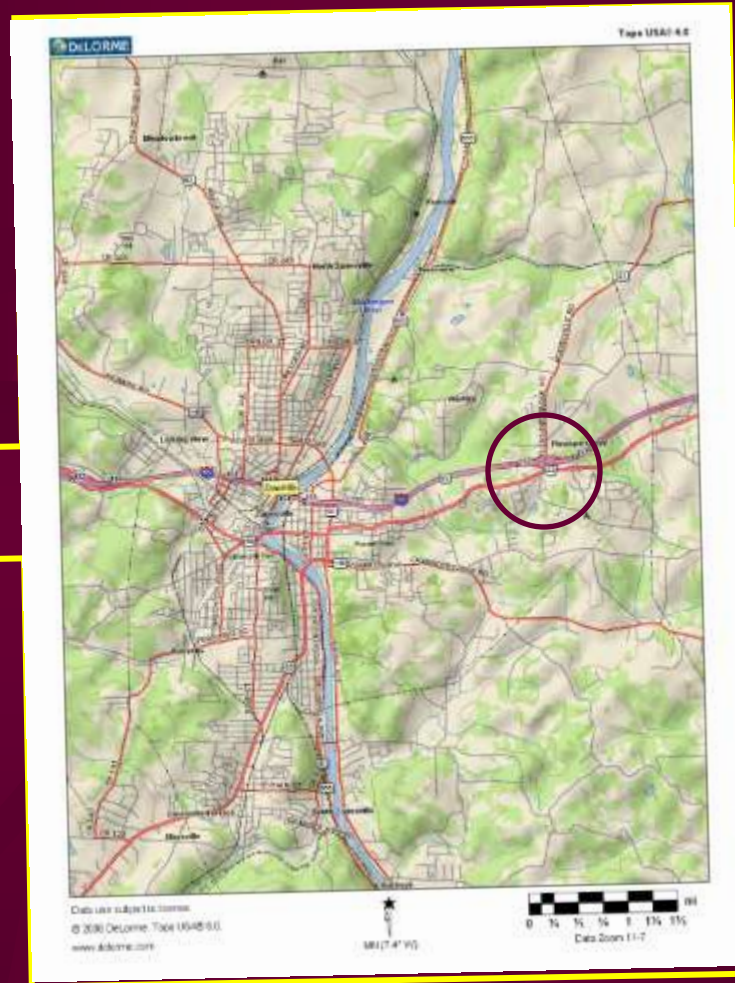
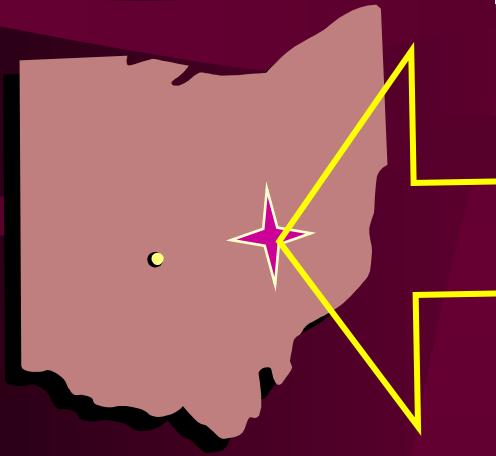


MUS-93-12.84
Mine Grouting Project

A Straightforward Enigma

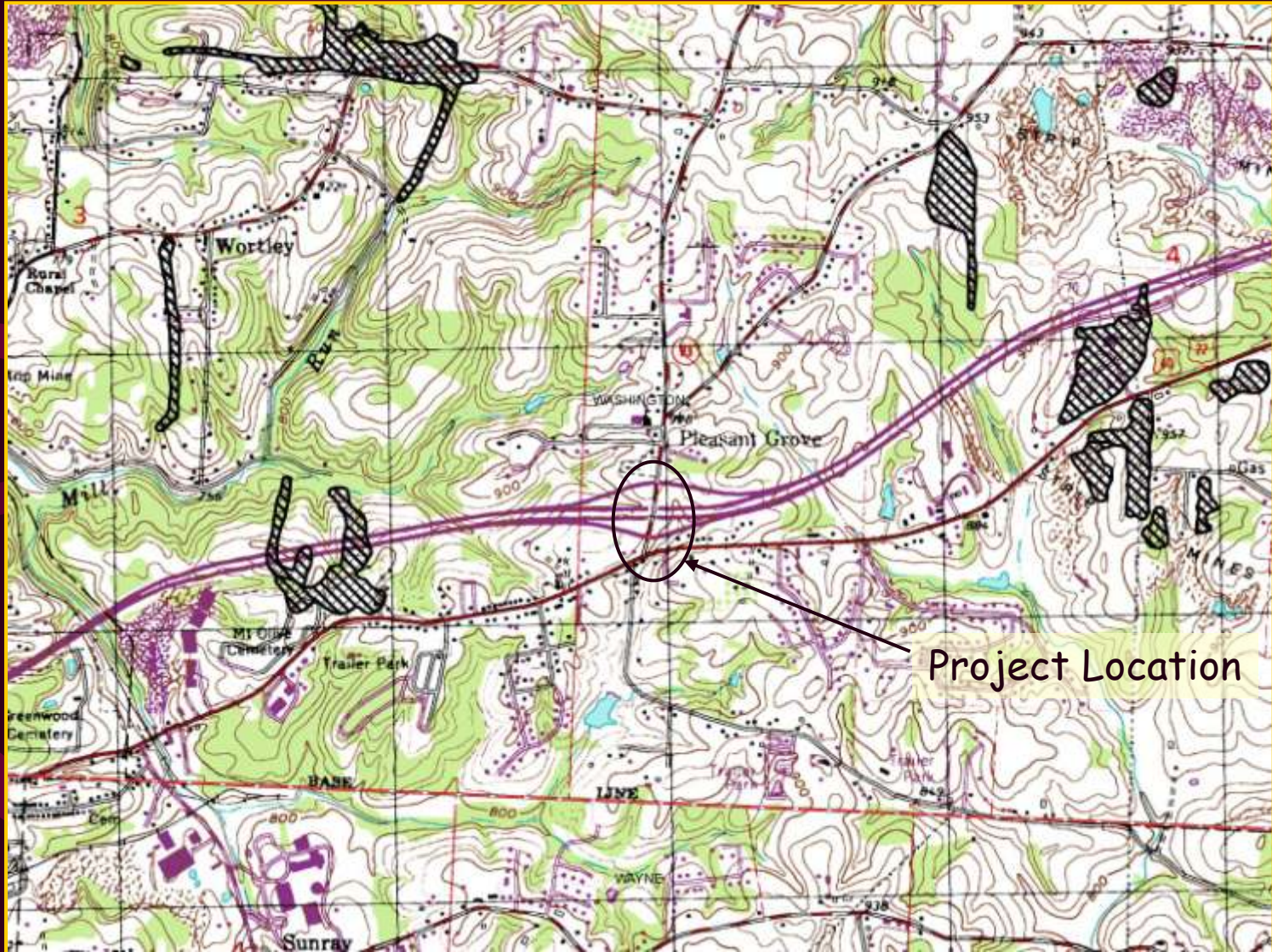
Project Location



Project Aerial Photo



Local AML Map



Mine Data (Real & Imagined)

