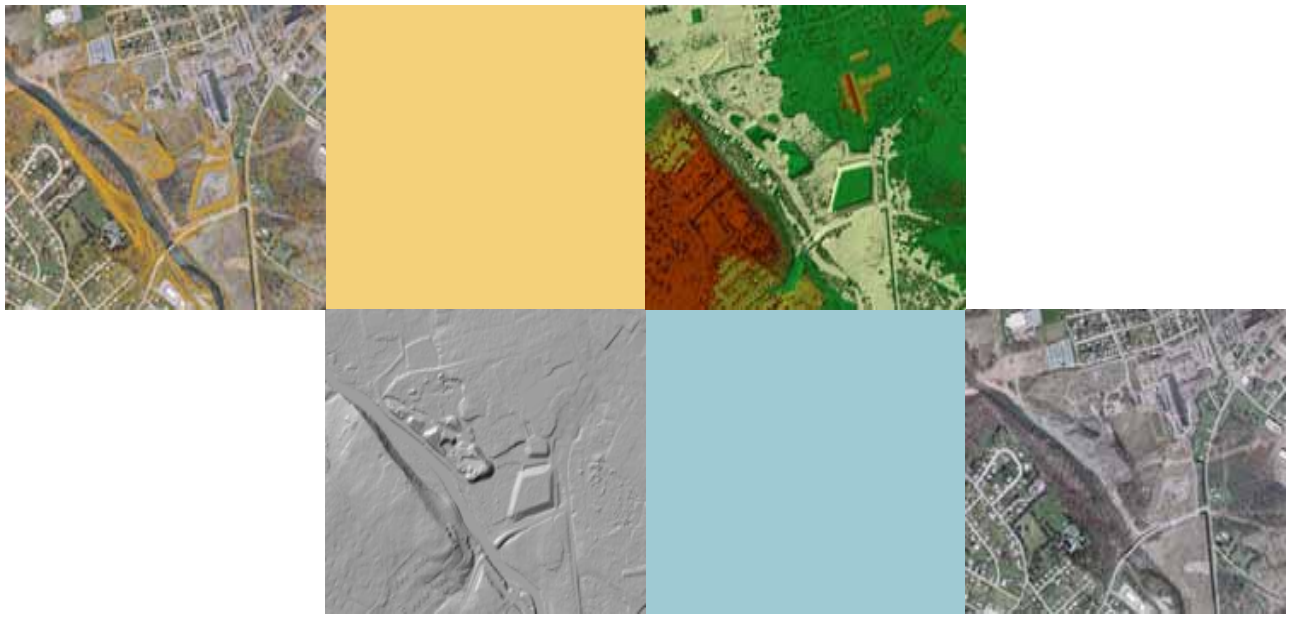
A Cause and Effect Relationship Between Antiquated Mapping Standards/Techniques and Recent Mining Accidents and Fatalities



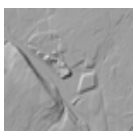
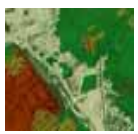
Incorporating Geospatial Technologies into SMCRA Business Processes

March 25 - 27, 2008

Atlanta, Georgia

Presentation Agenda

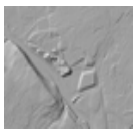
1. Recent coal mining accidents/disasters/deaths
2. Map automation errors & CAD errors
3. The MINER Act disconnect
4. State/federal government inertia
5. The future

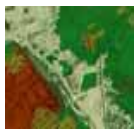



Why create unified national coal mining geospatial datasets?

1.

- Mining accidents & disasters
  - Recent
    - Inez, KY. slurry impoundment failure



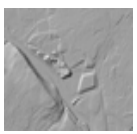
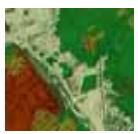


Why create unified national coal mining geospatial datasets?

1.

- Mining accidents & disasters
  - Recent
    - Martin County s
      impoundment
    - Quecreek

uncertified mine map of the Harrison No.2 mine."

Why create unified national coal mining geospatial datasets?

1.

- Mining accidents & disasters
  - Recent
    - Martin County slur
      impoundment fa
    - Quecreek
    - Sago

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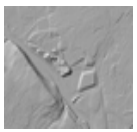
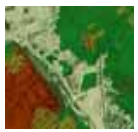


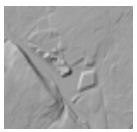
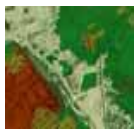


Why create unified national coal mining geospatial datasets?

1.

- Mining accidents & disasters
  - Recent
    - Martin County s impoundment
    - Quecreek
    - Sago
    - Aracoma

"Timmy Paul Morgan, who died Apr 9, '06 of a heart attack, gave a statement to an attorney representing the widow of Mr. Hatfield. In that statement, Mr. Morgan said rescue team members complained that the map of Aracoma they were given to search for the missing men was inaccurate, showing doors and stoppings in places that did not exist."

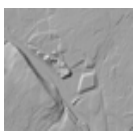



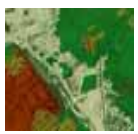
Why create unified national coal mining geospatial datasets?

1.

- Mining accidents & disasters
  - Recent
    - Martin County slur impoundment fail
    - Quecreek
    - Sago
    - Aracoma
    - Black Castle fatality

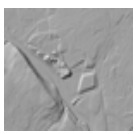
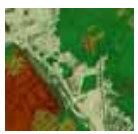
On Feb. 1, '06, a dozer operator at Black Castle strip mine in Drawdy, WV was fatally injured due to ignition of natural gas. As the operator with 15 years experience was





Magnitude of the inaccurate map problem 2.

