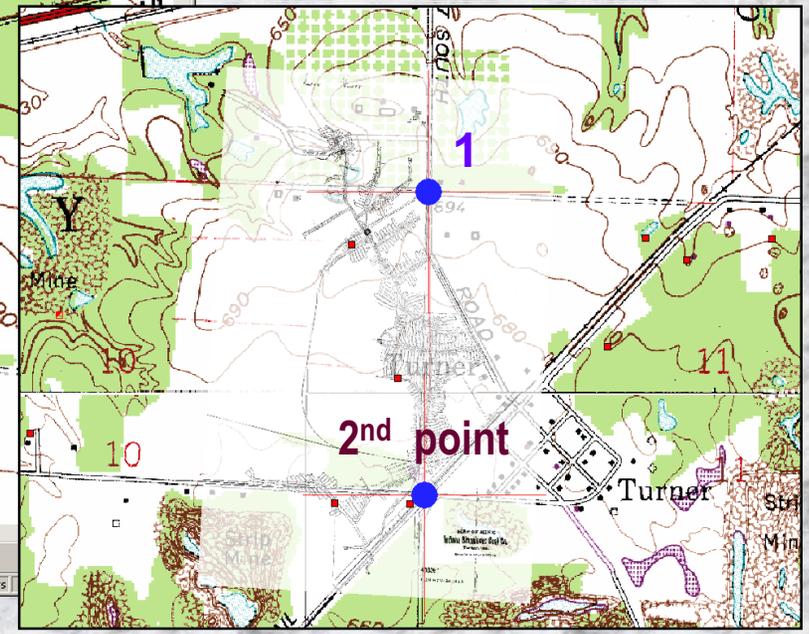
The screenshot shows the ArcMap interface with the following elements:

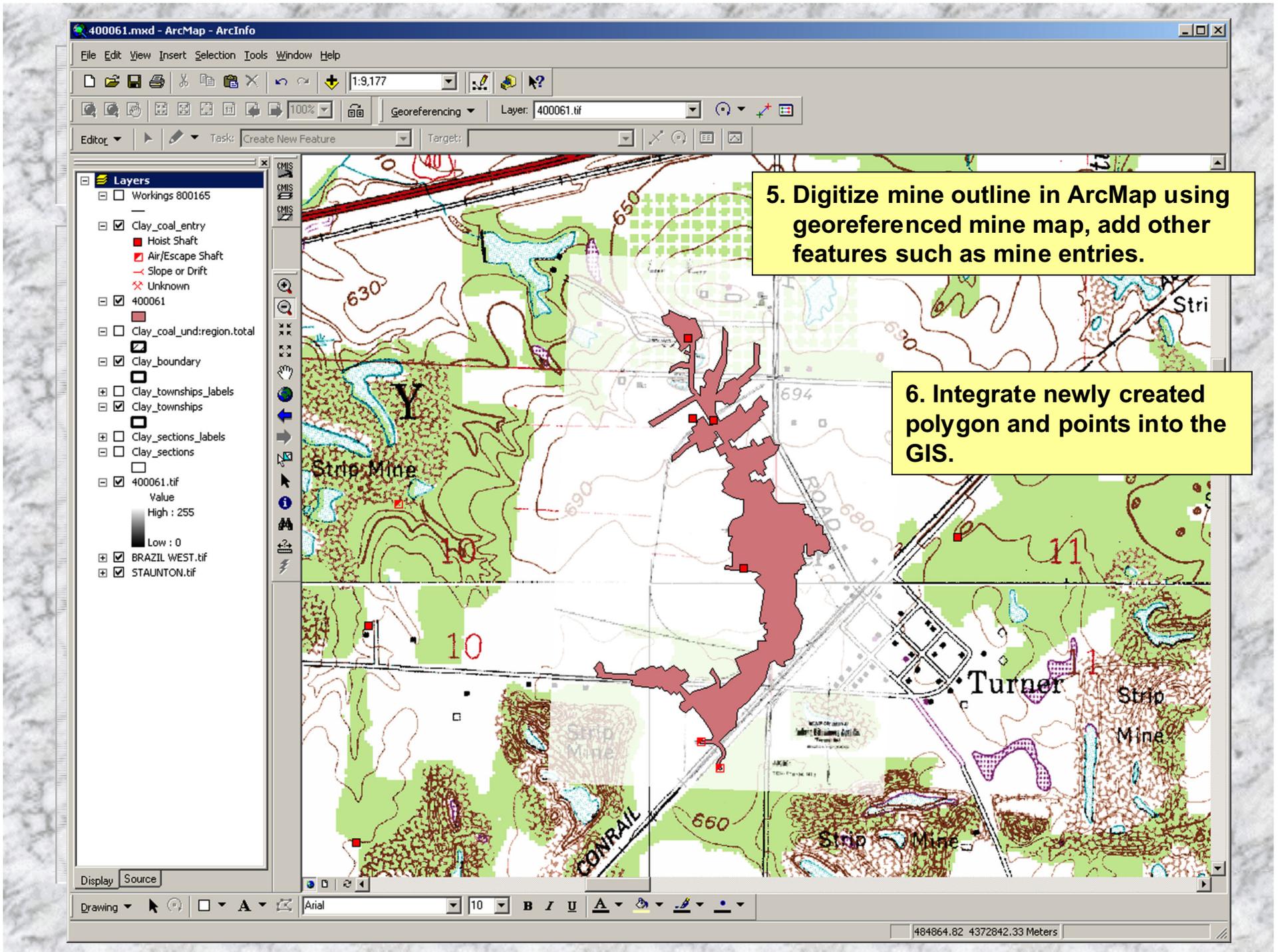
- Menu Bar:** File, Edit, View, Insert, Selection, Tools, Window, Help.
- Toolbars:** Standard, Georeferencing (highlighted with a red circle), and other toolbars.
- Georeferencing Menu:** Open, showing options like 'Fit to Image' (highlighted with a yellow callout).
- Legend:** Located on the left, listing various mine features. '400061.tif' is selected and circled in red. Other items include 'Clay_coal_und:region.total', 'Clay_boundary', 'Clay_townships_labels', 'Clay_townships', 'Clay_sections_labels', 'Clay_sections', 'BRAZIL WEST.tif', and 'STAUNTON.tif'.
- Main Map Area:** Displays a topographic map with mine features overlaid. Labels include 'Billtown', 'Turner', 'Cottage Hill', and 'CONRAIL'. A scale of 1:16,000 is shown in the top toolbar.
- Status Bar:** Shows coordinates: 484165.70 4374612.96 Meters.