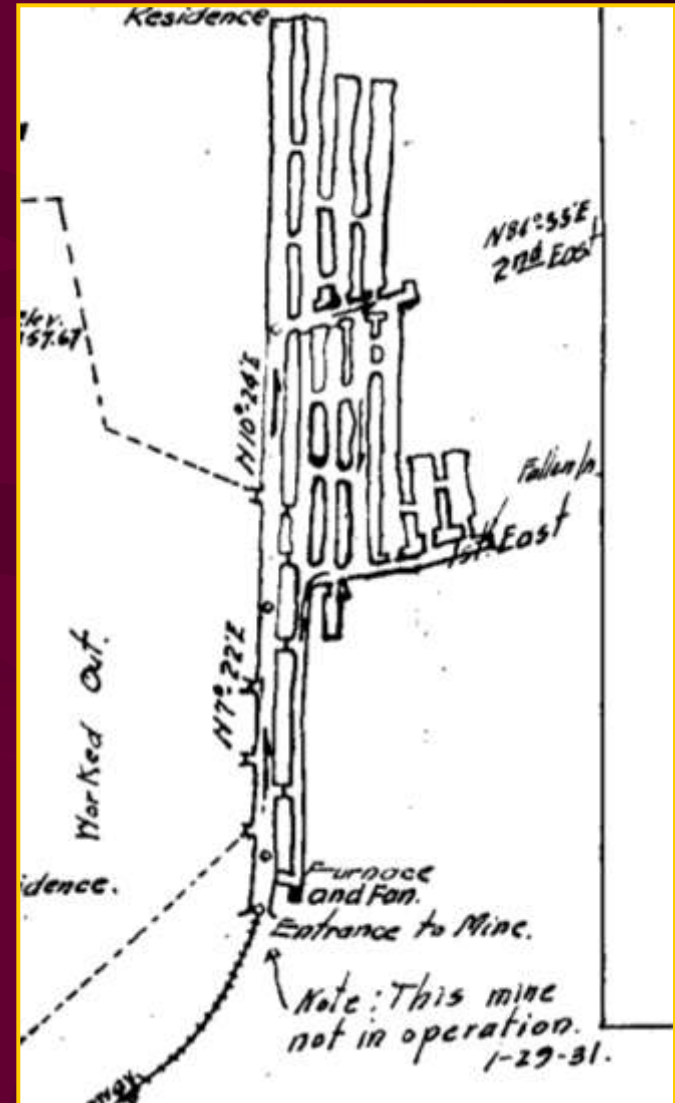
- No Site Specific Mine Map.
- Likely the No.7, Upper Freeport Coal.
- The mapped mines are drift mines.
- Drift entries advance into the coal seam in the head of tributary valleys.
- Shallow Cover

Mine Data (Real & Imagined)

- All of the local mines were abandoned prior to mechanization, circa 1930's.
- Most exhibit pre-mechanization mining features, i.e.,
 - Long, Narrow Rooms & Pillars (5-6 foot widths),
 - \pm 50% Extraction,
 - Rooms Driven on the Face Cleat,
 - No retreat or second mining.

Ex. Mine Map (1.0 mi. east of MUS-93 project)

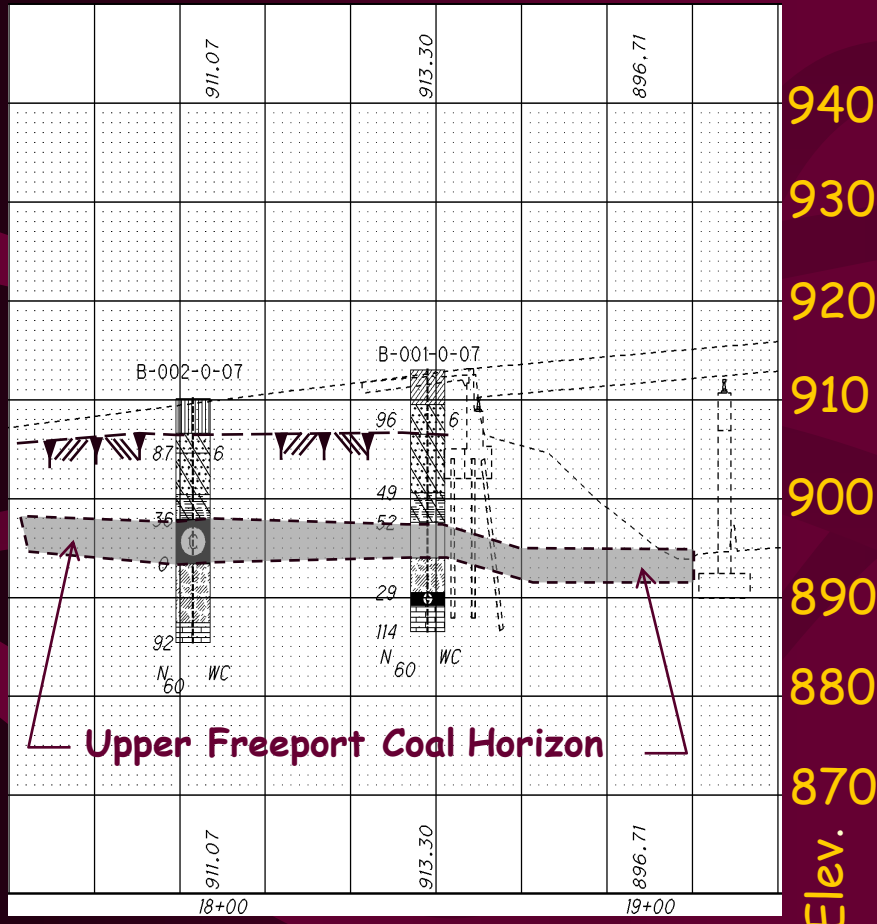
- Rooms driven on Face Cleat, N84°W.
- Long, Narrow Pillars.
- No Second (retreat) mining.
- Coal Elev. 858.0±; 30 ft. below MUS-93 site (El. 890.0).
- Drift entry from valley outcrop.



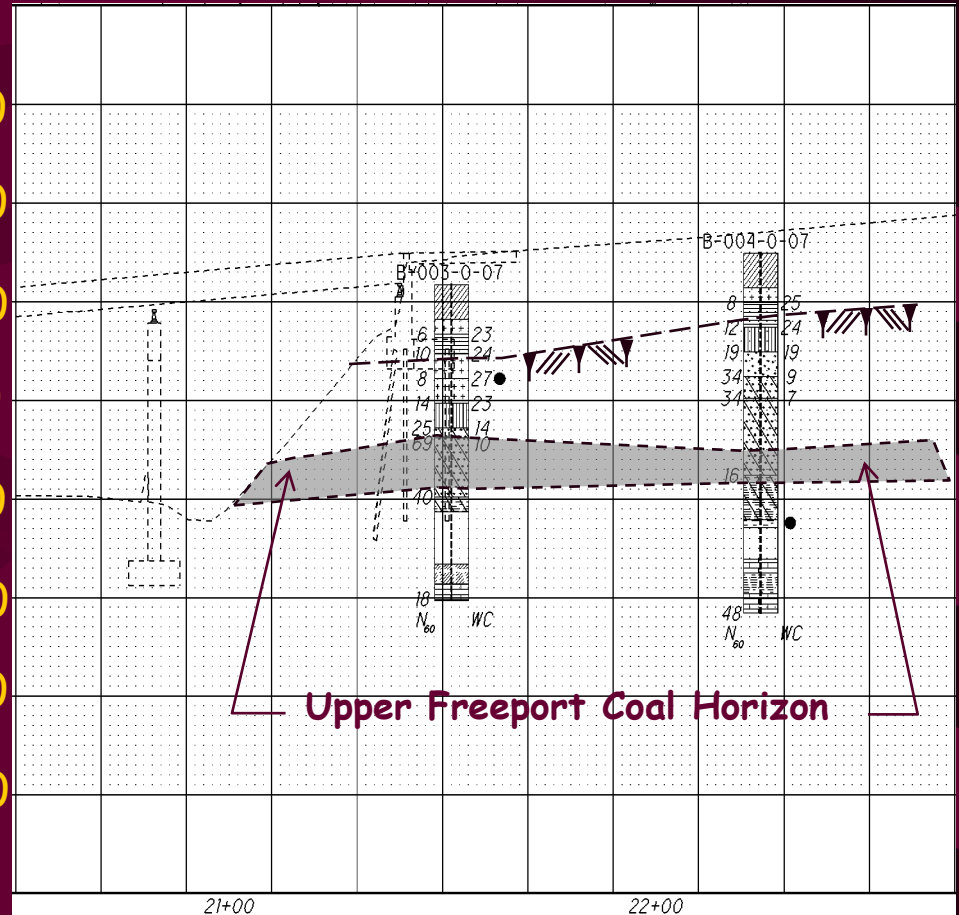
Background

- The abandoned coal mine was encountered during the I70 mainline excavation.
- Decision was made to excavate the workings under the mainline, fill and grade exposures in the cut slopes, and support the SR 93 bridge abutments on pile foundations.

