Accident Investigation Overview

Public Hearing on the Sago Mine Disaster

West Virginia Office of Miners' Health Safety & Training

U.S. Dept. of Labor, Mine Safety and Health Administration

Presentation Topics

- Purpose of the investigation
- Review progress of the investigation
- Preliminary results
- Review future plans, including
  - Seal testing and evaluation
  - Ignition sources
  - Interview
  - Evaluating evidence
  - Data analysis

MSHA Accident Investigation Team

Richard Gates* - Team Leader, CMS&H, District Manager, Birmingham, AL

John Urosek* - Technical Support, Chief Ventilation Division, Pittsburgh, PA

Clete Stephan - Technical Support, General Engineer Ventilation Division, Pittsburgh, PA

Richard Stoltz - Technical Support, Supervisor Ventilation Division, Pittsburgh, PA

Dennis Swentosky - CMS&H, Supervisory Mine Safety and Health Specialist, Ventilation, New Stanton, PA

Joseph O'Donnell – CMS&H, Field Office Supervisor, Bessemer, AL

Gary Harris – CMS&H, Supervisory Special Investigator, Barbourville, KY

Russell Dresch – CMS&H, Electrical Engineer, Norton, VA

The team is assisted by the following members of the Office of the Solicitor: James Crawford, Tim Williams, Robert Wilson.

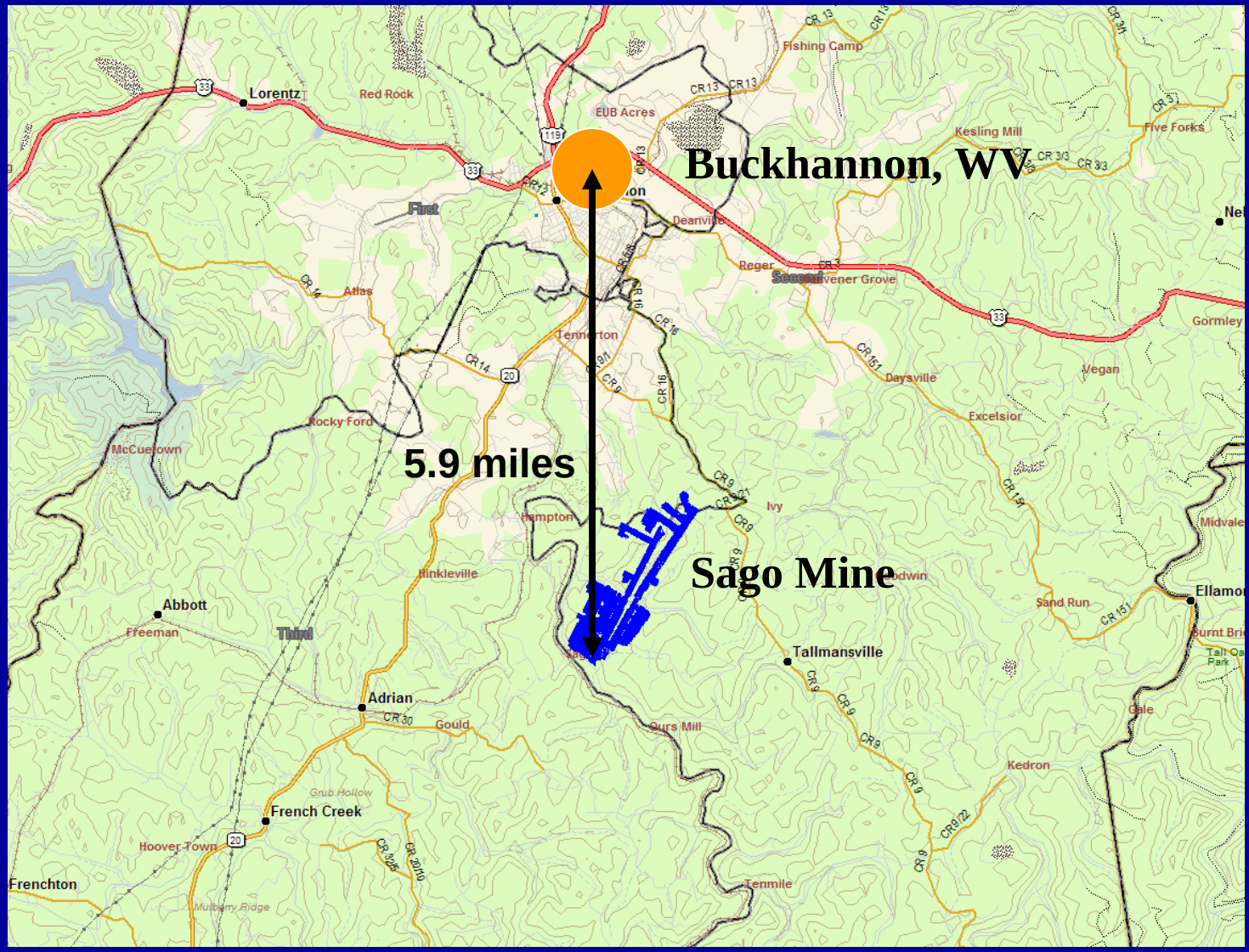
***Panelist**

WV MHS&T Accident Investigation Team

- **Doug Conaway** – Former Director
- **Brian Mills*** - Team Leader, Inspector-at-Large, Region 1
- **Monte Hieb*** - Chief Engineer
- **Mike Rutledge*** – Mine Safety Instructor
- **John Scott** - Electrical Inspector, Mine Rescue Team
- **John Hall** - Electrical Inspector, Mine Rescue Team
- **John Collins** – District Inspector
- **Jeff Bennett** – District Inspector, Mine Rescue Team
- **Barry Fletcher** – Roof Control, Mine Rescue Team
- **Robert True Jr.** – District Inspector

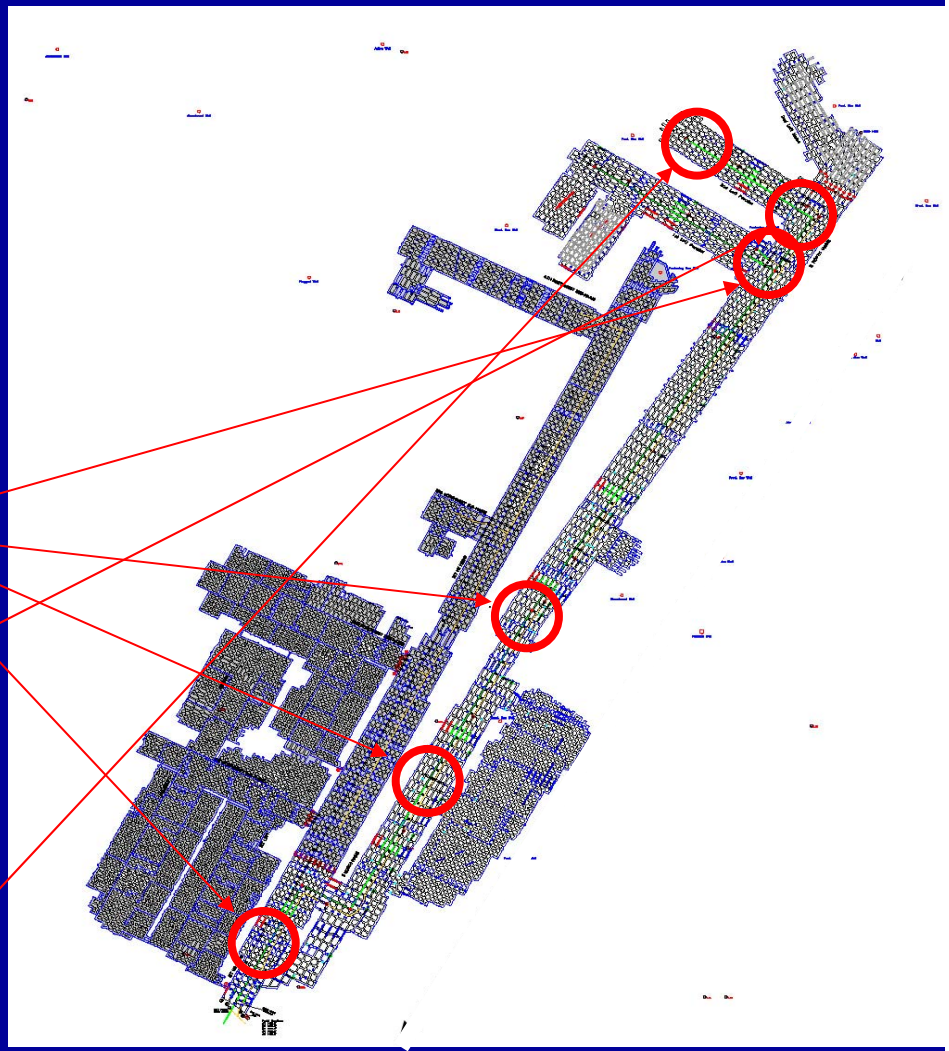
***Panelist**

Location map



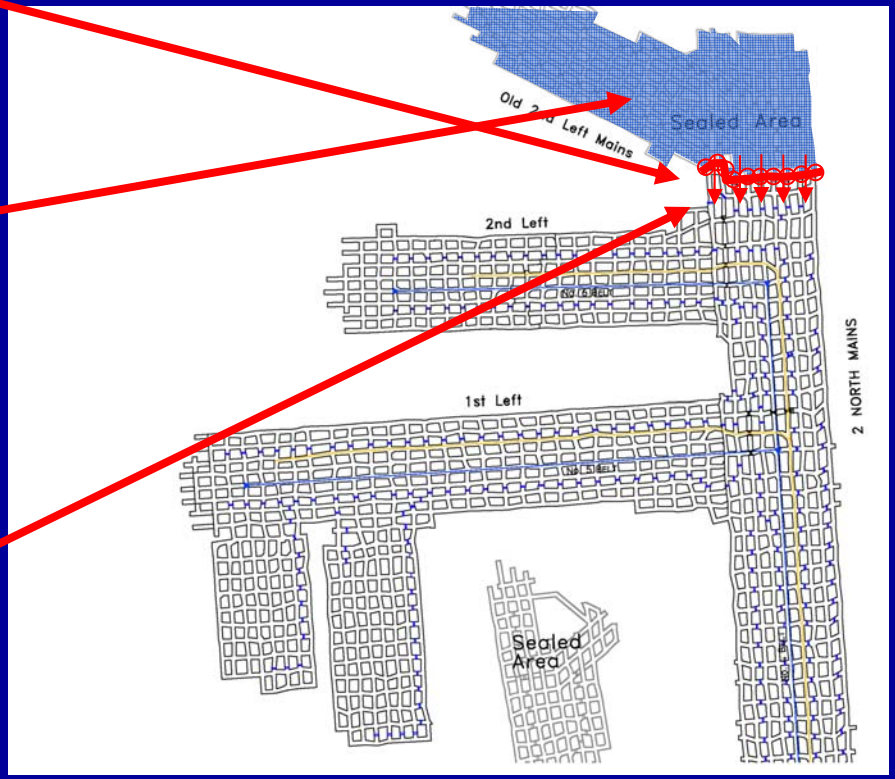
Sago Mine Investigation Overview

- **29 miners were in the mine when the explosion occurred at approximately 6:26 AM on January 2, 2006.**
- **All of the miners except one, appear to have initially survived the explosion.**
  - **Sixteen miners exited the mine safely.**
  - **One miner was found near 2 Left switch in direct line of the forces and gases from the explosion.**
  - **Twelve miners did not exit and they barricaded in the 2 Left Section.**