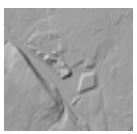
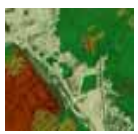
- WVDEP has processed **> 1000** mining permit **maps** in the **last 2 years**.
  - **Many** of these maps exhibited high quality and **appeared** to be very **accurate**.
  - This project showed that **error** could be **produced at every step** in the paper to digital conversion process → map automation

Errors in paper to digital conversion

2.

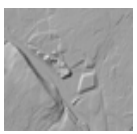
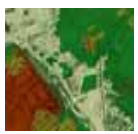
- First, **scanning** a paper map adds a small amount of error → folds in the map, creases, map slips while being scanned.
- More error is produced when the image **georeferencing** → ranges from a few feet to perhaps tens of feet.
- Finally, error is added when a technician traces a feature onscreen with a mouse → **heads up digitizing**.

CAD did not solve error problems

2.

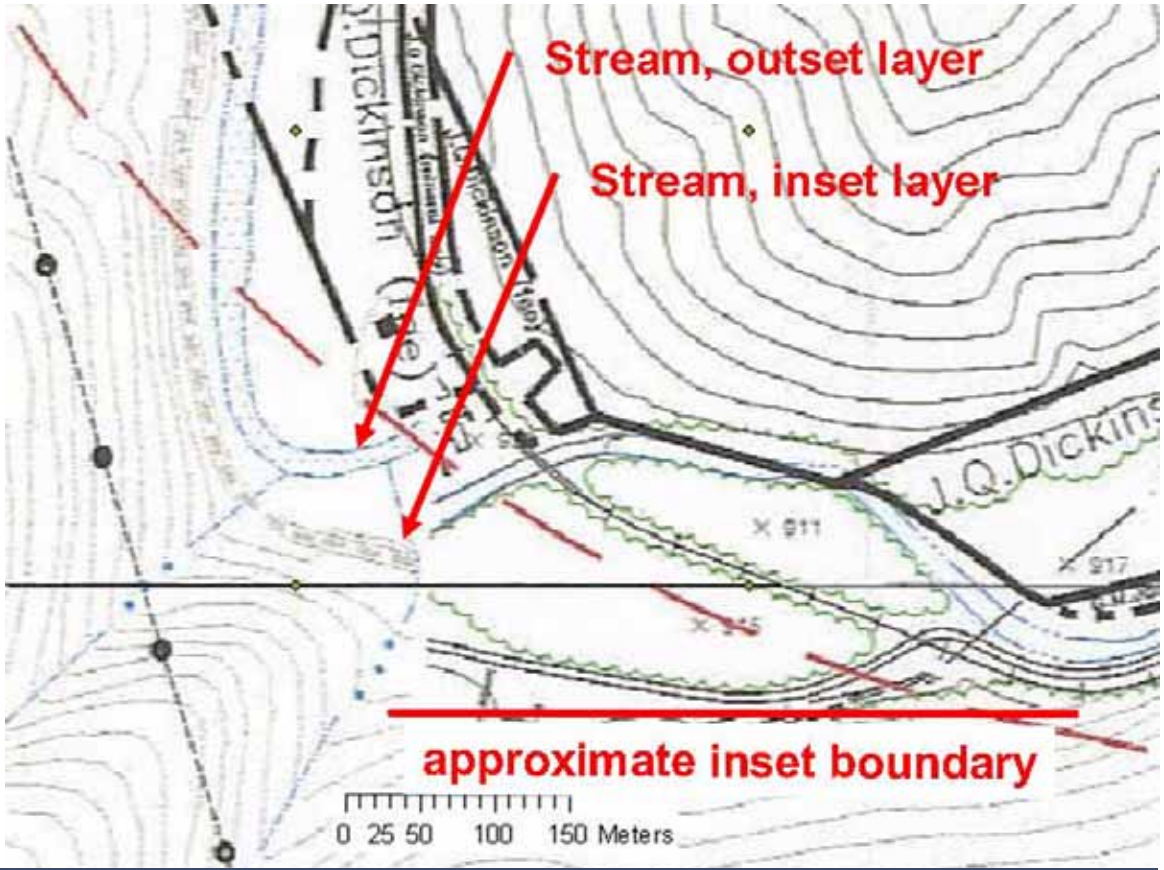
- Map automation errors can be quantified/controlled to some degree → impossible to evaluate overall map accuracy because the **accuracy of the source map** itself **is unknown**.
- The really bad news → this situation did not change with adoption of CAD by the mining industry.
- **CAD added new opportunities for inducing error** → also added a surficial appearance of precision that may not hold up under close scrutiny.

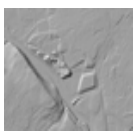
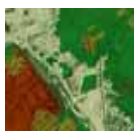
Quad features as backgrounds

2.

- Many CAD maps use digital features found on quads as a background.
- **Misaligned features** can make it difficult to georeference the map precisely
- Casts doubt on the accuracy of the map altogether.