Geologic X-Sections

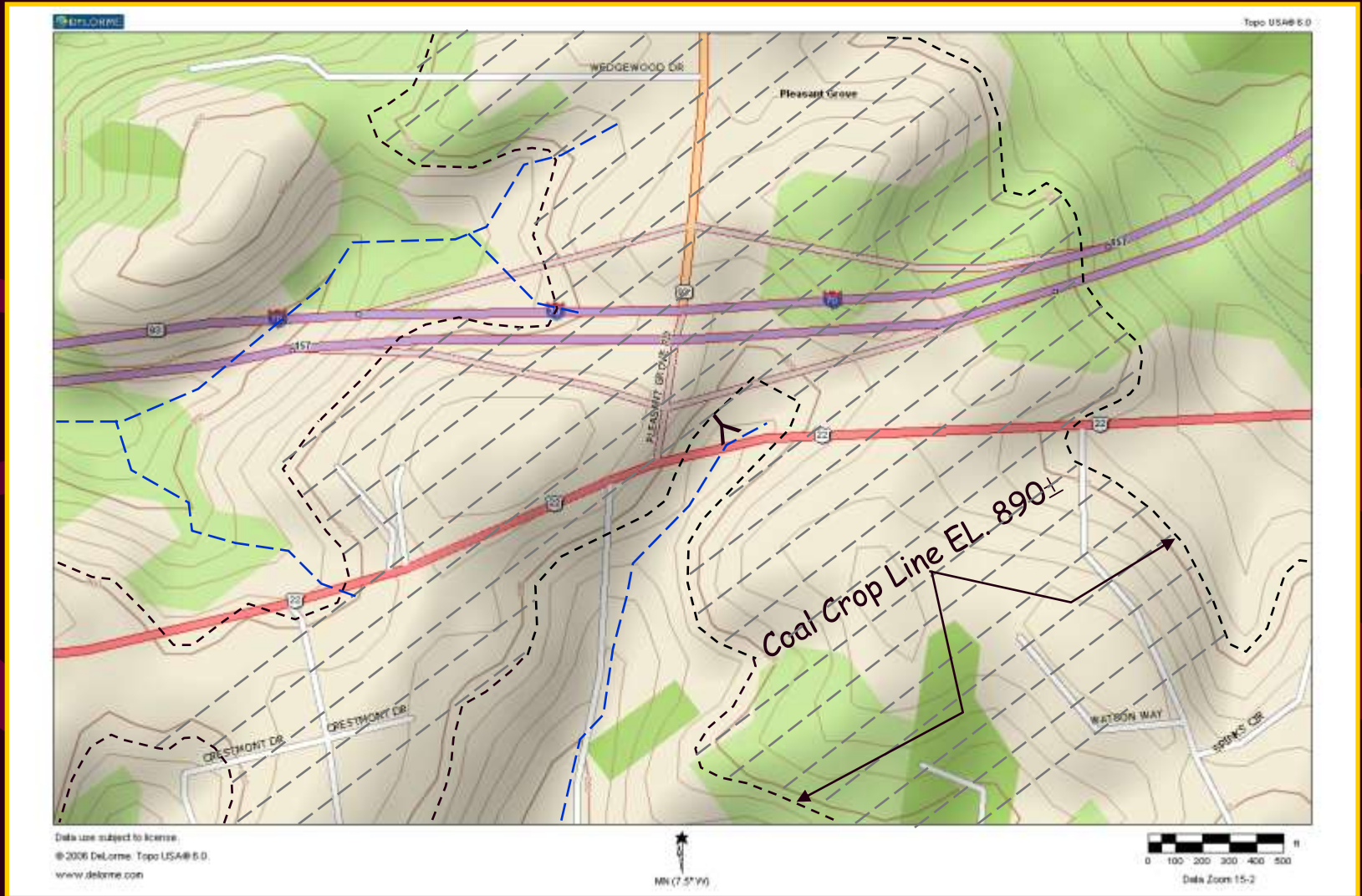


Rear Abutment



Forward Abutment

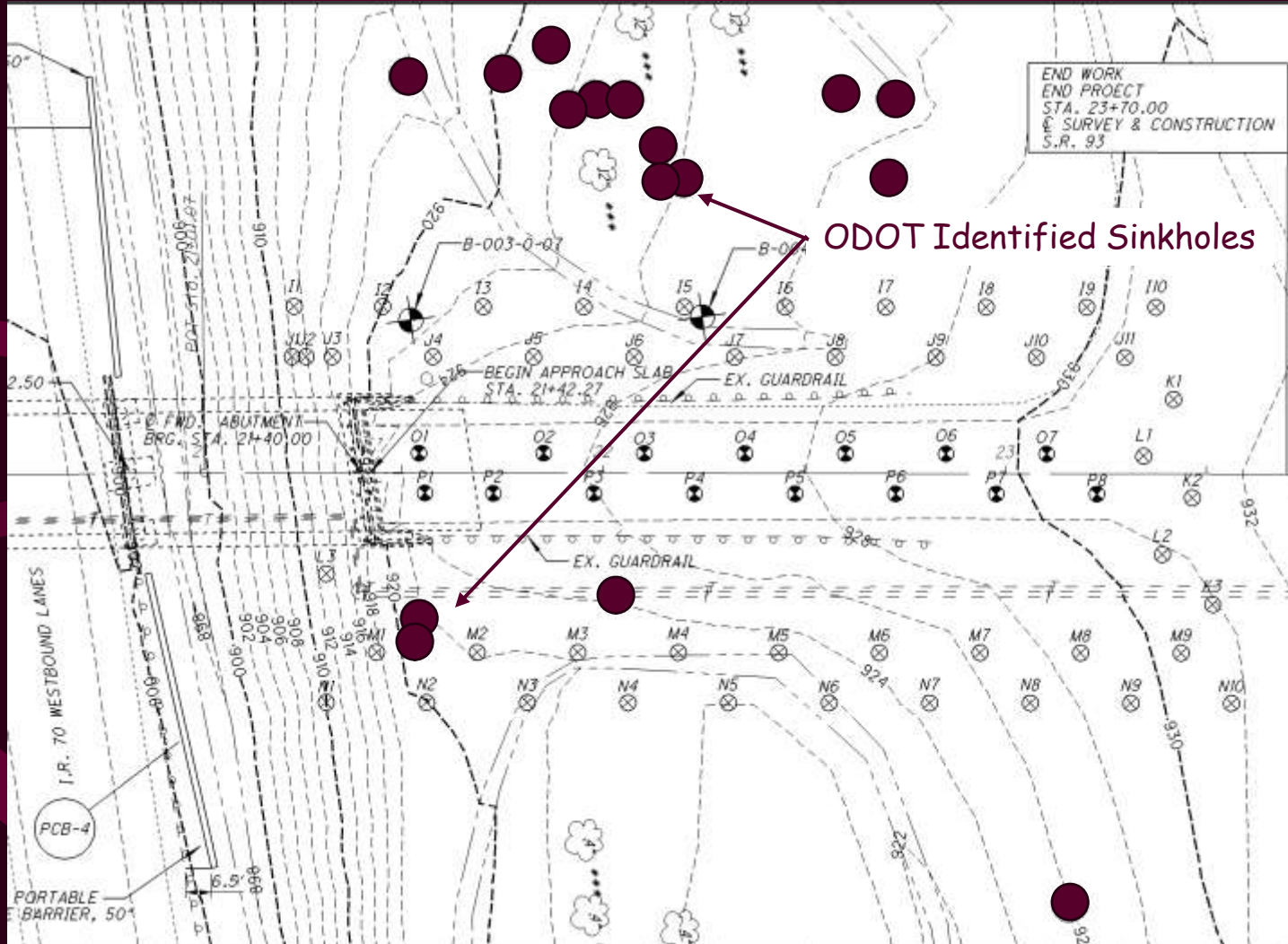
Coal Extent



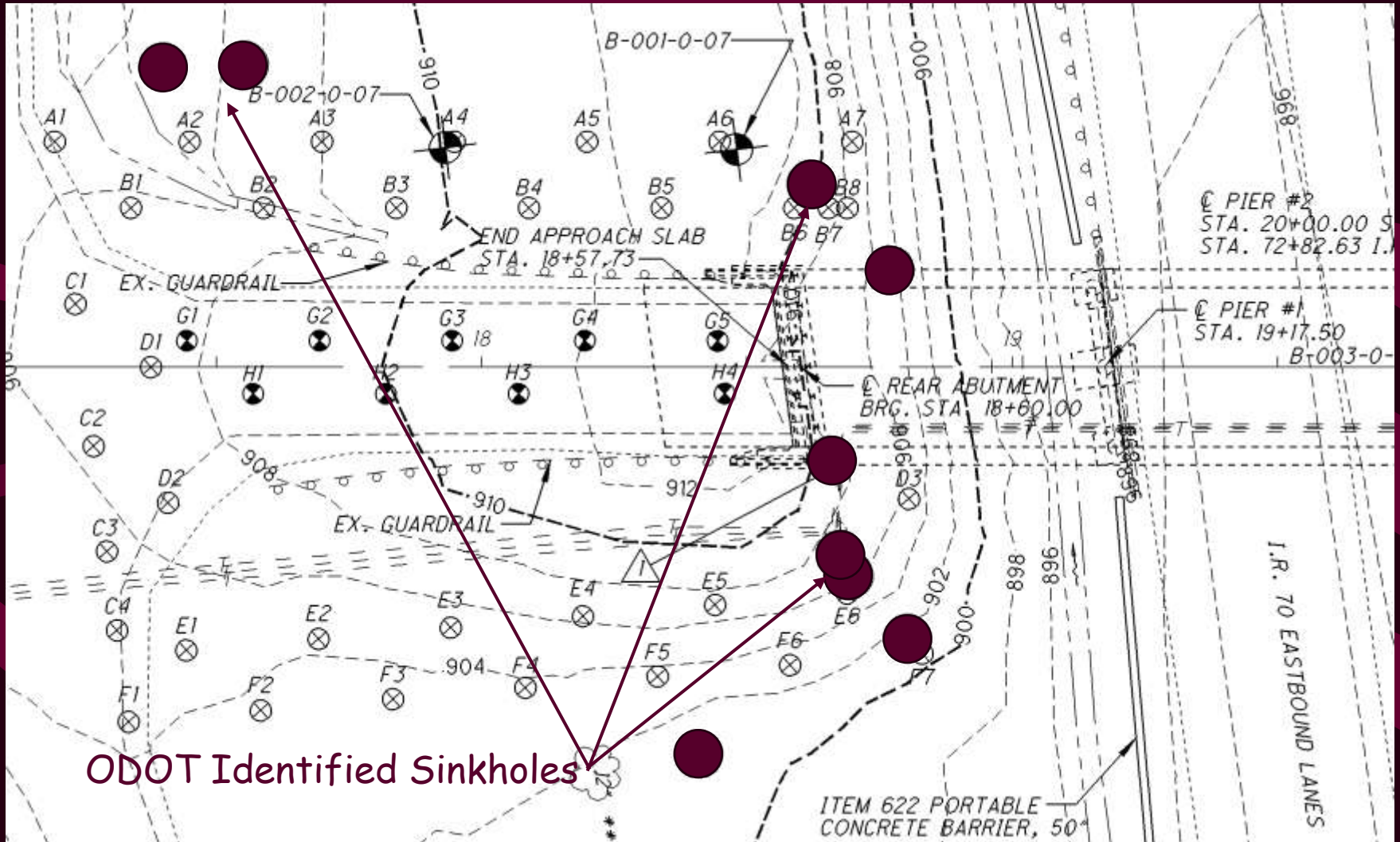
Project Scope

- The project consists of stabilizing the subgrade under the bridge approaches, structure abutments, and mainline SR 93 by drilling and grouting barrier holes adjacent to the roadway and structure, drilling and grouting production holes through the highway, and drilling relief or dewatering holes as needed.