Sago Mine Investigation Overview

- **The Old 2 Left Mains Seals were installed to isolate the active area from the sealed area.**
- **An explosive concentration of fuel was ignited in the sealed area inby 2 Left.**
- **These seals were totally destroyed.**



Sago Mine Investigation Overview

- **Investigation activities began on January 2.**
- **The underground portion of the investigation was delayed due to recovery efforts at the mine. It began on Thursday January 26, 2006.**
- **Interviews of miners, rescuers and officials began on January 17, 2006. The last interview was completed on April 5, 2006. The interview of Randal McCloy has not yet been scheduled.**

Sago Mine Investigation Overview

- **To date, 74 interviews of 70 persons including:**
  - **16 of the 17 survivors who were in the mine at the time of the event;**
  - **4 miners who entered the mine to begin rescue efforts**
  - **1 Mine Official not scheduled to work on the day of the accident**
  - **3 MSHA CMI's with inspection activities at the seals**
  - **2 MSHA mine rescue team personnel**
  - **9 industry mine rescue team personnel**
  - **1 medical professional who participated in rescue**
  - **3 dispatchers**
  - **6 ICG corporate management**

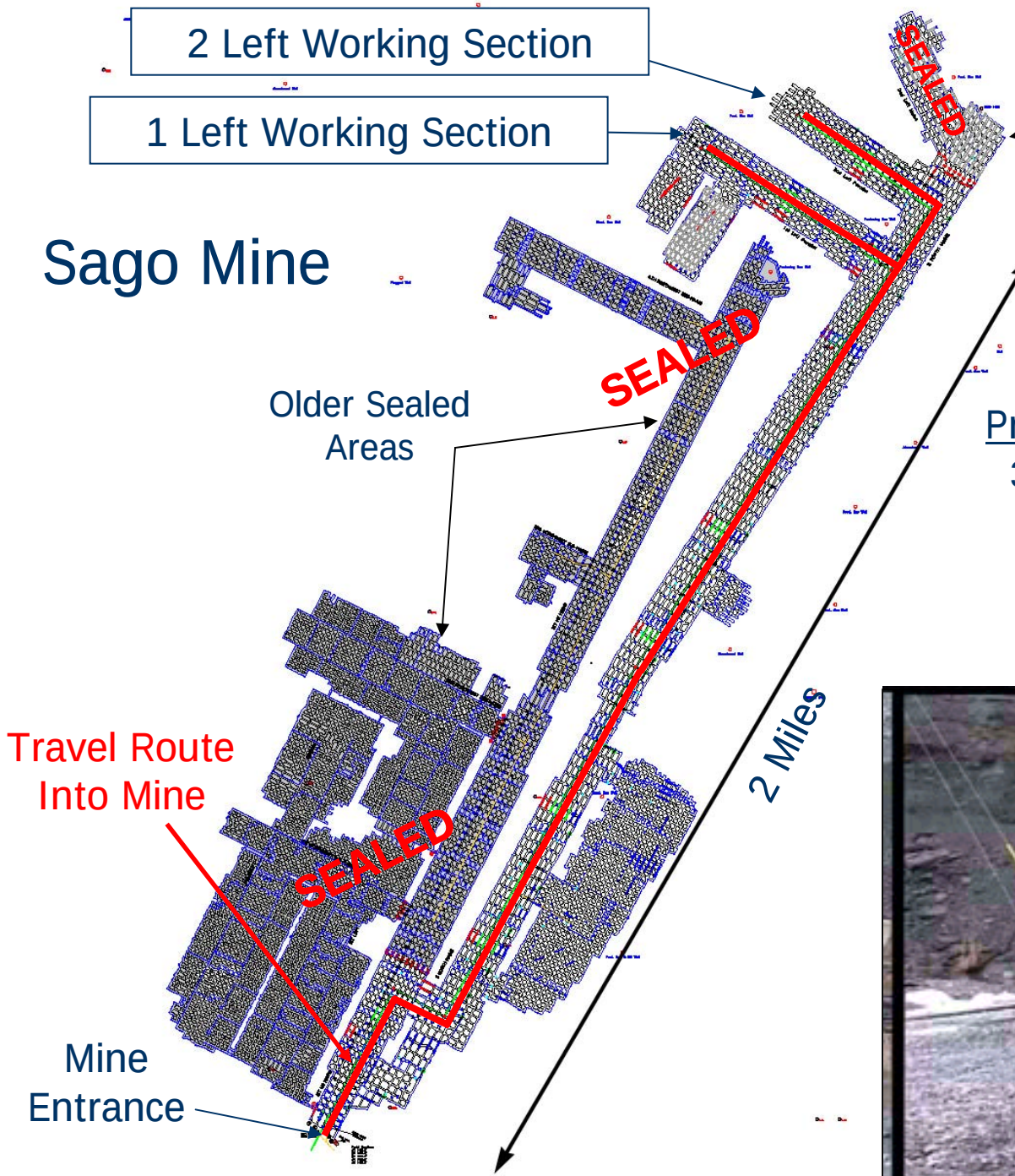
Sago Mine Investigation Overview

- **Continuing, 74 interviews of 70 persons including:**
  - **6 WV Office of Miners Health, Safety, and Training personnel**
  - **6 Sago management employees who worked on seals**
  - **1 former miner now employed by Massey who worked on seals**
  - **3 miners (2 were former independent contractor employees now employed by Sago) who worked on the seals**
  - **5 miners who worked the weekend prior to the explosion**
  - **2 miners who had worked in the Old 2 Left Section**
  - **1 owner of engineering firm responsible for surveying and mapping**
  - **1 electrical contractor**
  - **4 persons were called back for additional information on the seals**

Sago Mine Investigation Overview

- **Issues concerning the explosion include:**
  - **What were the activities of the miners?**
  - **Where did the explosion start?**
  - **What was the fuel for this explosion?**
  - **What was the ignition source for this explosion?**
  - **Why did the seals fail?**
- **Other issues include:**
  - **Gas detection equipment, including the AMS system**
  - **Self-Contained Self-Rescuers**
  - **Training**

Sago Mine



Prior to Accident on 1/2/06

3-6:00 am - Section preshift exams conducted.
6:00 am - 1 Left & 2 Left crews enter mine.

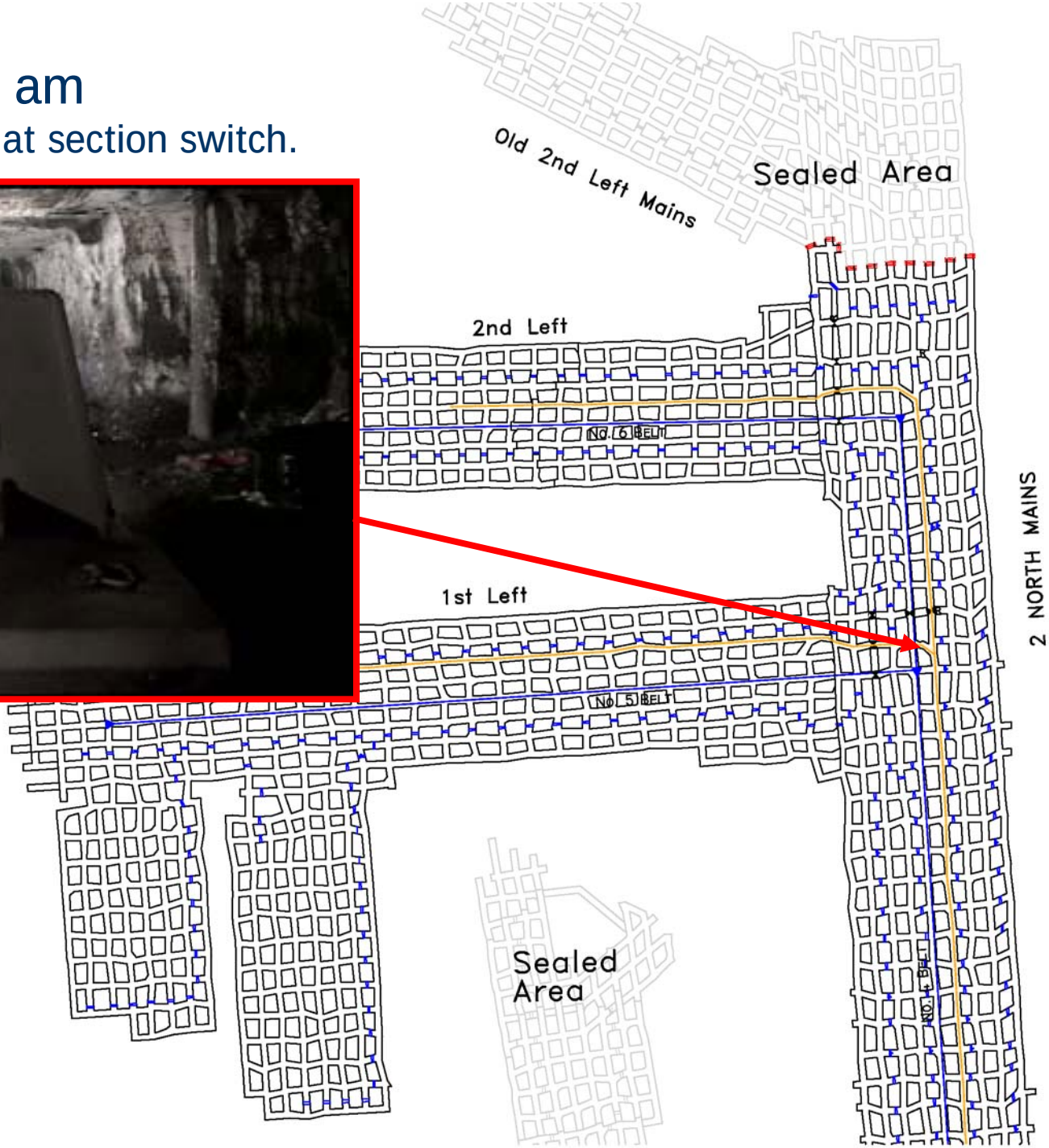
2nd Left Crew	1st Left Crew
Tom Anderson	Denver Anderson
Alva Bennett	Paul Avington
James Bennett	Gary Carpenter
Jerry Groves	Ronald Grall
George Hamner, Jr.	Randall Helmick
Randal McCloy	Eric Hess
Jesse Jones	Owen Jones
David Lewis	Hoy Keith
Martin Toler, Jr.	A. Roger Perry
Fred Ware	Gary Rowan
Jackie Weaver	Joe Ryan
Marshall Winans	Chris Tenney
	Alton Wamsley