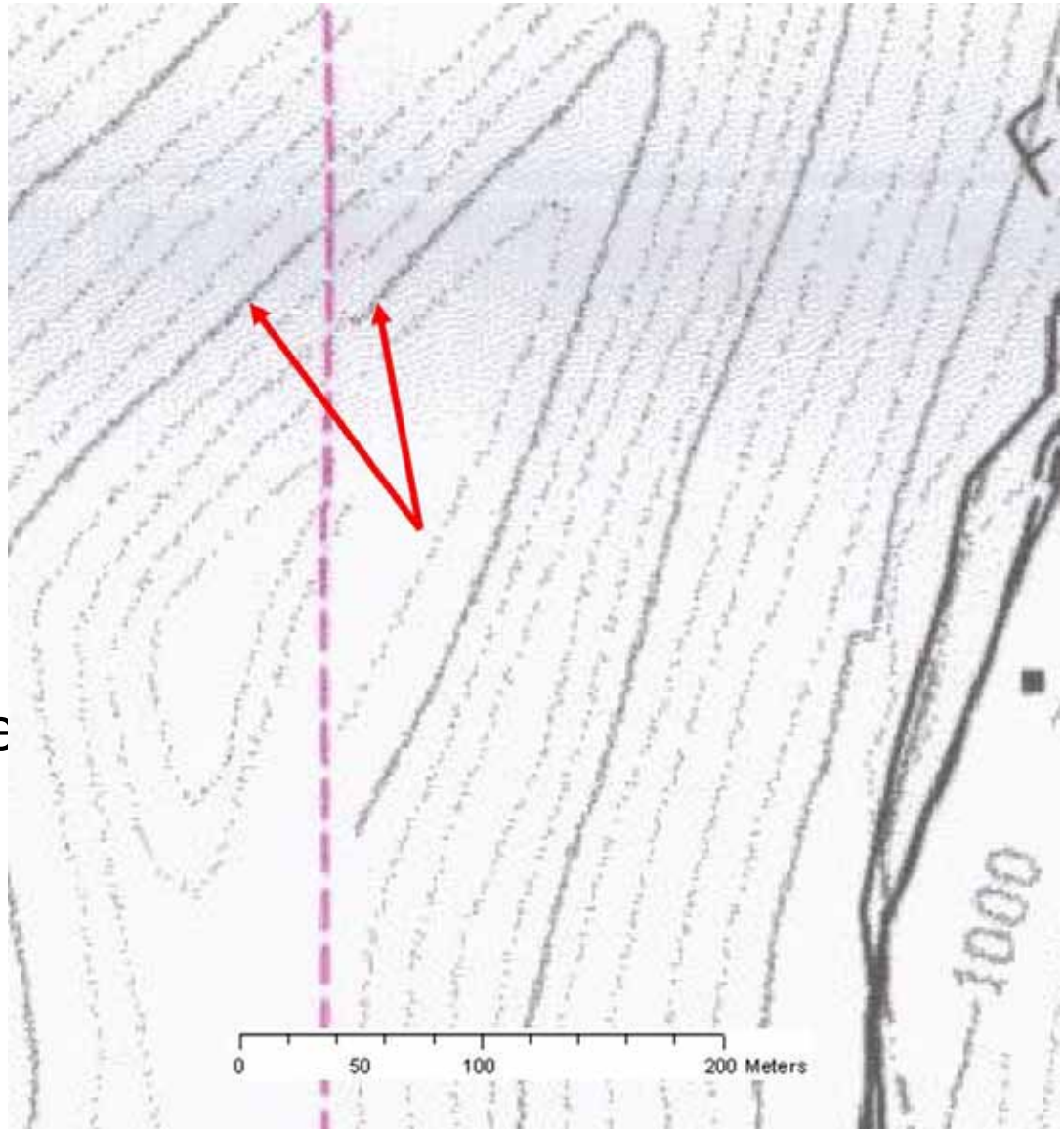
Second data source was used to create an inset in this permit map (figure shows lower left corner of the inset area). Misalignment of the two data sources is obvious in the mismatched location of streams and roads

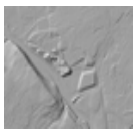
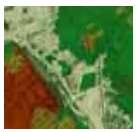



Quad features as backgrounds

2.

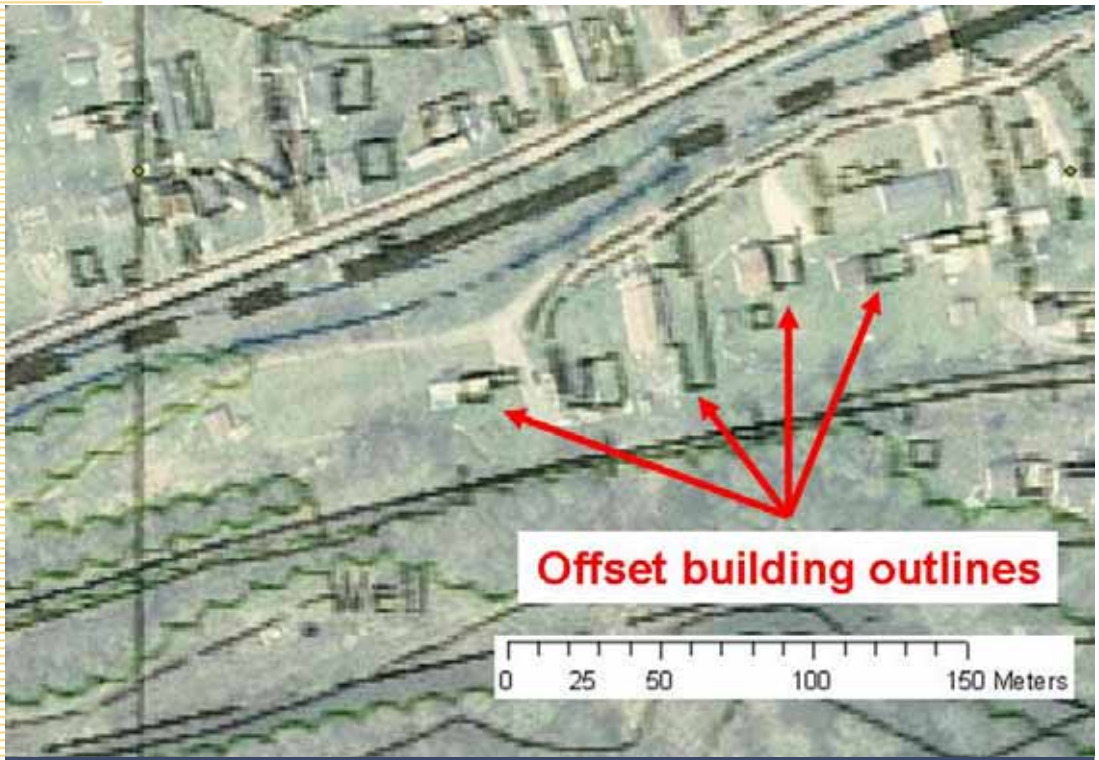
- This permit map requires features from **more than one quad**.
- Example shows mismatched seam between two quads resulting from improper placement of one, or both.
- The map had to be georeferenced by discarding reference features to the right of the seam.