Forward Abutment Sinkholes



Rear Abutment Sinkholes



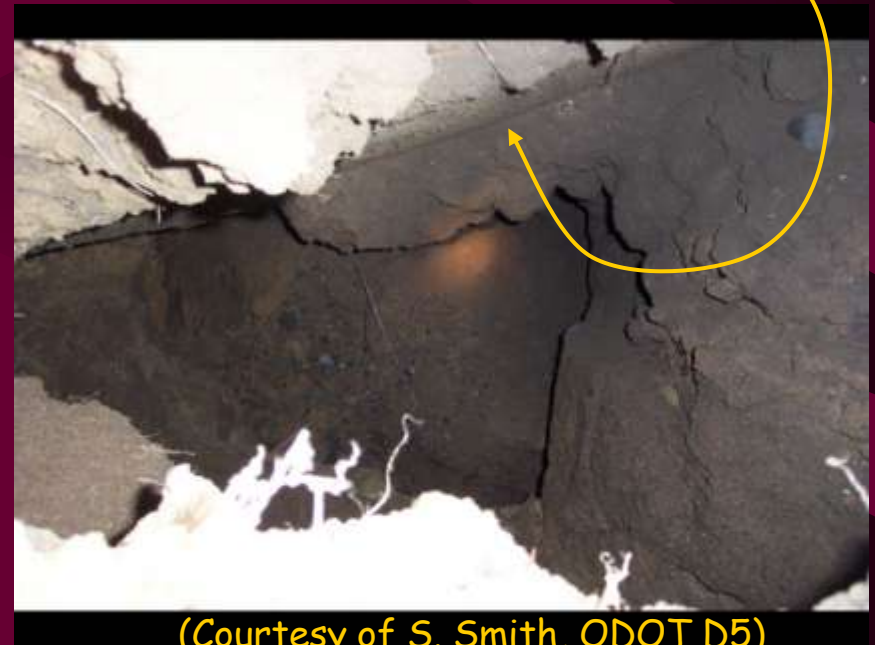
ODOT Identified Sinkholes

Rear Abutment Sinkhole



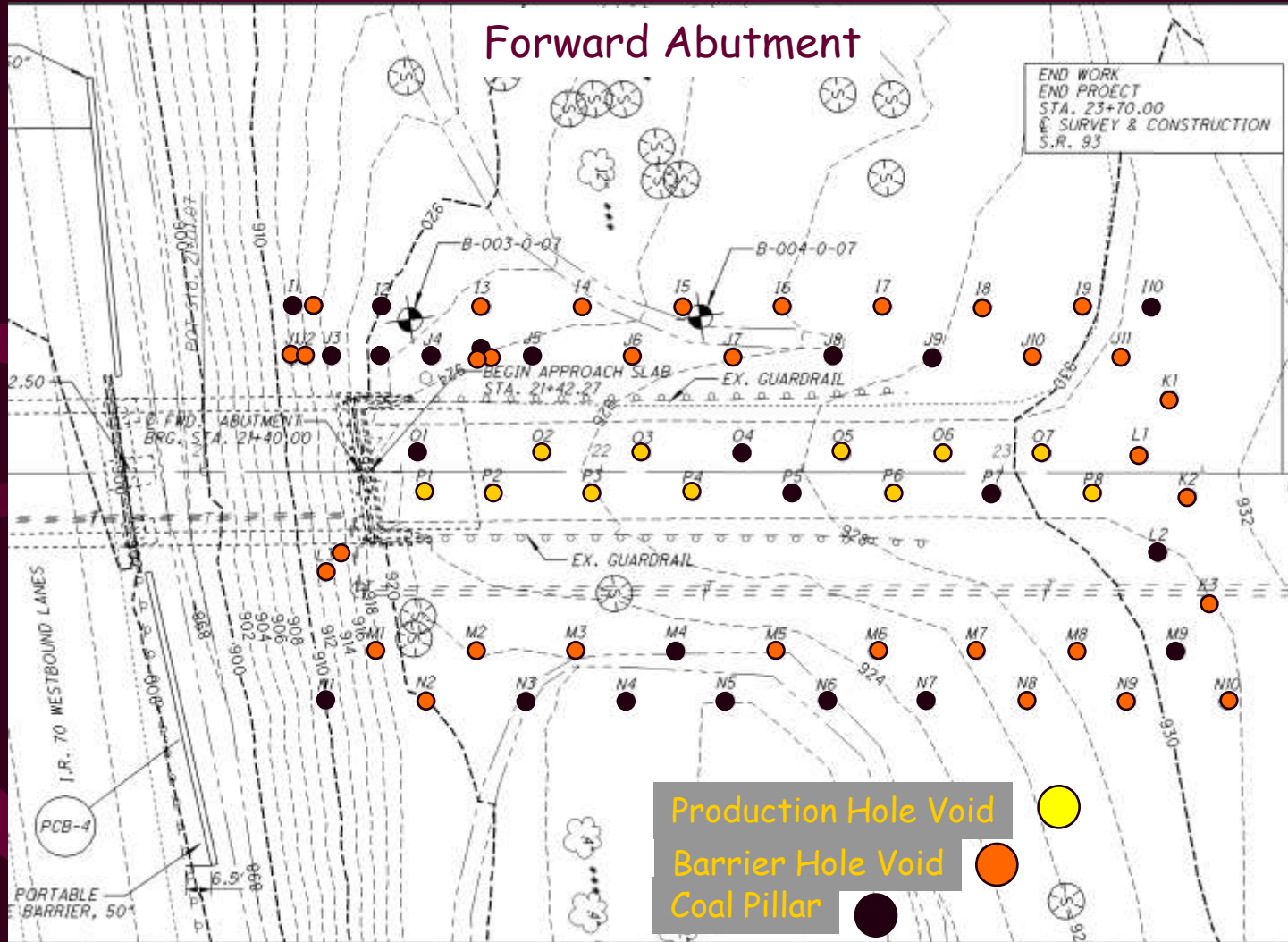
(Courtesy of S. Smith, ODOT D5)

Photo taken inside sinkhole,
note abutment wall.

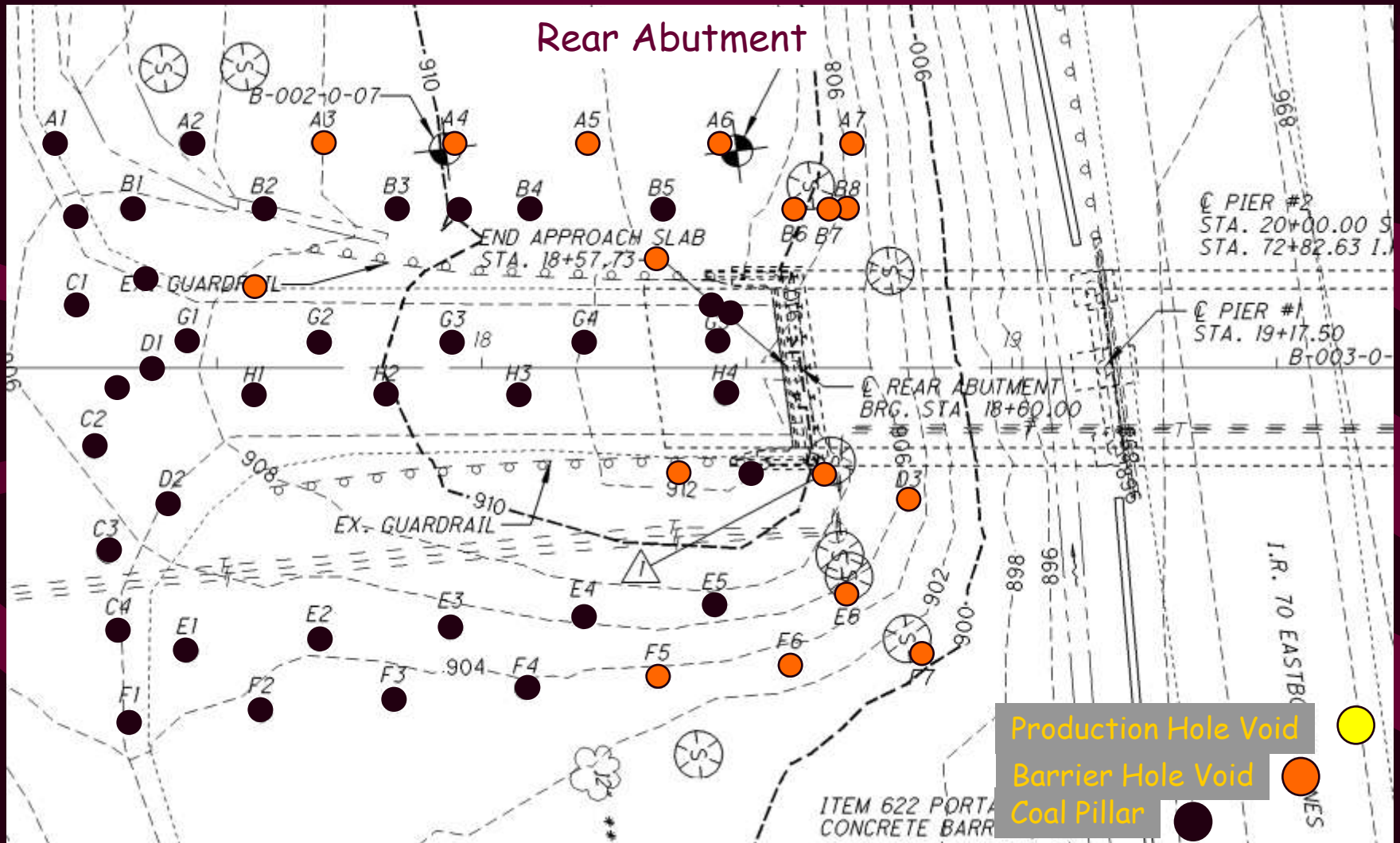


(Courtesy of S. Smith, ODOT D5)