3. Use georeferencing tool and click on 'common' points on the mine map and base map to align image.



4. Continue to register common points to fit mine map to base map features



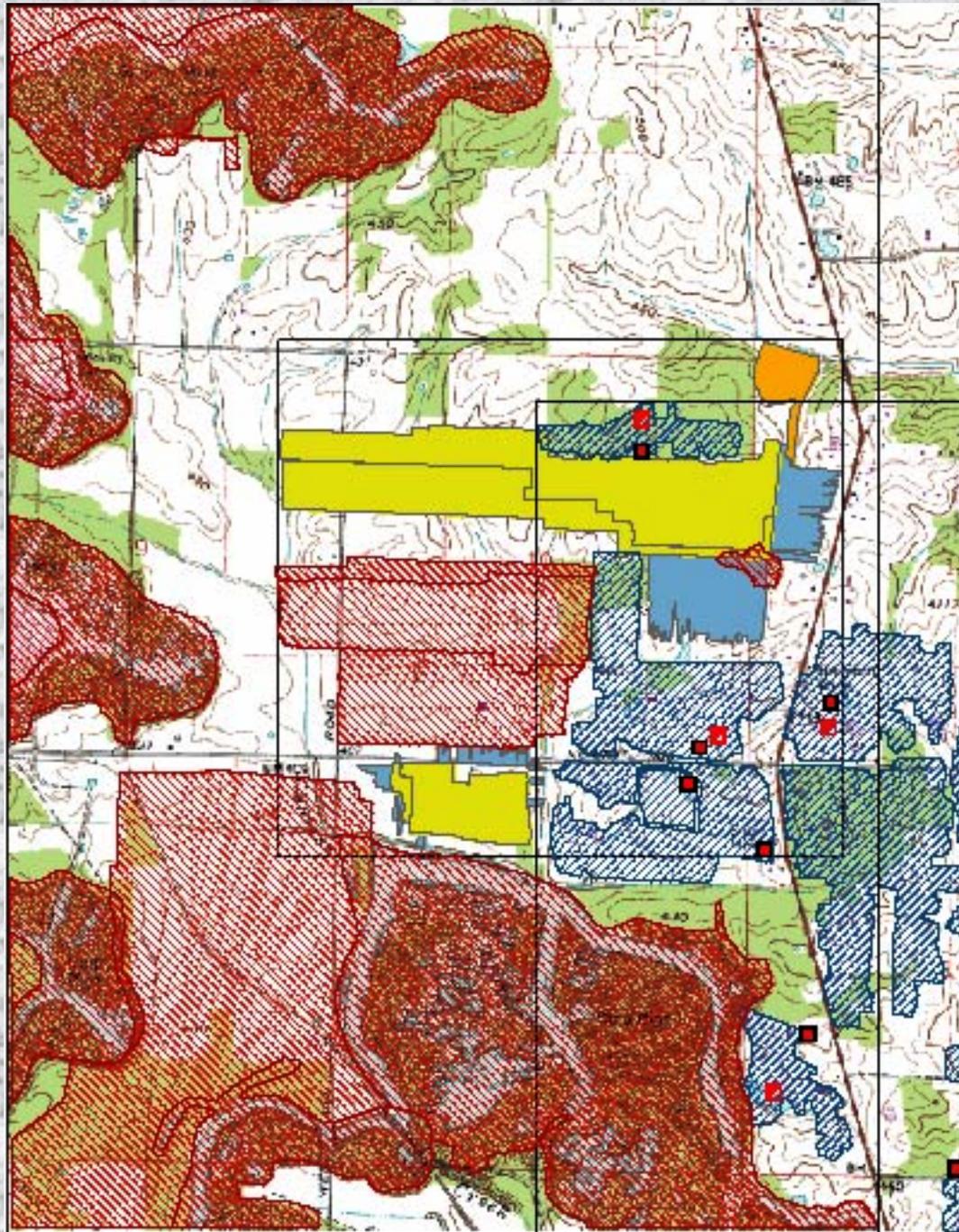


Current capabilities of ESRI's ArcGIS 8.x – Adding active mine map data

*-shows location of current
mining in relation to abandoned
works*

*-geo-referencing and digitizing
are done interactively*

Cypress Creek Mine in Warrick County, Indiana –
Boonville Quadrangle



<http://igs.indiana.edu>

Coal Mine Information System IMS site



**Interactive Map Server Site
DEMONSTRATION**

ArcIMS Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address <http://129.79.145.5/arcims/cmms/viewer.htm>

Indiana Coal Mine Maps

zoom in zoom out full extent zoom last pan identify query measure buffer select by rectangle select by line clear print Index Map Layers **Zoom to Location** Help Metadata