Pause
Resume
Restart

NEXT SLIDE

06:26 am

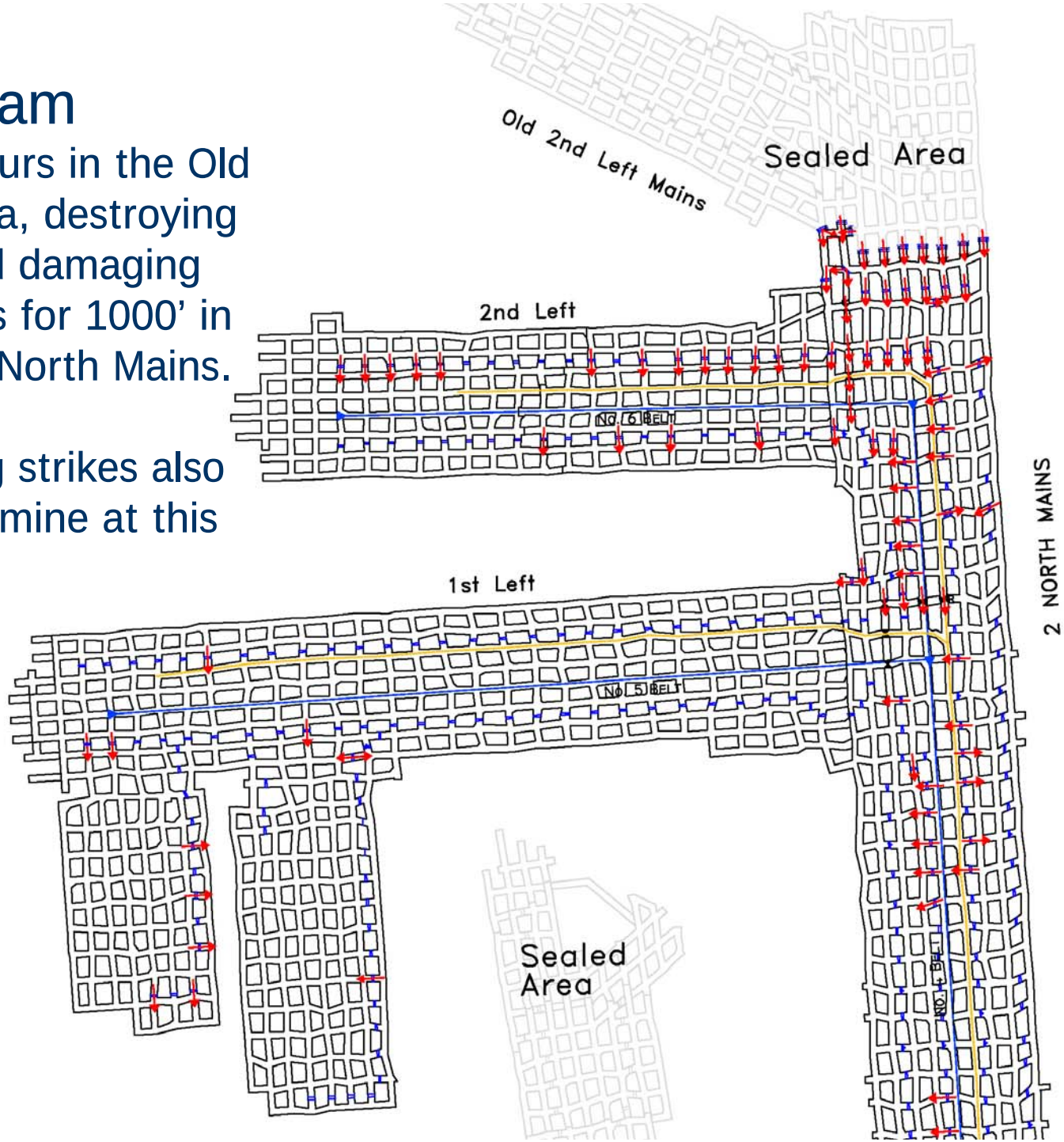
1st Left crew arrives at section switch.



06:26 am

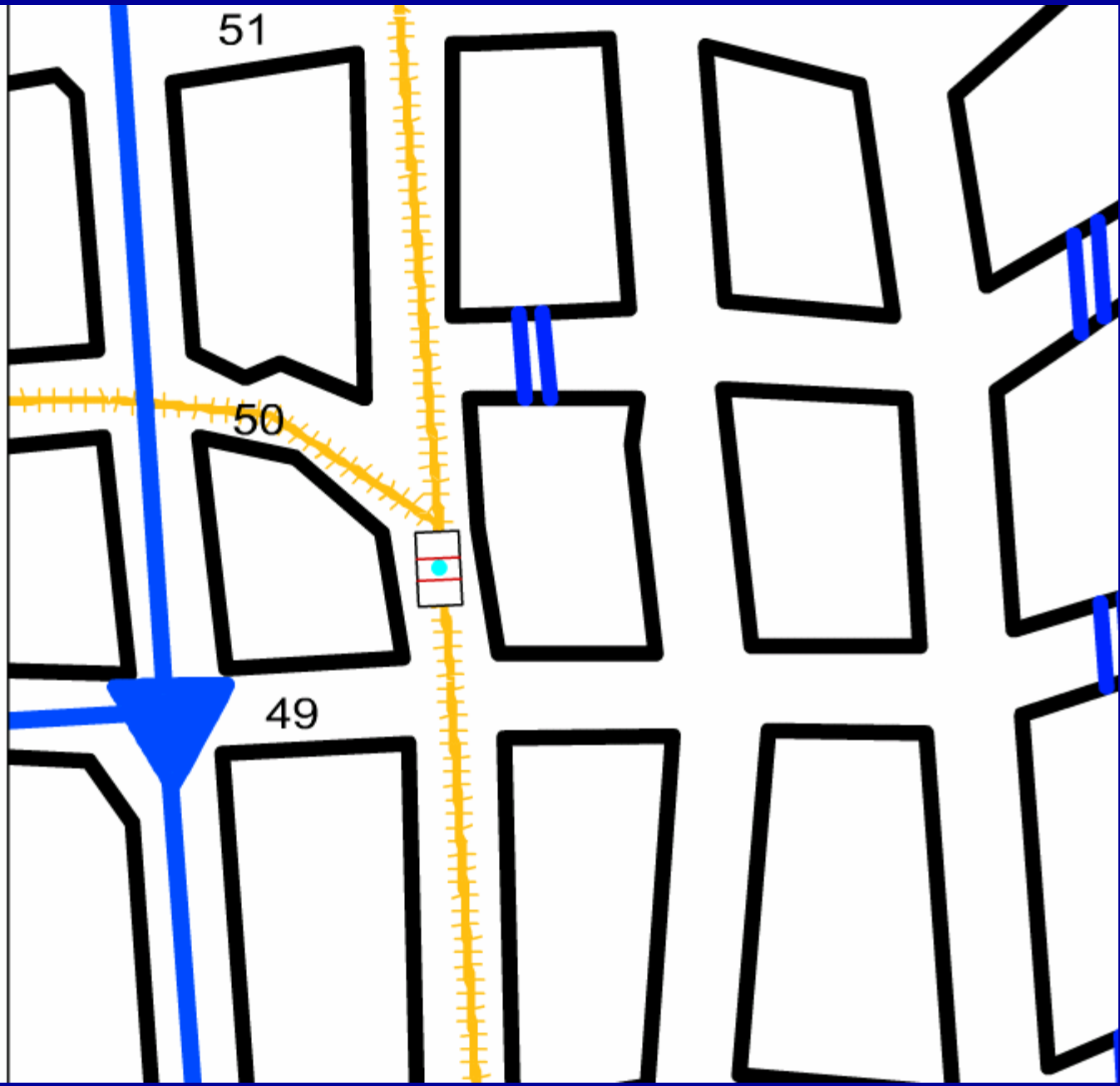
- An explosion occurs in the Old 2nd Left sealed area, destroying all of the seals and damaging ventilation controls for 1000’ in the 2nd Left and 2 North Mains.

- Multiple lightning strikes also occurred near the mine at this time.

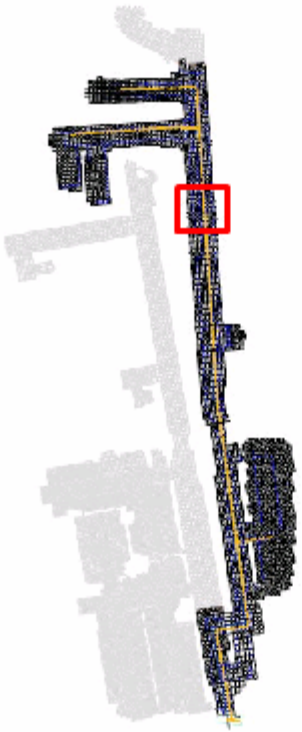


- Denver Anderson
- Paul Avington
- Gary Carpenter
- Ronald Grall
- Randall Helmick
- Eric Hess
- Owen Jones
- Hoy Keith
- A. Roger Perry
- Gary Rowan
- Joe Ryan
- Chris Tenney
- Alton Wamsley
- John Boni
- Jeffrey Toler
- James Schoonover
- Denver Wilfong
- Vernon Hofer