Grouting Plan/Results



Grouting Plan/Results



Project Stats

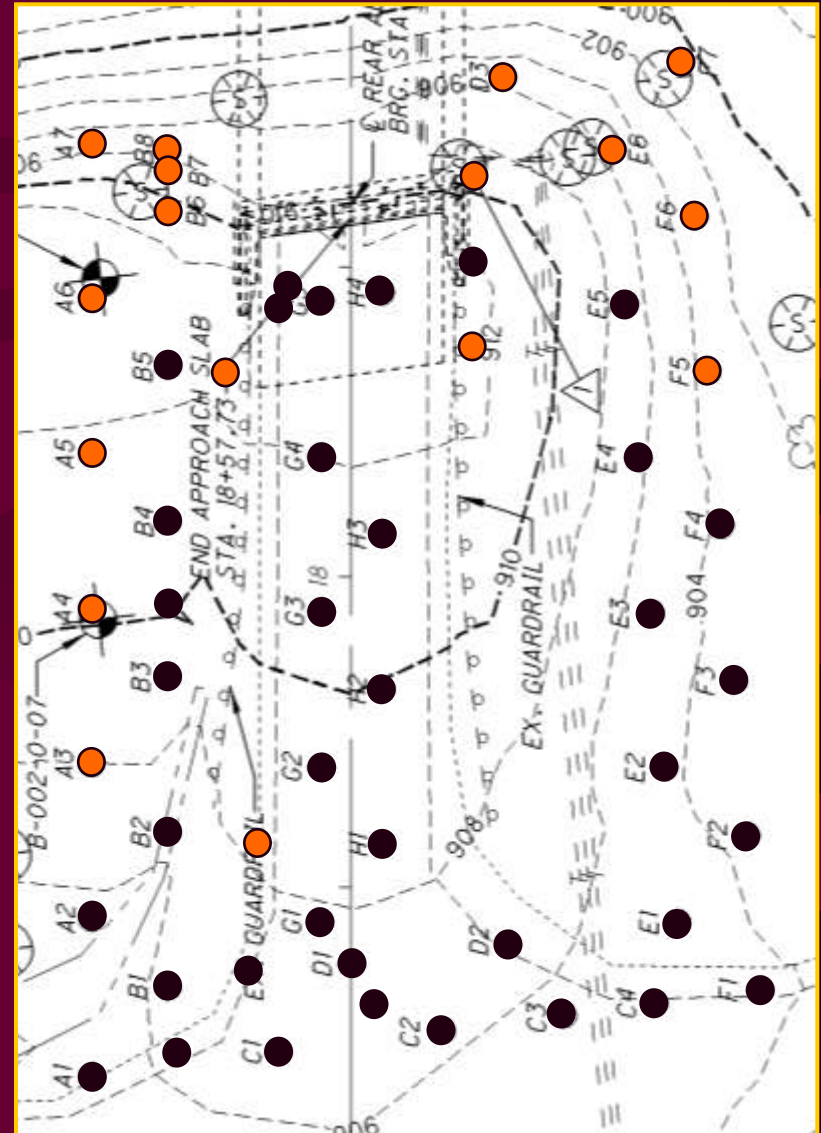
- Drilled 2,000 If injection holes.
- Placed about 2,000CY of Barrier Grout.
- Placed about 250 CY of Production grout (virtually all on the north side).
- Began project Feb 14th, completed Mar 4th.

Enigmatic Anomaly #1

"Puzzling"

"Departure from Normal"

- North side I70 lots of open voids, South side mostly coal.
- Proximity to crop line and shallow cover contribute to poor roof stability.
- Proximity to probable entrance, more coal left insitu.

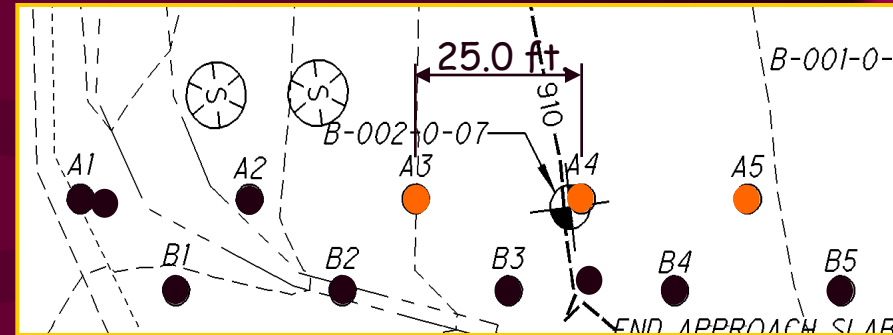


Enigmatic Anomaly #2

- Mine workings on the north side were "flooded", south side workings were "dry".
- Originally presumed a regional W-E geologic dip; drilling revealed a N-S dip.
- Unsure if mine was above or below GWT.
- Construction fill on I70 Cut slopes acted to dam water on North side.
- Greater aerial extent of mine workings (> volume) on the north side of I70 to collect more infiltrated groundwater..

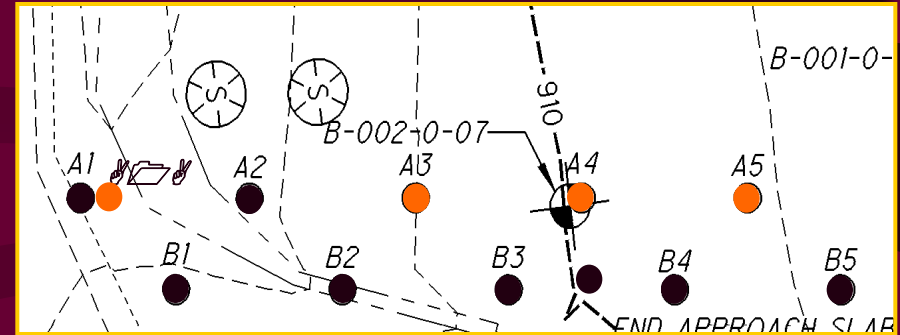
Enigmatic Anomaly #3

- A3 & A4 both encountered voids at 898.0 and 900.7, respectively. A3 was open 5 feet and full of water; A4 was open 5 feet and dry.
- Put light source in A3 could not see from A4.
- Borehole camera could see towards A3.
- A3 took 18 CY grout; A4 took 58 CY grout.
- Miners could have used soil to block rooms for ventilation control since this section of the mine was near the crop line.
- Possible collapse, but drilled like insitu material.



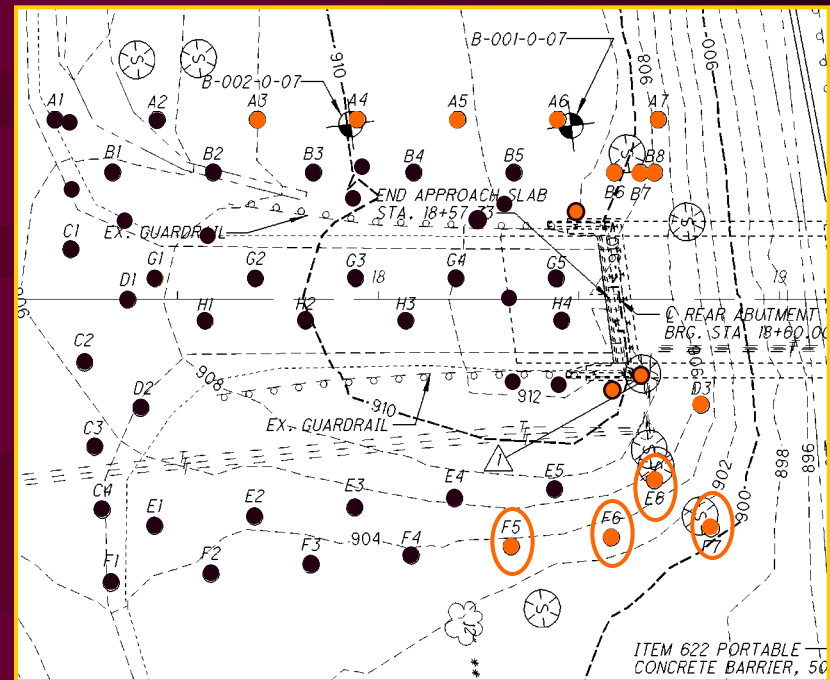
Enigmatic Anomaly #4

- A1 hit a coal pillar. A1A encountered a void. As soon as drill tools removed hole, hole would squeeze in with a highly plastic soil material. A1A was drilled out 3 times, same result.
- 9 feet of rock was drilled before encountering the void.
- Backfilled soil has become saturated enough to be at/near the liquid limit so as to act as a pseudo-liquid?
- Grout could not displace the "mud", virtually no take.