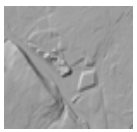
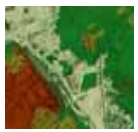
Quad features as backgrounds

2.



Buildings depicted above were offset when the map's coordinate grid was used to georeference it. Eventually, the map grid was discarded in favor of buildings and transportation features.

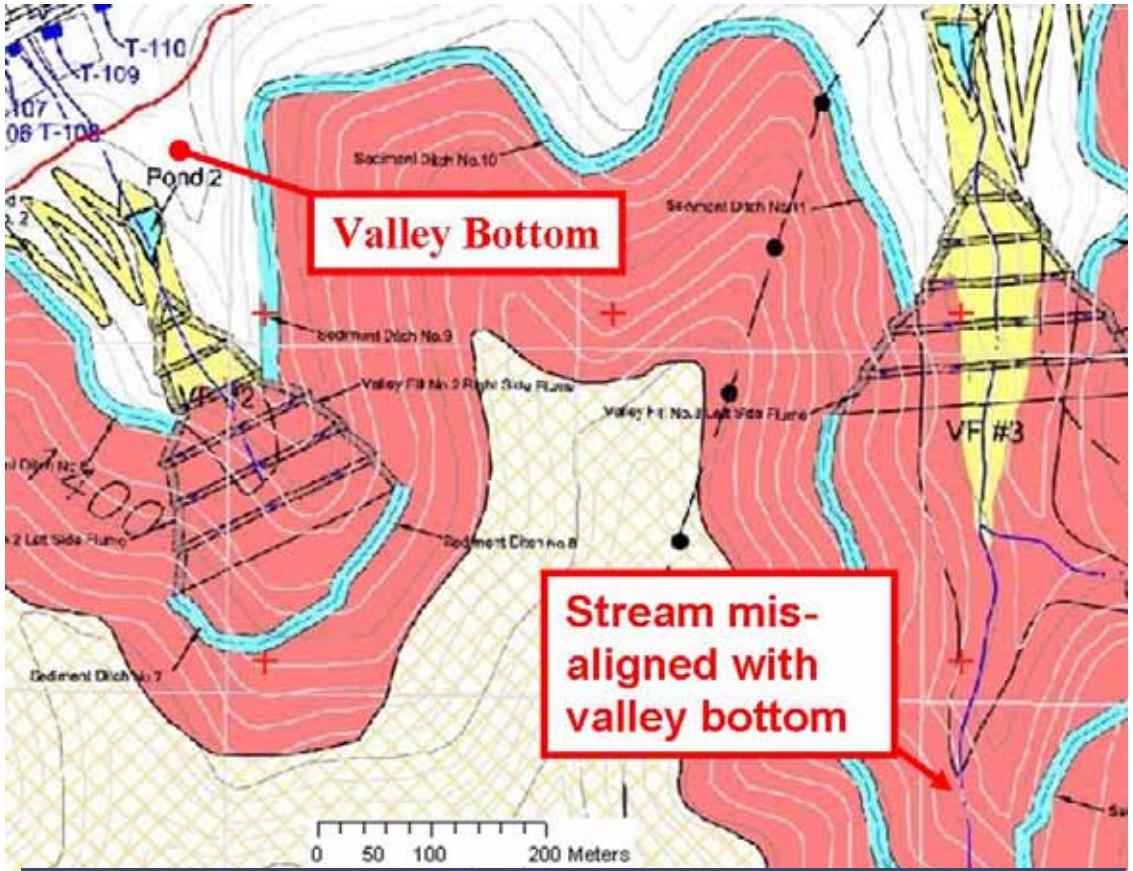
- In the last several years use of coordinate grids, or tic marks, that correspond to a common coordinate system have become more common.
- However, there have been occasions when the placement of the **coordinate grid** itself has **added uncertain**.

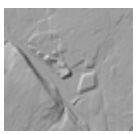
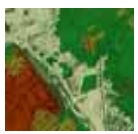
Quad features as backgrounds

2.

- The impact of **misaligned elevation contours** is very pronounced in this example … **valley fills no longer occupy the valley**, and **streams run along the sides of ridges**.
- The sediment control ditches are also badly misaligned.