Zoom to Location or Area

Zoom to City
[Select City or Town] Zoom

Zoom to County
Warrick Zoom

Zoom to Township/Range/Section
1N 1W All Zoom

Highlight Feature

© Indiana University 2003

0 15 30 mi

Tool mode: Zoom Out Active layer: Underground Mines

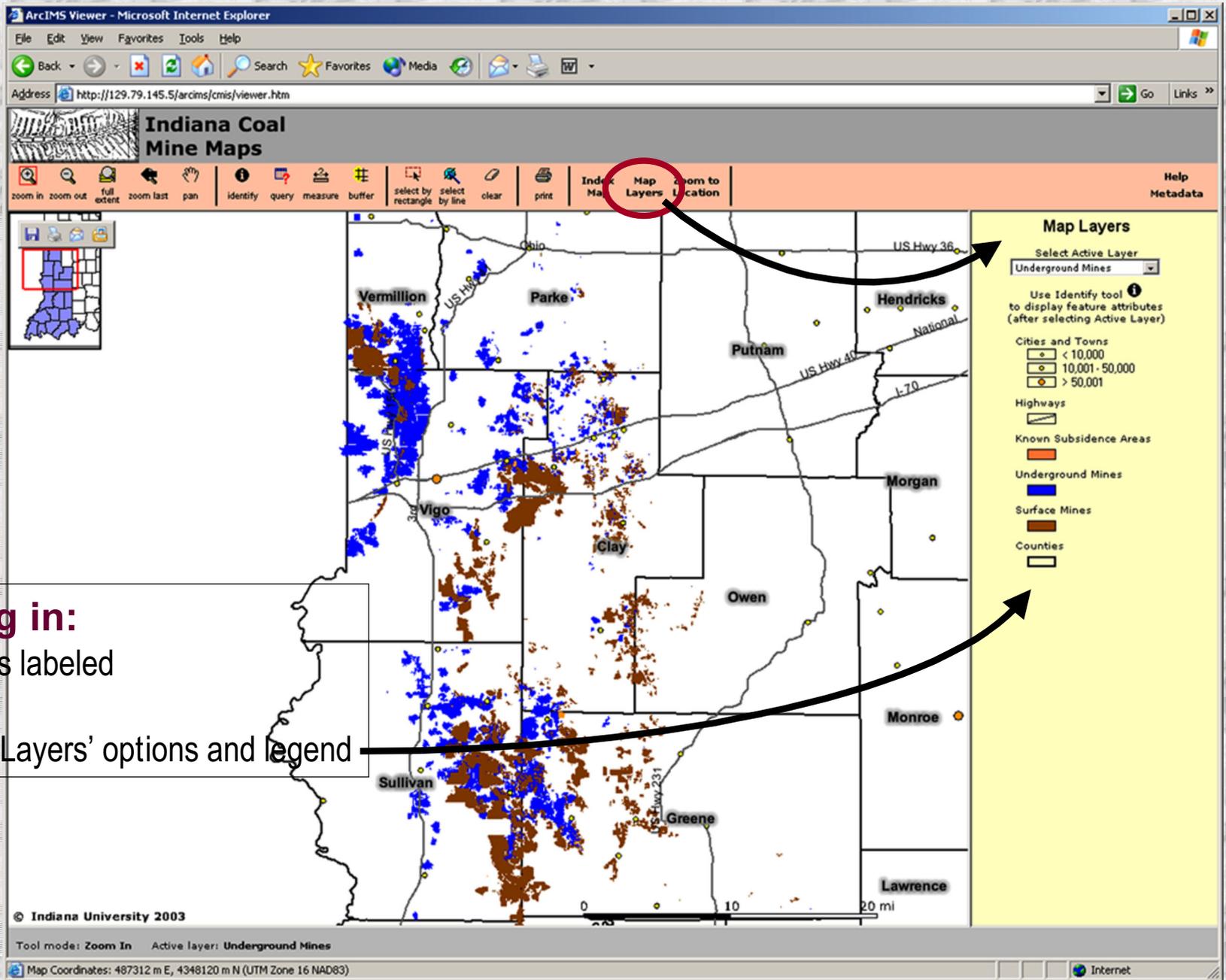
Map Coordinates: 250550 m E, 4405905 m N (UTM Zone 16 NAD83)

Internet

First map page: Southwestern Indiana

- underground and surface mine locations
- County labels & major roads

Note: 'Zoom to Location or Area' options



Zooming in:
-Highways labeled

Note: 'Map Layers' options and legend

ArcIMS Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media Print

Address http://129.79.145.5/arcims/cmris/viewer.htm Go Links

Indiana Coal Mine Maps

zoom in zoom out full extent zoom last pan identify query measure buffer select by rectangle select by line clear print Index Map Map Layers Zoom to Location Help Metadata