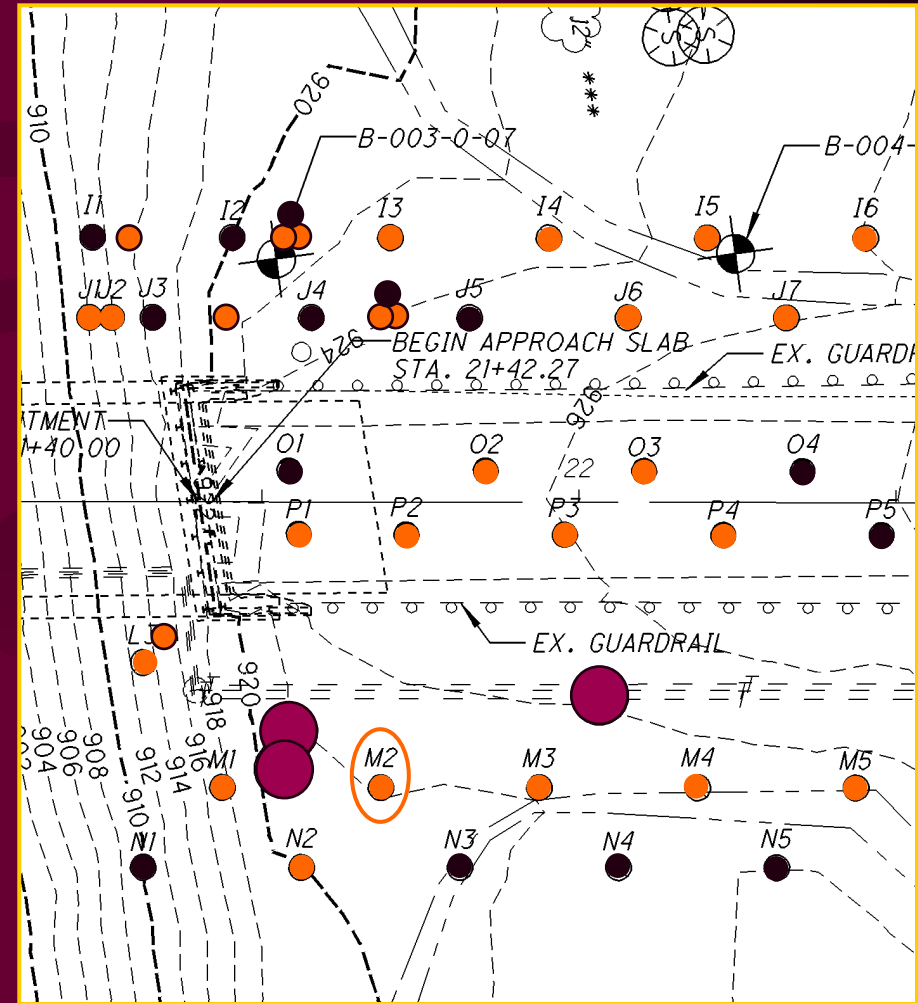
Enigmatic Anomaly #5

- E6, F5, F6, F7 encounter void 4 to 5 feet height but the camera inspection showed about 0.8 ft of open void and relatively horizontal soil backfill.
- This backfill was not as 'fluid' as that encountered in A1A.
- Whether the backfill was contemporaneous with the mining or part of the Interstate construction is unclear.



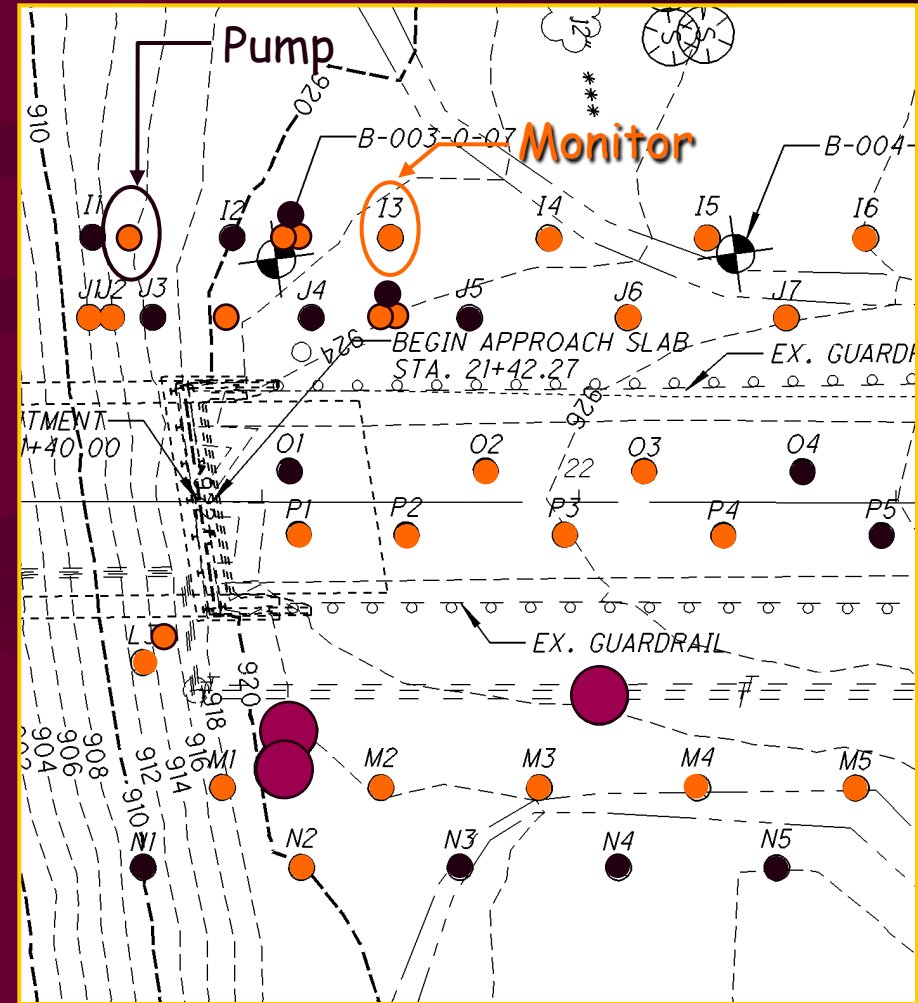
Enigmatic Anomaly #6

- M2 was drilled with 8-inch diameter air rig which never encountered rock. However, when grouted it took over 68 CY.
- Camera inspection suggested soil walls thru the bottom of mine elevation.
- Area likely a previous collapsed backfilled with soil or a backfilled air or water shaft.



Enigmatic Anomaly #7

- Pump Test in I1A, monitored in I3. 4-inch Godwin, CD100M operating at 1900 rpm (710 gpm).
- Pumped for 88 minutes. Obtained a drawdown of 0.3 ft (30 min/0.1 ft).
- Wanted to drawdown pool ± 2 ft. (10 hrs.) so grout injection wouldn't overpressure the mine pool.
- 12 hours later the pump was sucking air.



Enigmatic Anomaly #7

- Hadn't Drilled entire North side to realize the local N-S dip.
- Mine floor at the pump was about 18' higher than surrounding mine.
- Proved that mine was above the regional GWT.

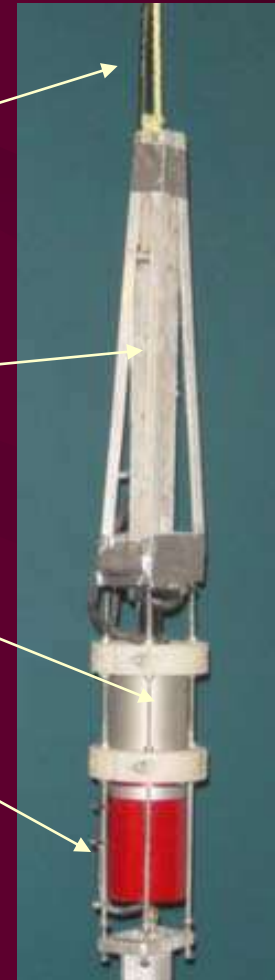
Workhorse Technologies



(Courtesy Workhorse Technologies, LLC.)