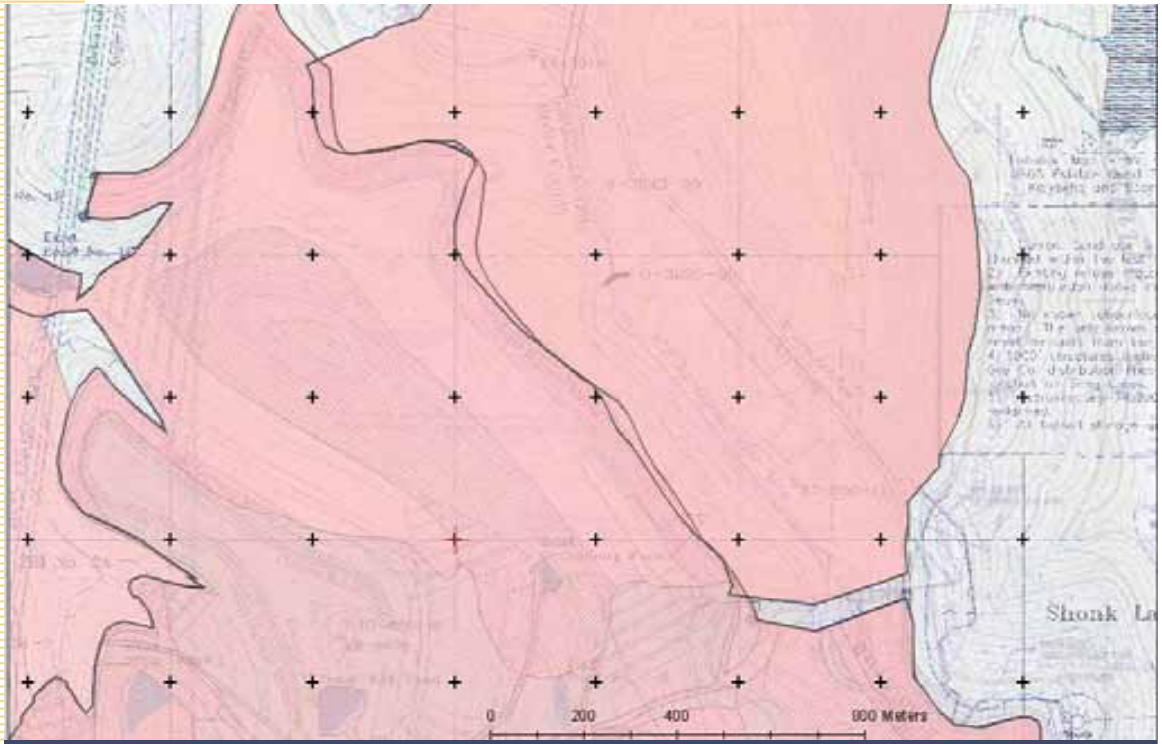


Pretty CAD drawing … but not a map

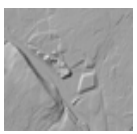
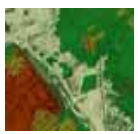
Two permits … same company

2.



Two permits **issued to the same company that share a** common boundary**. Though both permits were** issued on the same day**, maps for the two permits do not depict the boundary in a consistent way.**

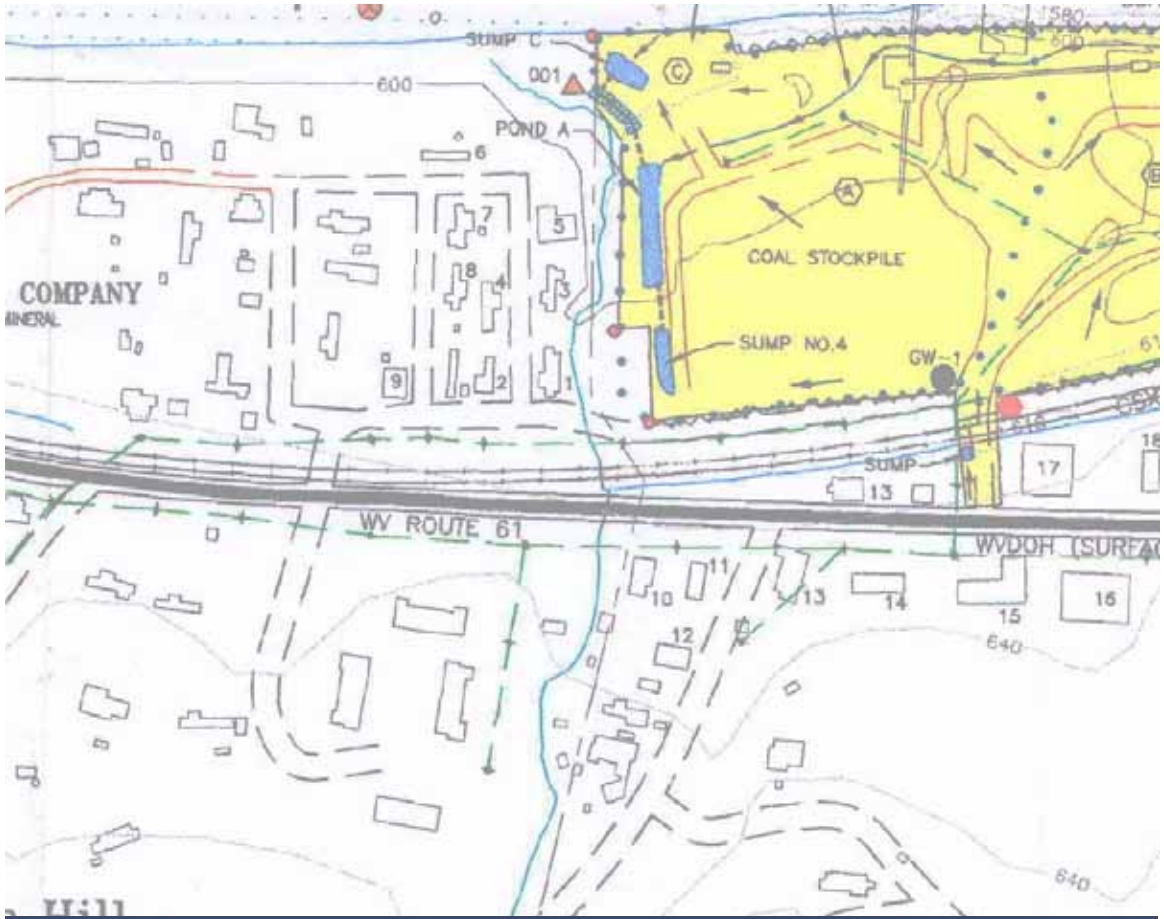
- The previous cases represent errors within a single map that were revealed during georeferencing.
- Other errors can become apparent when maps depict **adjacent operations.**
- Neither map could be judged significantly inferior to the other.