Zoom to Location or Area

Zoom to City

[Select City or Town] Zoom

Zoom to County

Sullivan Zoom

Zoom to Township/Range/Section

1N 1W All Zoom

Highlight Feature

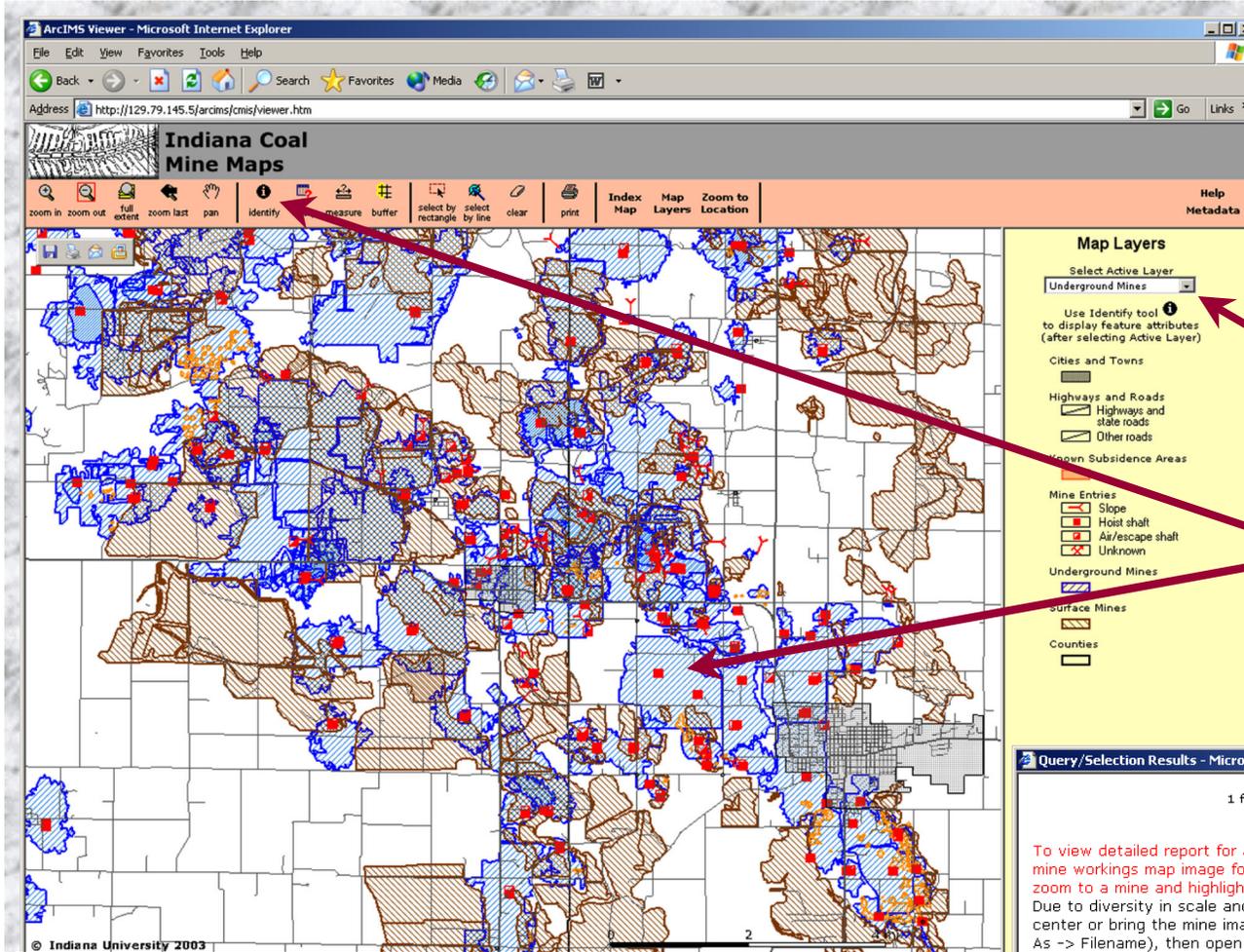
Zoom to Sullivan County:

- Addition of Entry Locations
- More base map details (secondary roads & town labels)

© Indiana University 2003

Tool mode: Pan Active layer: Underground Mines

Internet



1. Select active layer

2. Using 'identify' tool, select mine

Zooming in-

- Additional detail
- Querying capabilities

**Results of selection inquiry
(Note links to Mine Report and Mine Image)**

Query/Selection Results - Microsoft Internet Explorer

1 feature(s) have been identified in layer **Underground Mines**

To view detailed report for a particular mine, follow the [View Mine Report](#) link. To view detailed mine workings map image for a particular mine (if available), follow the [View Mine Image](#) link. To zoom to a mine and highlight it, click its record number.