Pause
Resume
Restart

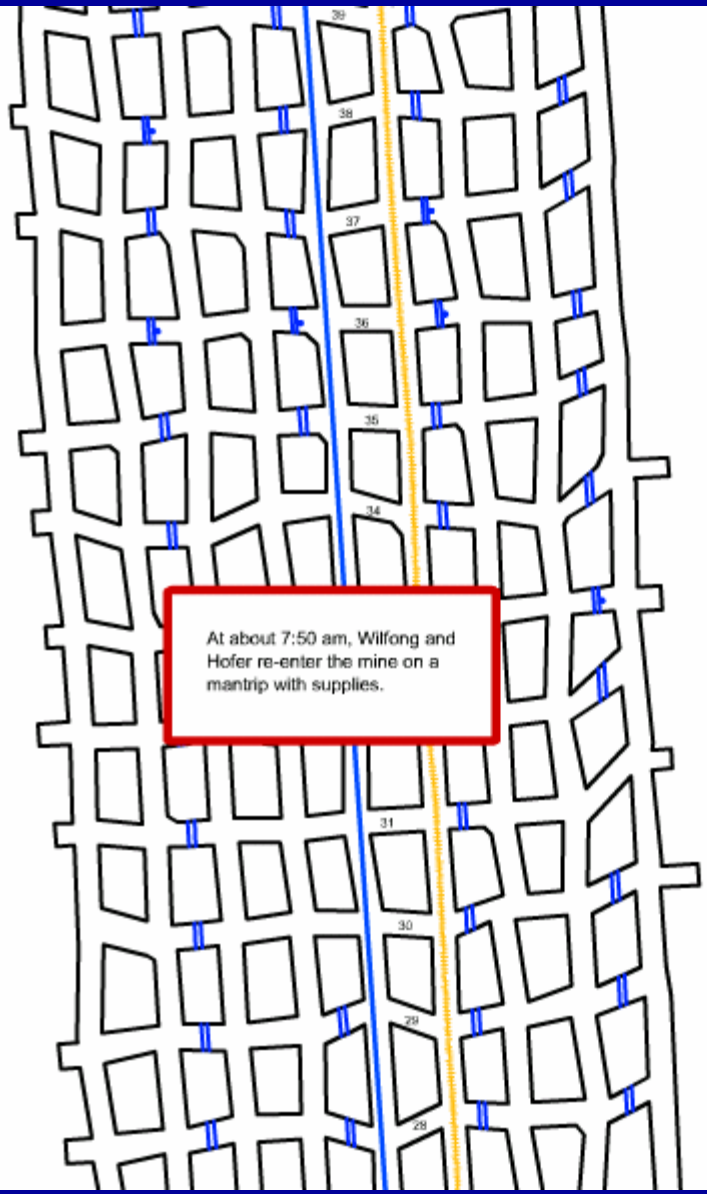


NEXT SLIDE



Owen Jones
Jeffrey Toler
James Schoonover
Denver Wilfong
Vernon Hofer

Pause
Resume
Restart



NEXT SLIDE

Mine Re-entry

As the miners advanced, they replaced the damaged ventilation controls –

with curtains

Where did the explosion start?

- **In order to determine where the explosion may have started, investigators are evaluating:**
  - **Activities of the miners**
  - **Physical evidence inby and outby the sealed area**
  - **Testimony from persons interviewed**
  - **Likelihood of fuel for the explosion inby and outby the seals**
  - **Likelihood of ignition sources inby and outby the seals**

Where did the explosion start?

- **Based on an evaluation of the information reviewed to date, results of the investigation indicate that the explosion was initiated inby the seals in the Old 2 Left Section:**
  - **The seals were blown in an outby direction.**
  - **Methane accumulated inby the seals.**
  - **Ventilation outby the seals should have diluted any methane present.**

Fuel

- **The two possible sources of fuel for the explosion are:**
  - **Methane**
  - **Coal Dust**

Fuel

- **Methane**
  - **The final two seals were completed on December 11.**
  - **Methane accumulated in the sealed area for the next 22 days.**
  - **Investigators are working to evaluate the methane accumulation in the sealed area.**
- **Volume**
  - **The volume of the sealed area was preliminarily determined to be about 4,020,000 cubic feet.**

Fuel

- **Methane**
  - **Examination Records**
    - **A review of the mine operator's examination records is on-going.**
  - **An evaluation of gas wells in the area**
  - **Methane liberation investigation February 7-9**
    - **Preliminary results indicate an average daily methane liberation rate from the sealed area was about 14,400 cubic feet per day.**
  - **Methane liberation investigation March 2-3**
    - **Preliminary results indicate an average daily methane liberation rate from the sealed area was about 14,000 cubic feet per day.**

Fuel

- **Coal Dust**
  - **Review Testimony and Records**
  - **Conducted a mine dust survey.**
    - **The samples were analyzed for incombustible content. An alcohol coke test was also completed.**
      - **Preliminary results indicate that the flame from the explosion ended in the vicinity of the Old 2 Left Seals.**

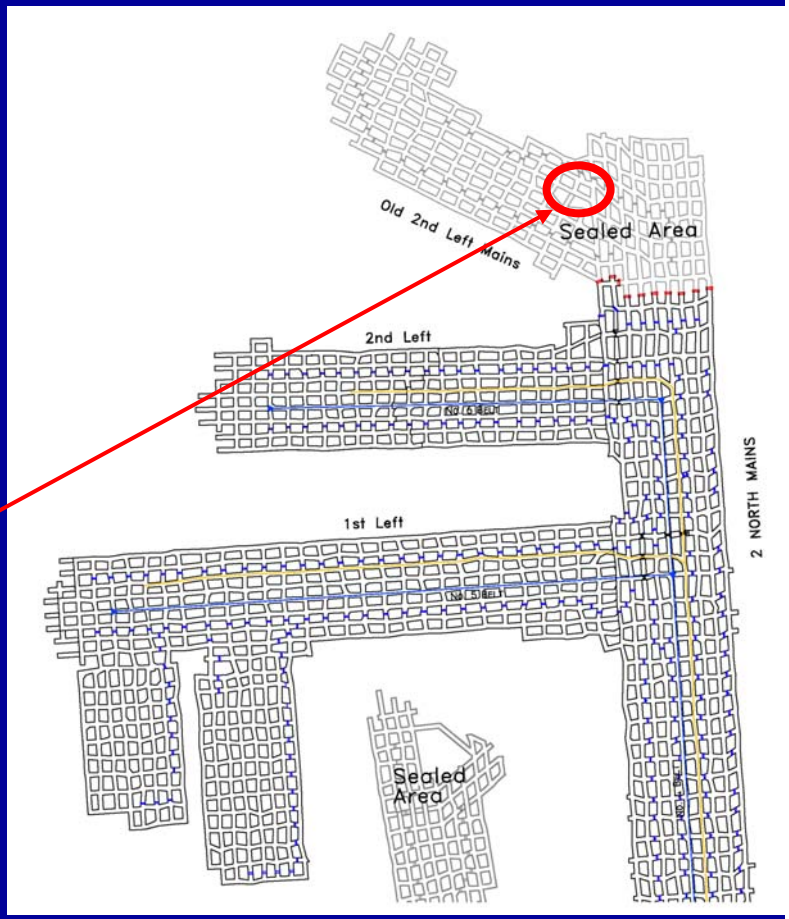
Fuel

- **Preliminary results indicate:**
  - **The methane liberation investigations indicate the potential for explosive mixtures of methane in the sealed area. These results indicate that it was the primary fuel for the explosion.**
  - **Coal dust was not a primary fuel for the explosion.**

IGNITION SOURCES

- **The MSHA investigation has determined that the explosion was initiated inby the seals in the Old 2 Left Section.**

- **The forces within the sealed area appear to propagate in all directions from the area near spads 4010, 4011, 4047, and 4048.**



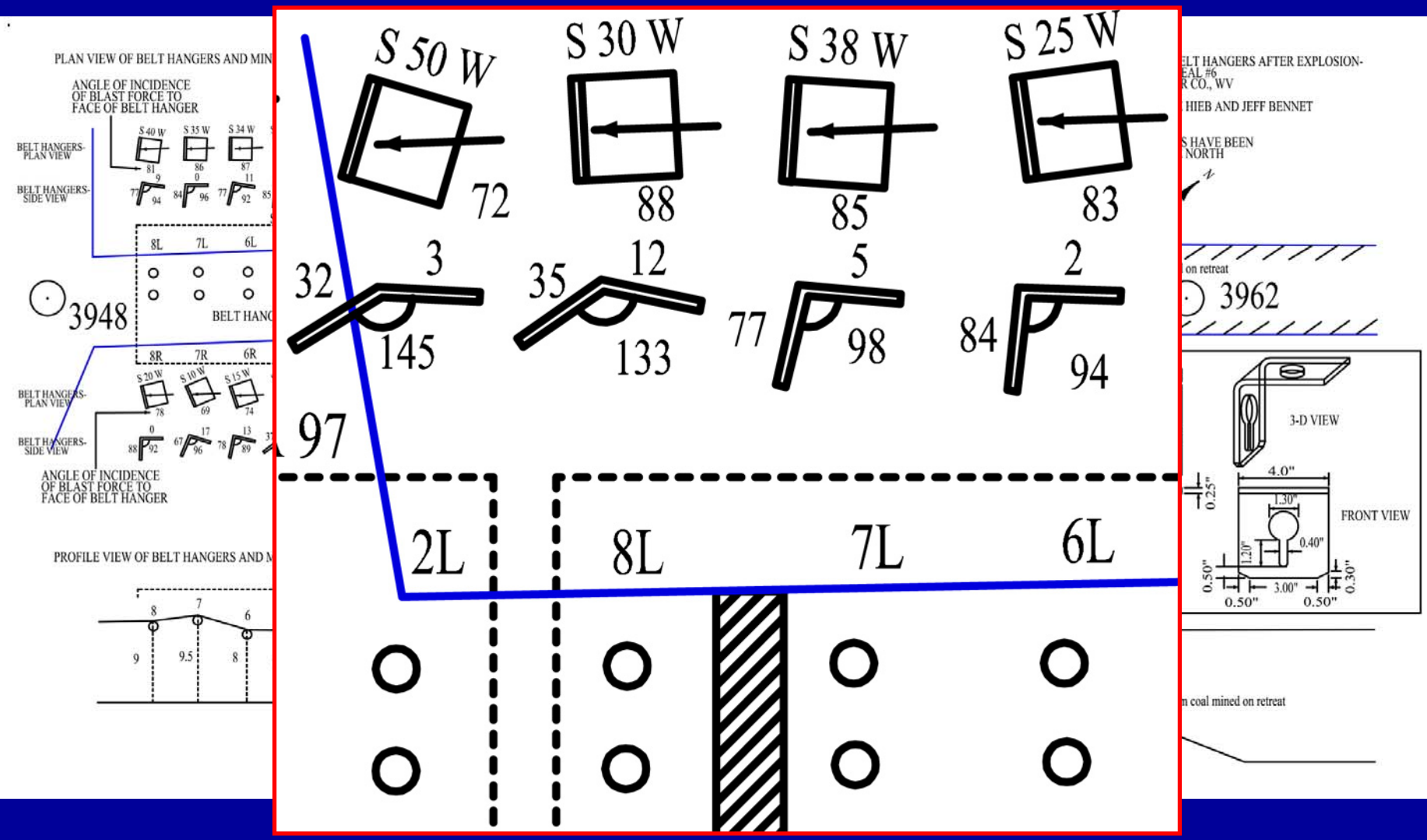
How Force Directions were Determined

- Roof support plates and pans are undeformed where blast forces were mild or absent

- The direction and intensity of bending of plates and pans indicates the direction and intensity of blast forces
- Other information, such as dust deposition, was also used