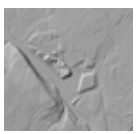
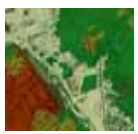
CAD didn't save the day

2.

- It is **just as easy to produce an inaccurate map using CAD** as it is to draw one by hand.
- Figure (right) shows part of a permit map with detailed building outlines created using CAD software.



During the georeferencing process, it became apparent that many structures on this map were not positioned correctly.

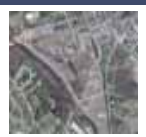
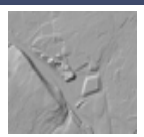



CAD didn't save the day

2.

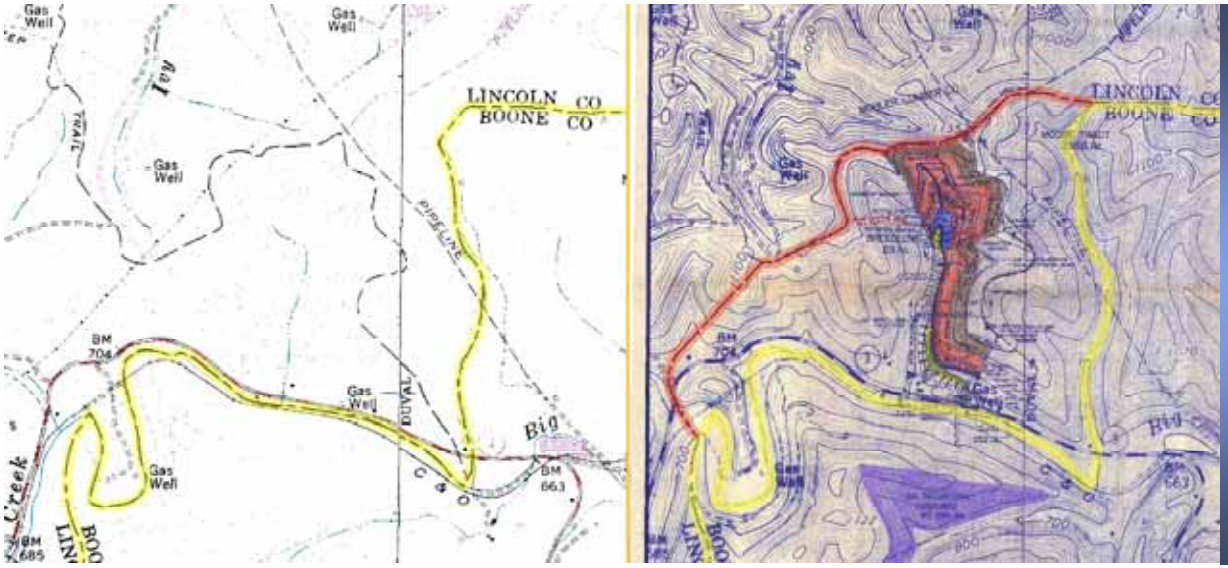
Hopefully, features within the permit boundary are positioned with greater care.

- Same map shown on the previous slide overlaid on an aerial photography basemap.
- Buildings at points **A - D** show **accurate** placement, while **buildings** at points **1 - 4** are **shifted in a variety of directions.**

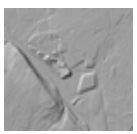
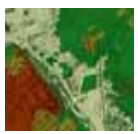
The coup de grâce

2.



True county line between points where the red line revision was made had been skillfully removed prior to submittal of the blueline.

- Left panel is a DRG (colors removed) with the boundary separating two counties highlighted in yellow.
- The right panel shows a map received from the company → county boundary is depicted in **red**.
- No "official" change in the boundary between Boone and Lincoln Counties occurred during the time period this area was mined.

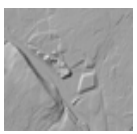
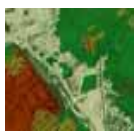
A golden opportunity was lost for a 2006 legislative fix.

3.