Wet Ferret Sonar

- "WET FERRET" sonar unit consist of ...
 - Tether
 - Support Frame
 - Sonar Profiling Unit
 - Underwater Camera

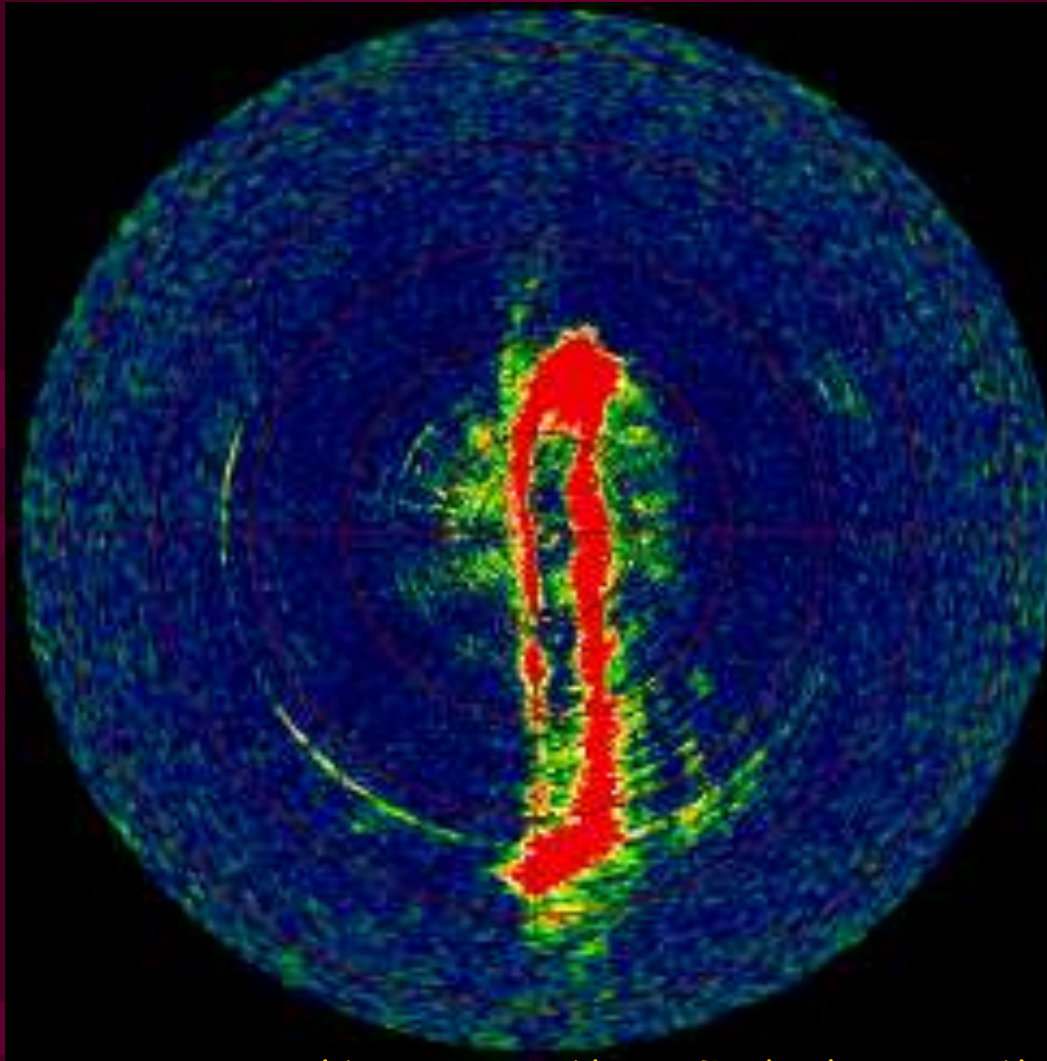


(Courtesy Workhorse Technologies, LLC.)

Sonar Applicable Conditions

- Accessible through 6-inch diameter boreholes.
- Flooded voids or at least 3 ft. of water covering unit.
- Clear to low turbidity water.
- Unit makes thousands of 3D measurements in minutes.
- Produces highly accurate volumetric calculations.
- Unit referenced to ground control for accurate plan display of results.
- Produces plan, orthogonal, and x-section views.

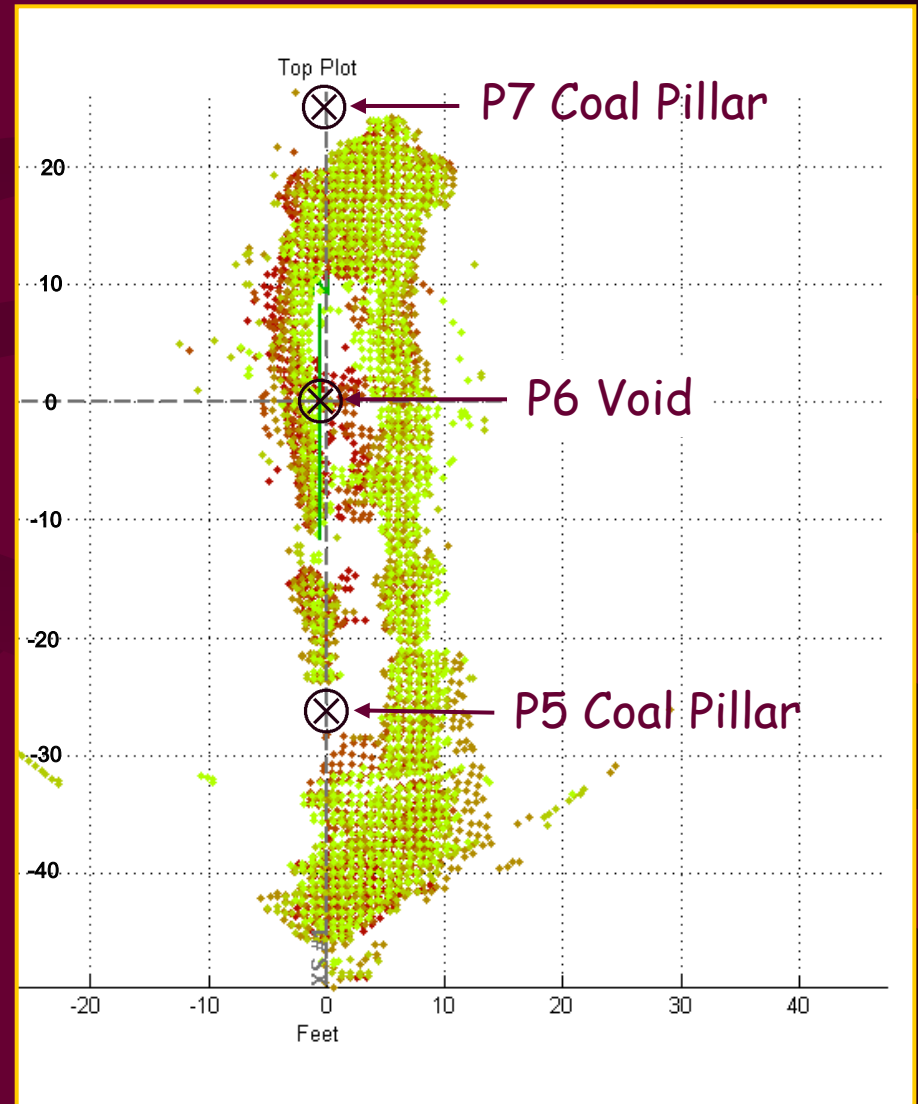
Field Screen Capture



(Courtesy Workhorse Technologies, LLC.)

Sonar Mapping

- Scan in P6 revealed a void:
 - 2.5 ft. high.
 - 15 ft. wide.
 - 70 ft. long.
 - Est. volume 97 cy.
- Excellent correlation with borehole camera.
- P6 took 90 cy grout!



(Courtesy Workhorse Technologies, LLC.)

QUESTIONS?

Special Thanks to:

ODOT D-5, S. Smith and L. Zimmerman;
ODOT OGE, K. Beach and P. Painter;
Burton Scot Contractors;
Stable Construction Company;
Workhorse Technologies LLC.