Illustration of Belt Hanger Bending

Inby and Outby Omega Seal #6



How Force Directions were Determined

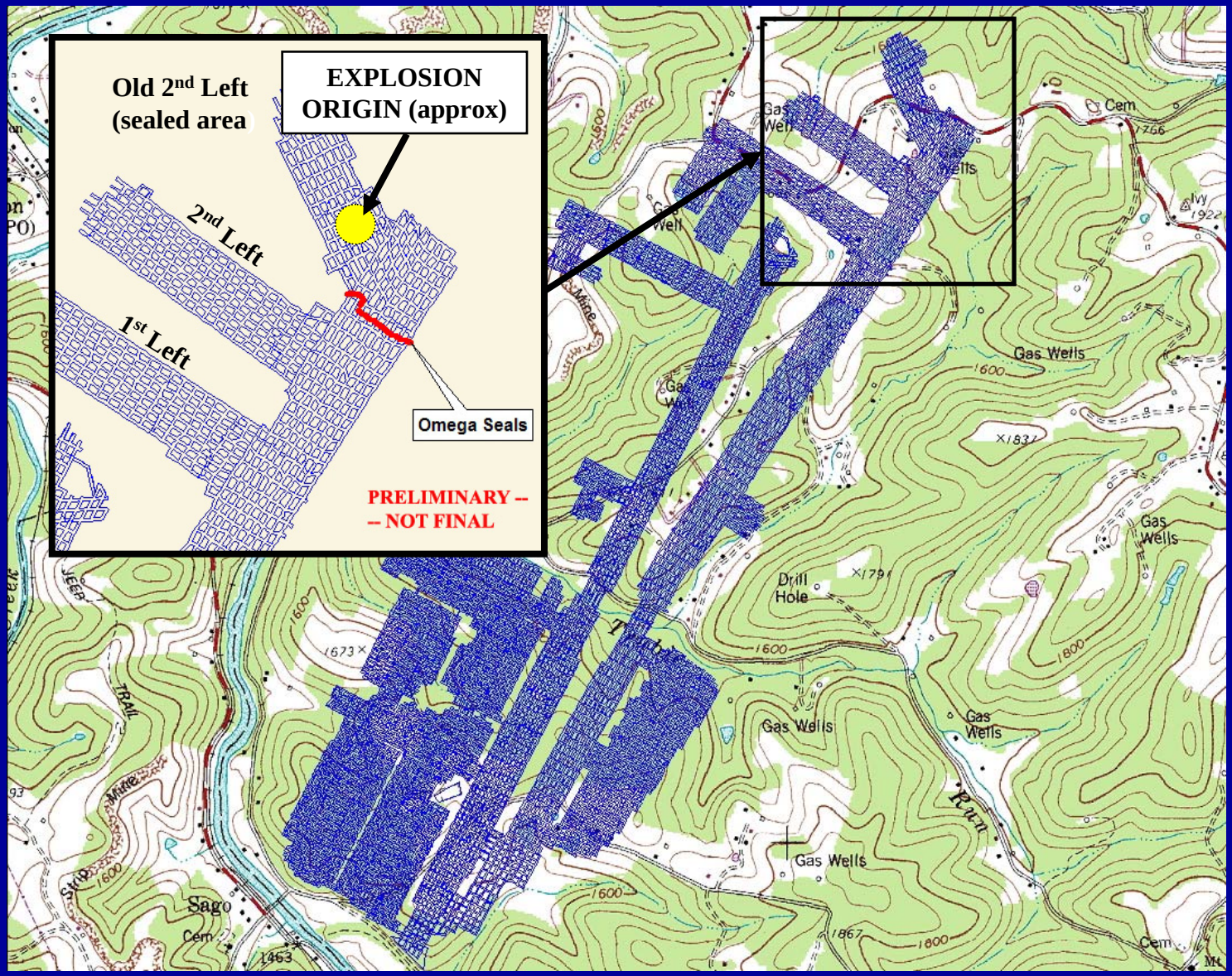
- Distortions of other structures such as Wire Mesh (shown here) were used to determine direction of forces.

- Severity and geometry of damaged ventilation controls were also used to determine direction and magnitude of forces.

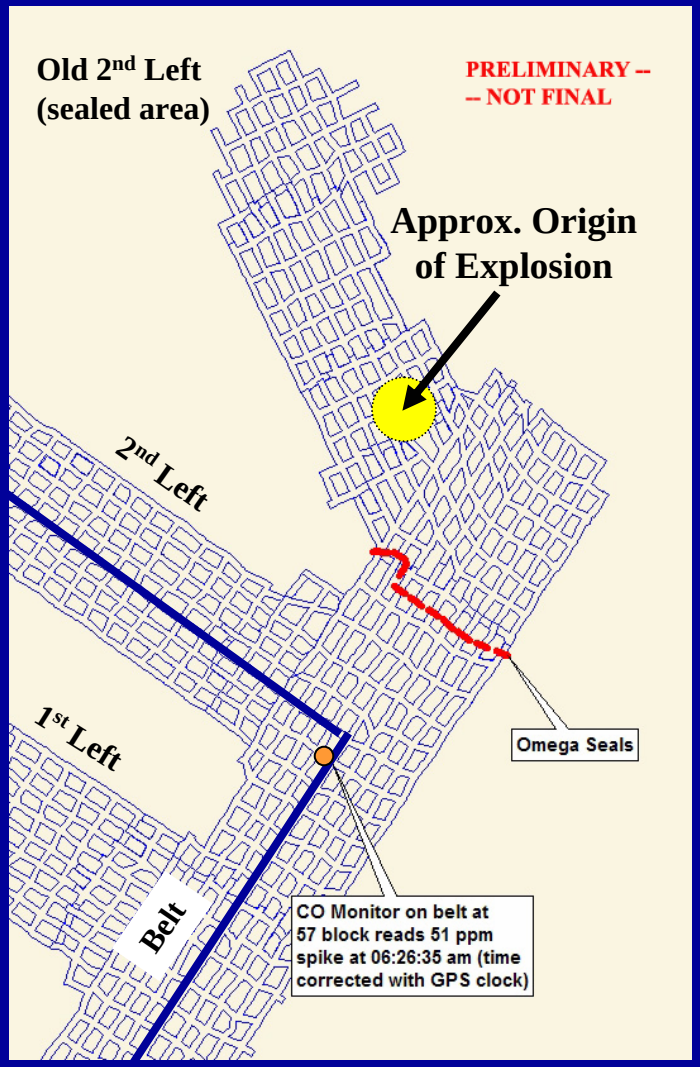
IGNITION SOURCES

- **Lightning strikes on the surface may have been conducted underground through:**
  - **Mine Electric System**
  - **Equipment and structures**
  - **Surface mine telephone communication system**
  - **Gas wells and interconnected piping**
  - **Mine water piping system**
  - **Strata**
- **Roof falls**
- **Other ignition sources**

LOCATION OF EXPLOSION ORIGIN



TIME OF EXPLOSION



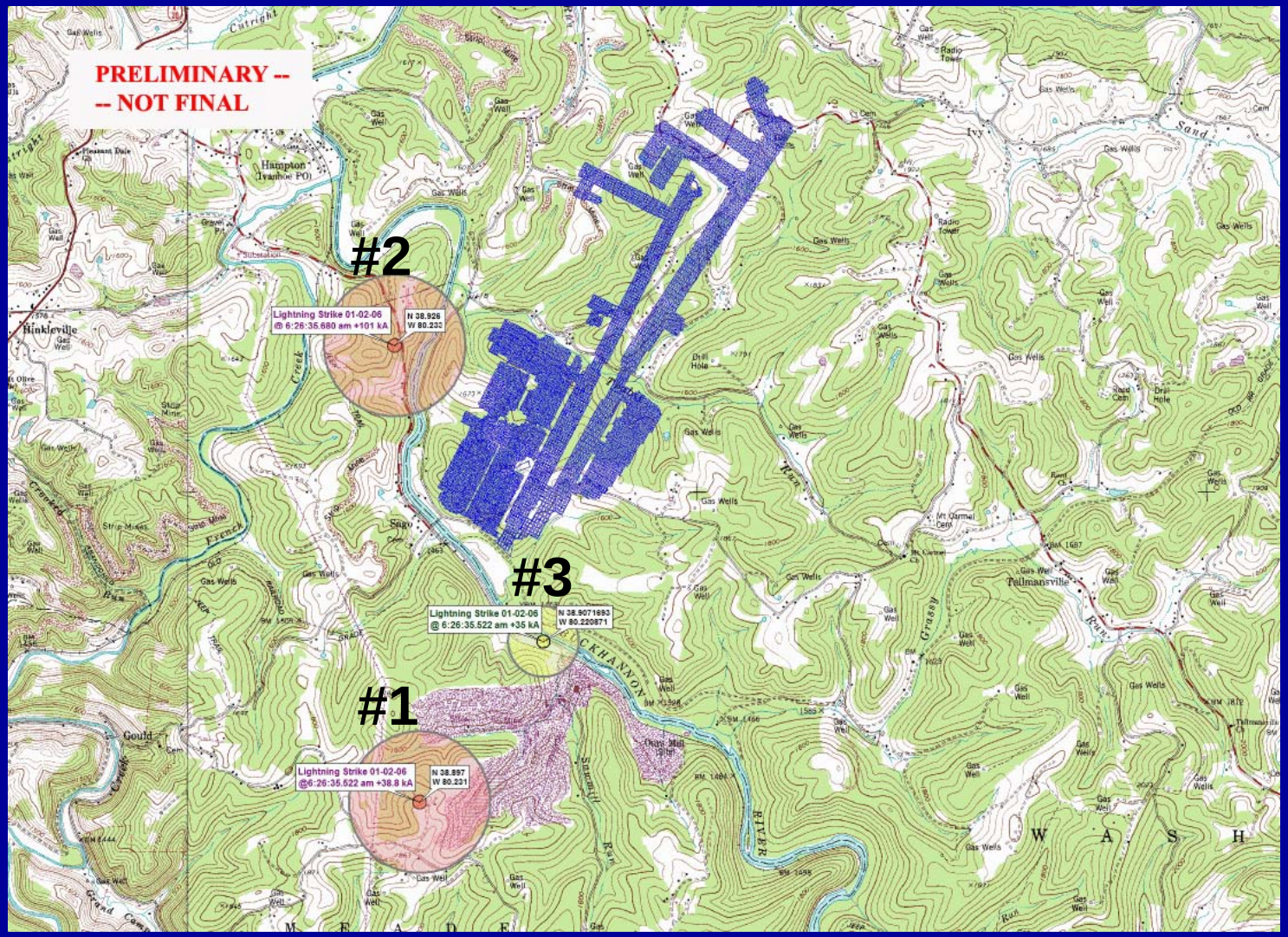
CARBON MONOXIDE BELT MONITOR

- Computer printout shows first CO spike from explosion at 6:31:31 am.
- When synchronized with GPS clock, the true time of the CO spike (51 ppm) at 57 Block is actually 6:26:35 am.