- Mining accidents & disasters
  - Recent
    - Martin County
    - Quecreek
    - Sago
    - Aracoma
    - Black Castle
    - A Google search for "mining accident" + map yields **54,100** hits

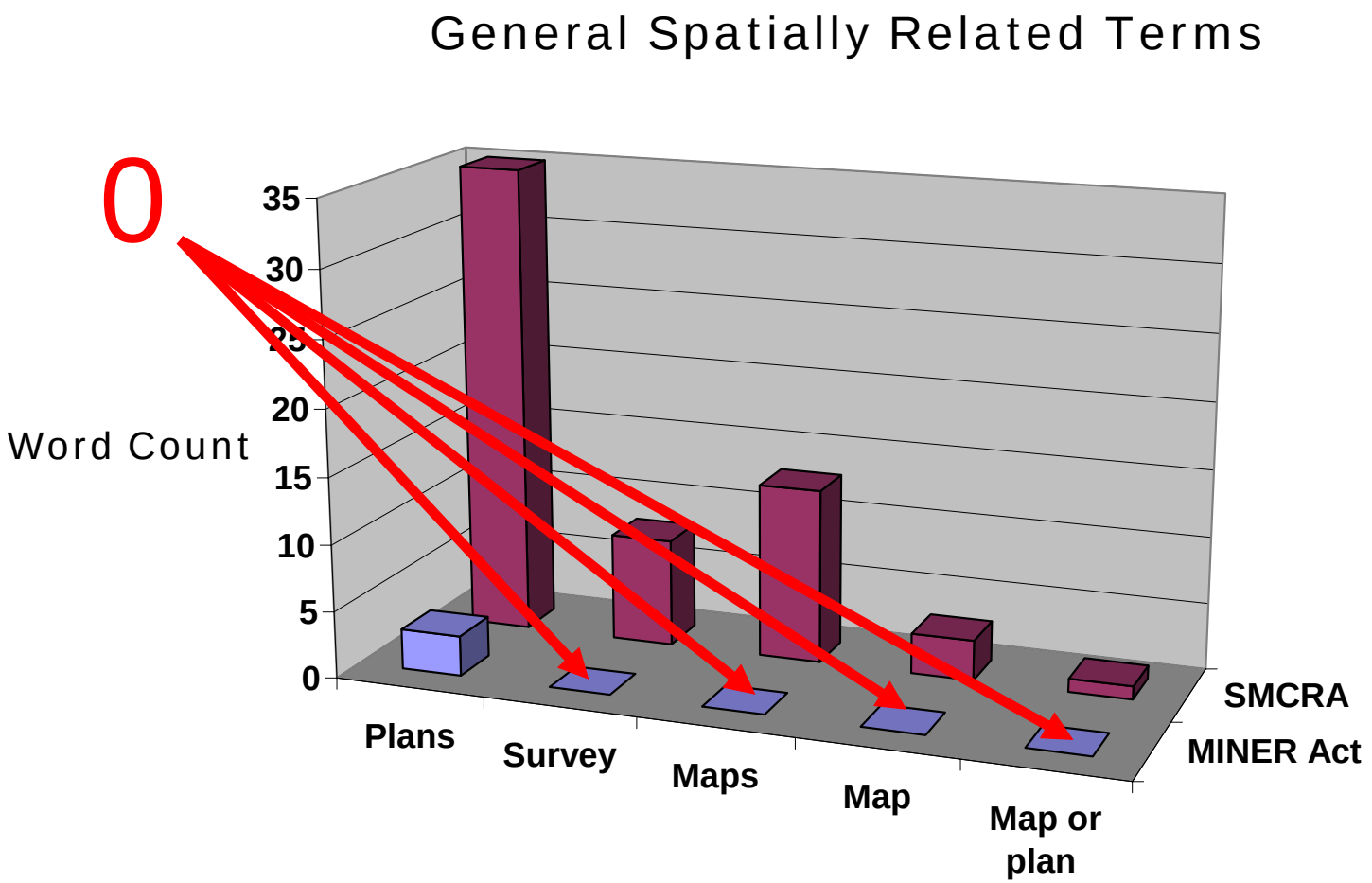
Unfortunately the importance of accurate maps wasn't even on the radar!!

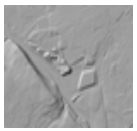
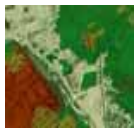
Miner's Act signing ceremony

That conclusion is based on …

3.

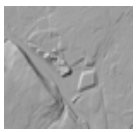
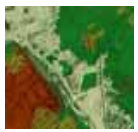


Government inertia

4.

- **Too many State agencies** receiving paper or digital mine maps and produce mining related geospatial datasets with insufficient coordination.
- This is cause for **great inertia** in discovery of cause and effect relationship between antiquated mapping standards/techniques and recent mining accidents and fatalities in West Virginia.
- Both **OSM and MHSA have oversight** of different facets of mining at the federal level, **each has different state partners** in West Virginia.

West Virginia Mine Mapping Geospatial Data Archives

4.

Level of Government	Agency	Abbreviation	Dataset
State	Department of Environmental Protection	DEP	$^{GIS}DEP_1$
State	Office of Miners' Health, Safety & Training	MHST	$^{GIS}MHST_2$
State	Geologic & Economic Survey	GES	$^{GIS}GES_3$
State	Division of Homeland Security & Emergency Response	DHS&EM	$^{GIS}DHS\&EM_4$
State	State Tax Department	TAX	5
Federal	Office of Surface Mining	OSM	$^{GIS}OSM_6$

State Mining Hardcopy & Digital Data Exchanges → Environmental Protection holdings [1]

4.

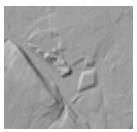
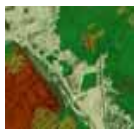
Source Co./ Agency	Source of Data	Mining Data Layers Produced	Exchange Mechanism/ Direction	Mining Data Layer	Database	Agency
Mining Com-panies	Co	Permit boundaries	→	*perbd*	1	DHS&ER
dep	1	Underground extent	→	Mined area	3	GES
dep	1	*perbd*	→		4	MHST
dep	1	*perbd*	→		6	OSM
GES	3	Coal beds	→		1	MHST

Legend: Co Paper maps; 1 GIS; Sneakernet; Mirror; ET

Conclusions

5.