Due to diversity in scale and size of the detailed maps, it may be necessary to use the scrollbars to center or bring the mine image into view. For best viewing, save image to local drive, (File -> Save As -> Filename), then open the file using local image viewing software (such as Imaging for Windows by Kodak).

Data from mine attribute table (this information is also included on the Mine Report page):

Rec	AREA	PERIMETER	MINE_TYPE	MINENUMB	SOURCE_CON	YEAR_START	YEAR_END	MAPNUMB	IMG_AVAIL
1	4139843.268	10504.386	U	800479	Primary	1903	1919	342743	Y

[View Mine Report](#) [View Mine Image](#)

Some explanation: The six digit Mine Number is an Indiana Geological Survey (IGS) identification number used to uniquely identify each mine.

On the **Mine Report** page, "Source Confidence" indicates whether or not the Indiana Geological Survey has a detailed map of the specific mine. The IGS has detailed maps for "Primary" source mines and does not have maps for "Secondary" source mines.

The six digit Map Number is the unique number of the source map used to map a specific mine polygon. This number can be used to request a detailed mine map from the IGS.

For more detailed information about mine attributes follow the **Metadata** link from the Map window.

**Zoomed in with USGS quad as base
- showing selected UG mine**

**Query result -
Mine report**

The screenshot displays the ArcIMS Viewer interface. The main map shows a grid of USGS quadrangles over a topographic base map. A red arrow points from a yellow callout box to a specific underground mine location on the map. A second red arrow points from another yellow callout box to a query result window on the right side of the screen.

Map Layers

- Select Active Layer: Underground Mines
- Use Identify tool to display feature attributes (after selecting Active Layer)
- Cities and Towns
- Highways and Roads: Highways and state roads, Other roads
- Known Subsidence Areas
- Mine Entries: Slope, Hoist shaft, Air/escape shaft, Unknown
- Underground Mines
- Surface Mines
- Counties

COAL MINE INFORMATION SYSTEM
Main Data Sheet

MINE NUMBER: 800550
Underground

MINE NAME HISTORY

Mine Name	Start	End
Westphalia No. 4	1994	1930
Westphalia	1920	1934
Clara	1917	1920
Fourth Vein	1001	9000

START DATE

MIN	Start	MAX	MIN	End	MAX
1917	1917	1917	1930	1930	1930

OWNERSHIP HISTORY

Company Name	Start	End
Knox County Fourth Vein Coal Co	1920	1930

OPERATIONS

Coal Removal Method	Shaft
Removal Equipment	Machine
Transportation Type	Railroad
Preparation Method	Mine run

COUNTIES

County Name	Primary
Knox	Yes

QUADRANGLE

Quad Name	Primary
Plainville	Yes

TRS LOCATION

Twp	Dir	Range	Dir	SecType	Sec	Quarters
5	N	7	W	Sec.	19	
5	N	7	W	Sec.	20	
5	N	7	W	Sec.	29	
5	N	7	W	Sec.	30	
5	N	8	W	Sec.	24	
5	N	8	W	Sec.	25	
5	N	7	W	Sec.	30	SE NW NW

Lith

Lith	Floor Lith	Original Correlation
OWN	UNKNOWN	CO-4 PCM

CTIONS

Abbreviated Citation	Fernal No	Digital
Card	2193	No
Card	2227	No

Linton 342743

Query result - .jpg map image

CMIS: Current & Future Activities



+ **Migrate from ESRI's 'coverage' data model to 'geodatabase' data model.**

+ **Inventory historic coal mine maps at IBMM.**

As a result of new georeferencing tools, IGS is reassessing Indiana's historic coal mine maps and the quality of current microfilm copies. Selected maps (approximately 500) will be digitally reproduced, and these new higher quality digital images will be georeferenced to improve location accuracy.

+ **Add coal thickness and elevation data from drill records and other sources to facilitate mine depth analysis.**

+ **Continue to update CMIS and IMS Web site with current mining data and refine the system to provide accessibility and accuracy of mine information.**

+ **Contribute IGS expertise and input to the current national mine mapping effort.**

CONCLUSION



“I cannot exaggerate the importance of having correct plans. When our present mines are abandoned and filled with water, these maps will have to guide us in future mining operations, and if they are misleading we should be much better without them, for they may cause much destruction of life.”

1880 State Mine Inspector's Report