SEISMOGRAPH NEAR MORGANTOWN

- Seismic event recorded at appox. 6:26:36 am to 6:26:40 am

LOCATION OF REPORTED LIGHTNING STRIKES
IN THE VICINITY OF SAGO MINE NEAR THE TIME OF THE EXPLOSION



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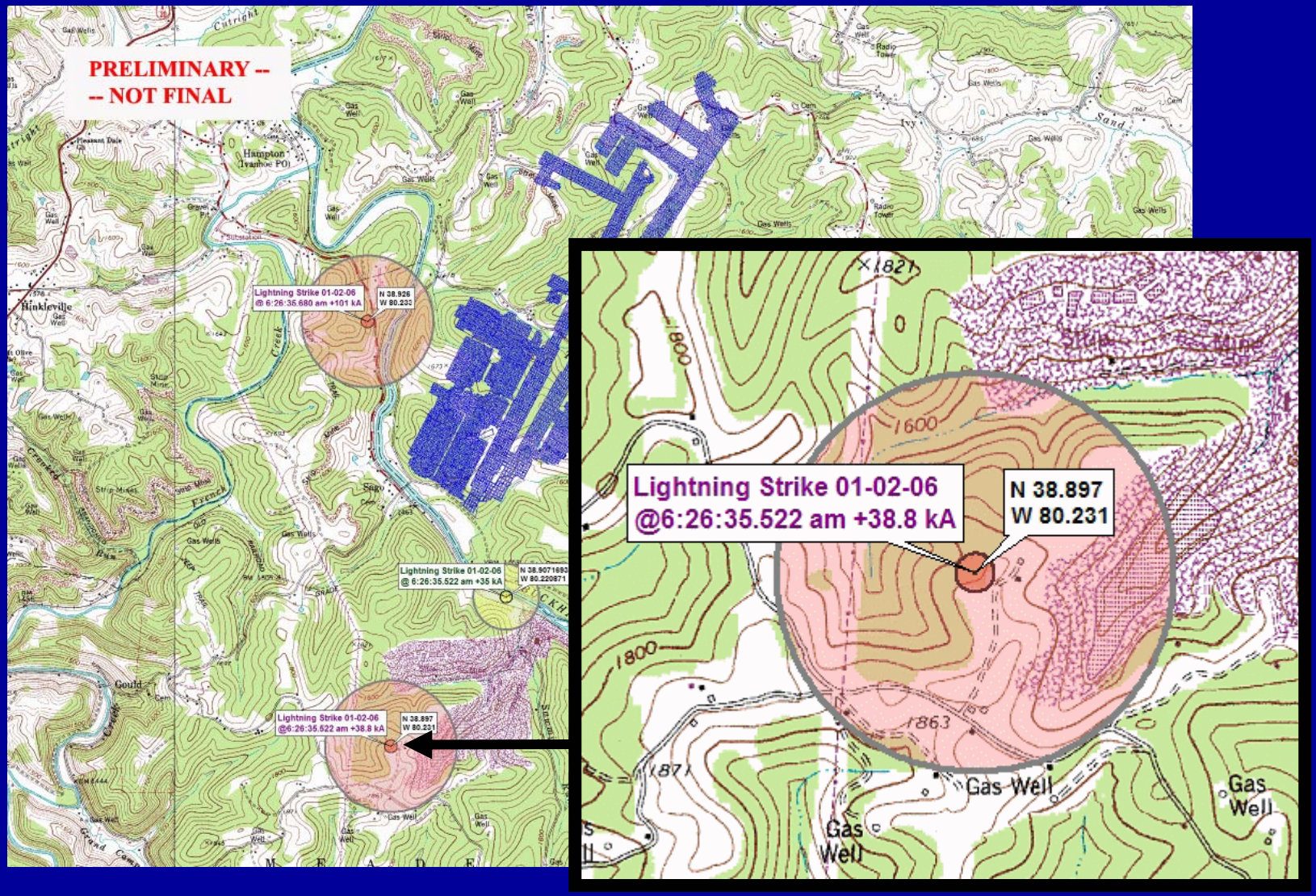

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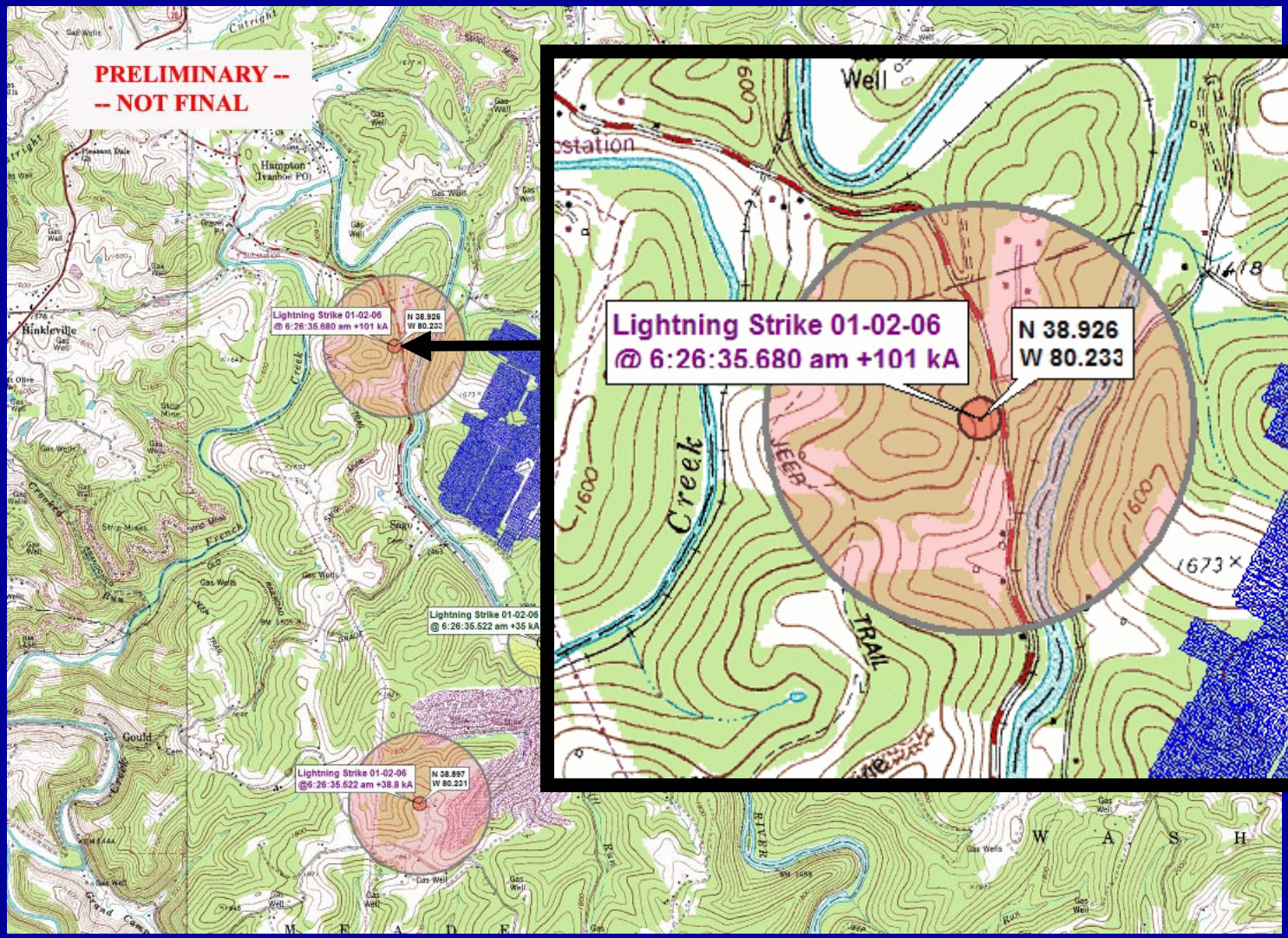

LOCATION OF REPORTED LIGHTNING STRIKES
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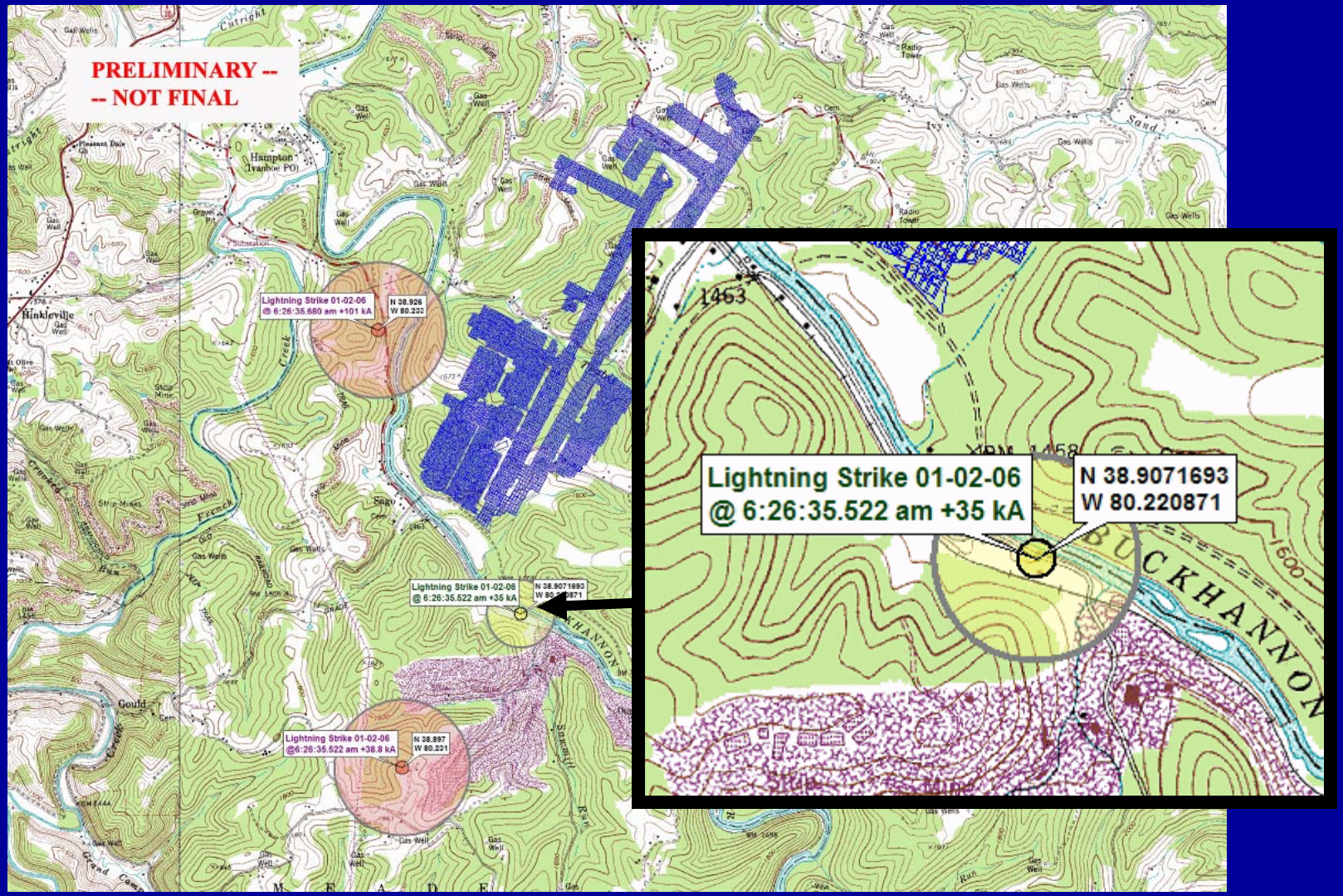