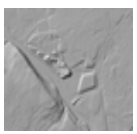
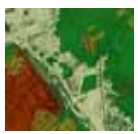
- A cause & effect exists between antiquated mapping standards/techniques & recent mining tragedies.
- Paper maps provide problematic geospatial information in the permitting process.
- CAD did NOT solve map quality issues.
- SMCRA's mapping requirements are tied to last millennium's technologies … no geospatial "best practices" language.
- No legislative progress on geospatial issues between SMCRA and the MINER Act.
- Passage of the MINER Act was a golden opportunity to fix map quality issues → opportunity went unrealized.
- Mining geospatial information is very important in both state and federal regulatory decision making processes.
- Exchange (state ←→ federal) of mining geospatial data remains mostly sneakernet with excessively long refresh cycles.

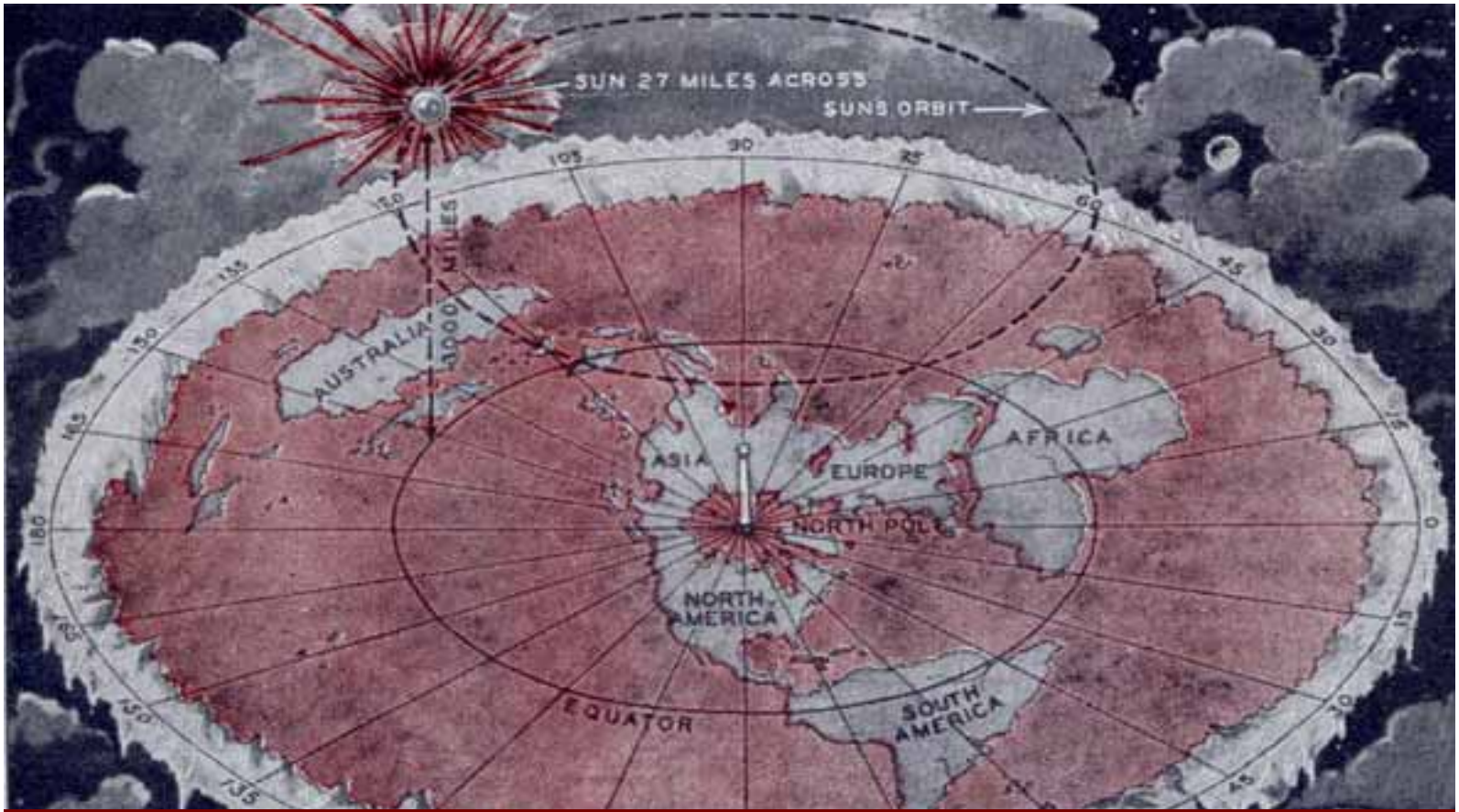
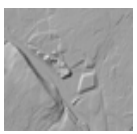
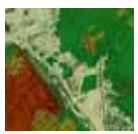
Recommendations for future legislation

5.

- **Only digitally** permit **mapping** accepted.
- Digital mining maps should be composed of **data layers for inclusion in a national coal mining GIS**.
- **Accuracy/precision standards** for national coal mining layers should reflect current **best practices** (now and future) → no significant additional cost to industry.
- Submitted **layers accessible** by regulators, the mining industry, oil and gas extraction interests, etc.
- Due diligence (geospatial data quality) given to **document**ing **underground mined areas** to prevent blowouts, impoundment failures, flooding from adjacent works, etc.
- **Surface survey control** of underground mines must be extended **along** the **axis of** progressing **mining**.
- **National mining geospatial datasets + personal location technology + mine site thermal and gas sensors =** best route to exit a mine.

The end



Voliva's flat world with the North Pole in the center and the sun revolving in its orbit above the equator. A wall of ice around the edge keeps mariners from falling off in space.