LOCATION OF REPORTED LIGHTNING STRIKES
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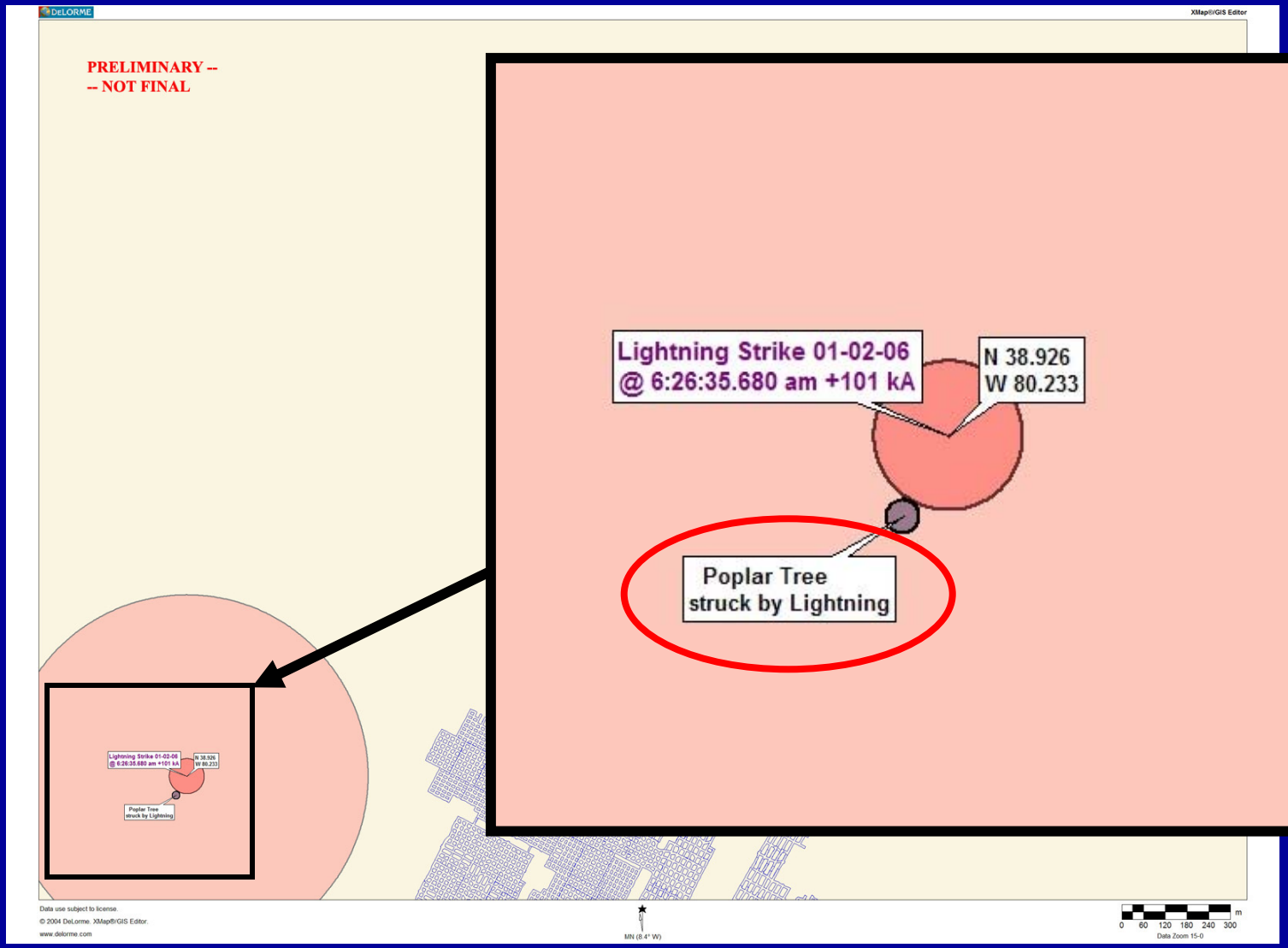


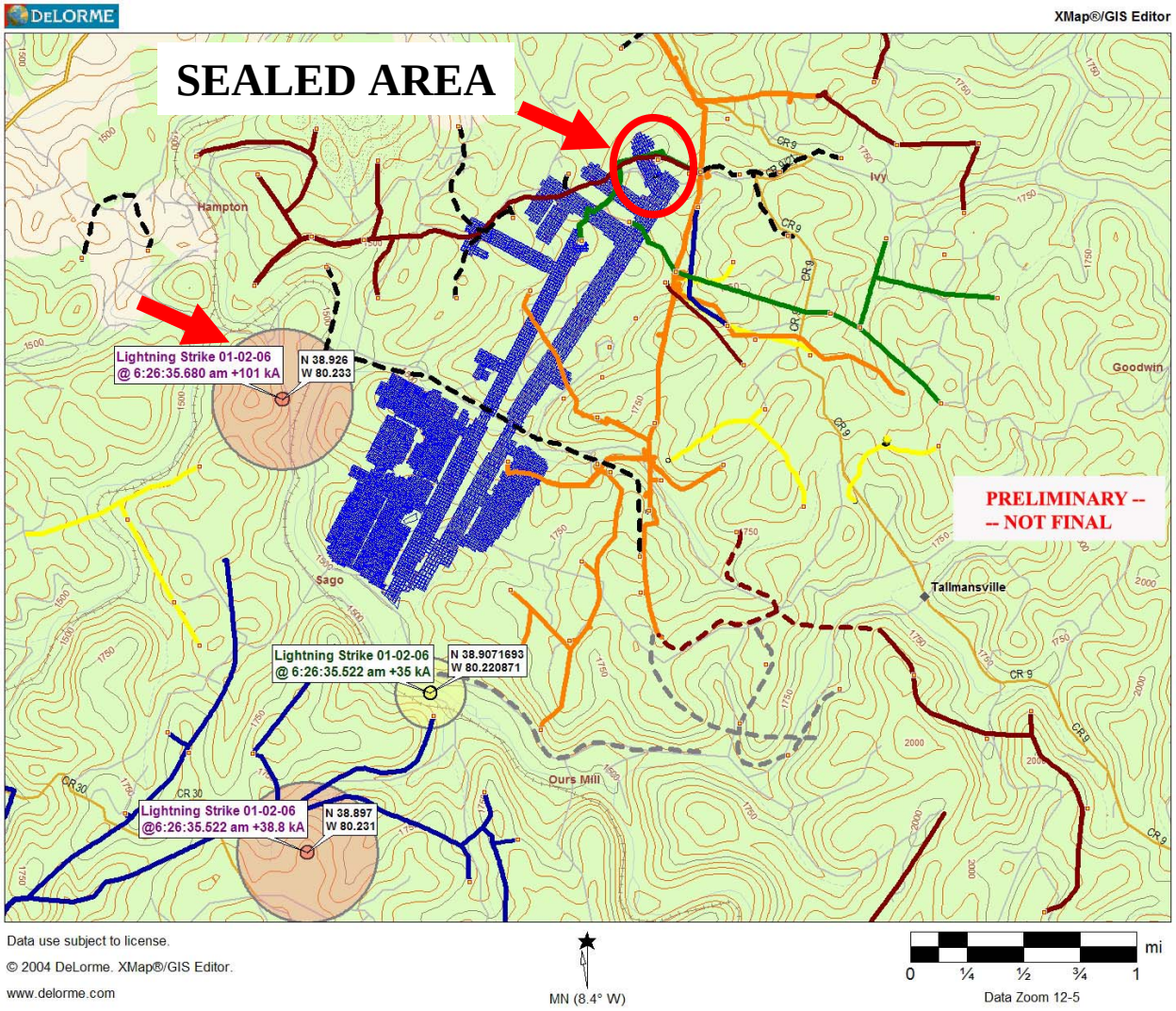
PHYSICAL EVIDENCE OF LIGHTNING STRIKE
IN THE VICINITY OF SAGO MINE NEAR THE TIME OF THE EXPLOSION

Photograph taken at location #2 the morning of January 6, 2006
(photo by Kermit Melvin, ICG)

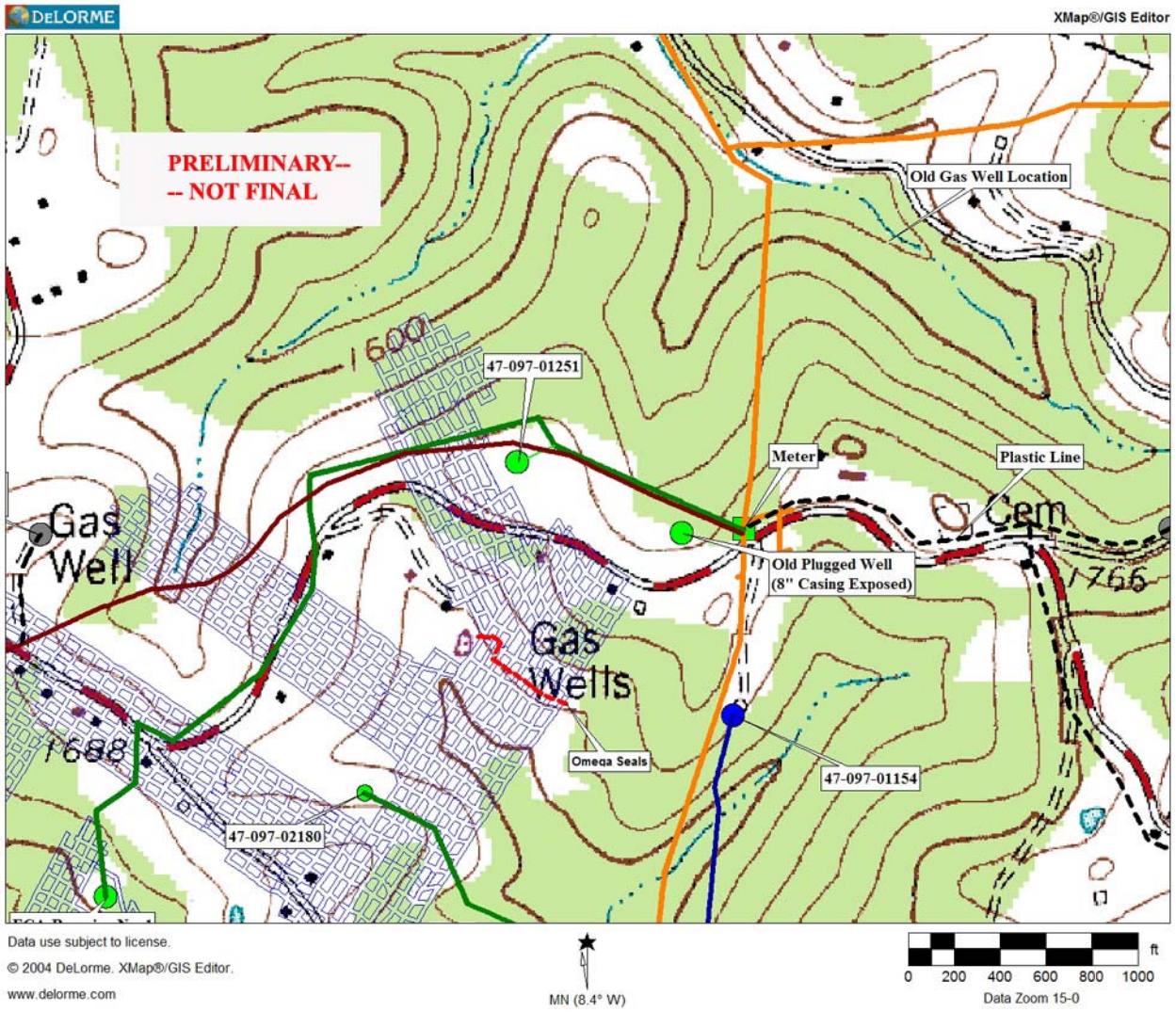
This strike was found using a handheld GPS and using strike coordinates supplied by Vaisala.

This location is approx. 1.9 miles from site of the Jan. 2, 2006 mine explosion and about 1.5 miles from Sago Mine portal.

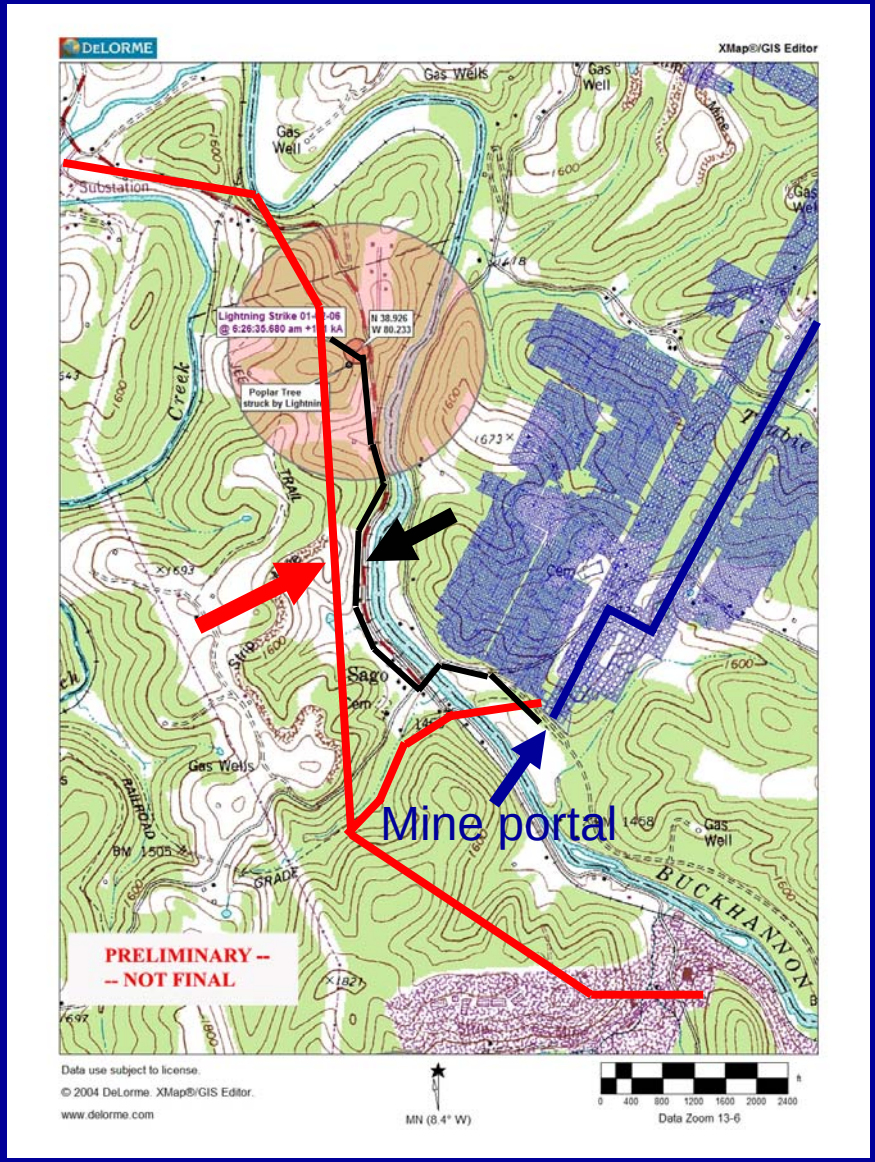
ACTIVE GASLINES on the surface in the vicinity of SAGO MINE



NO KNOWN ACTIVE OR ABANDONED GAS WELLS PENETRATE SEALED AREA

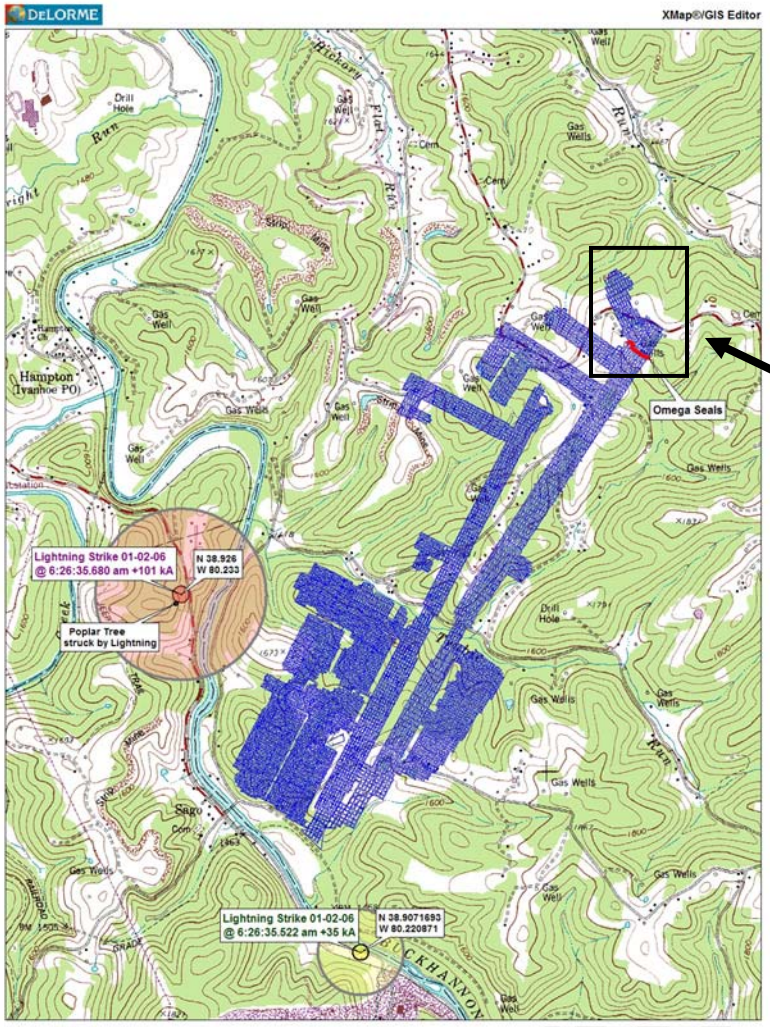


UTILITY LINES



- Private powerline servicing Sago Mine and Prep Plant
- Telephone Utility Line - Verizon
- The possibility that voltage entered the mine at the portals through the belt structure, track, or other structure is being investigated

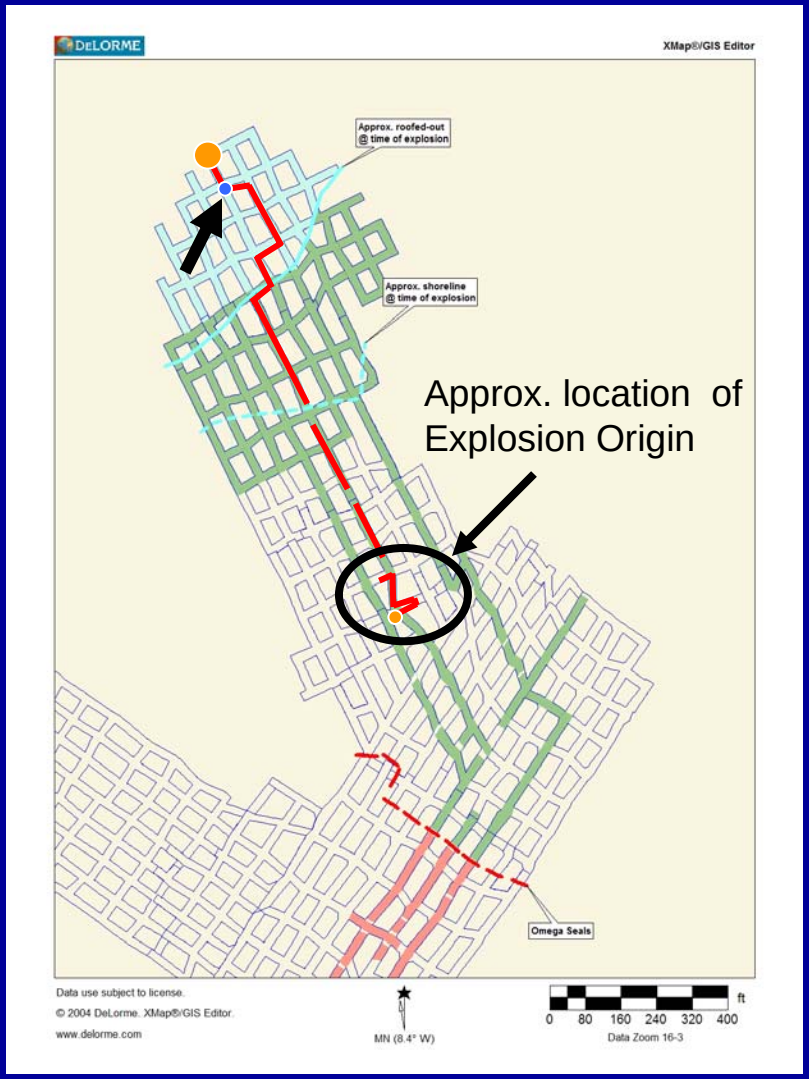
OTHER POTENTIAL POINTS OF ENTRY



- The possibility that voltage may have entered the mine directly over the Sealed Area is being investigated

SEALED AREA

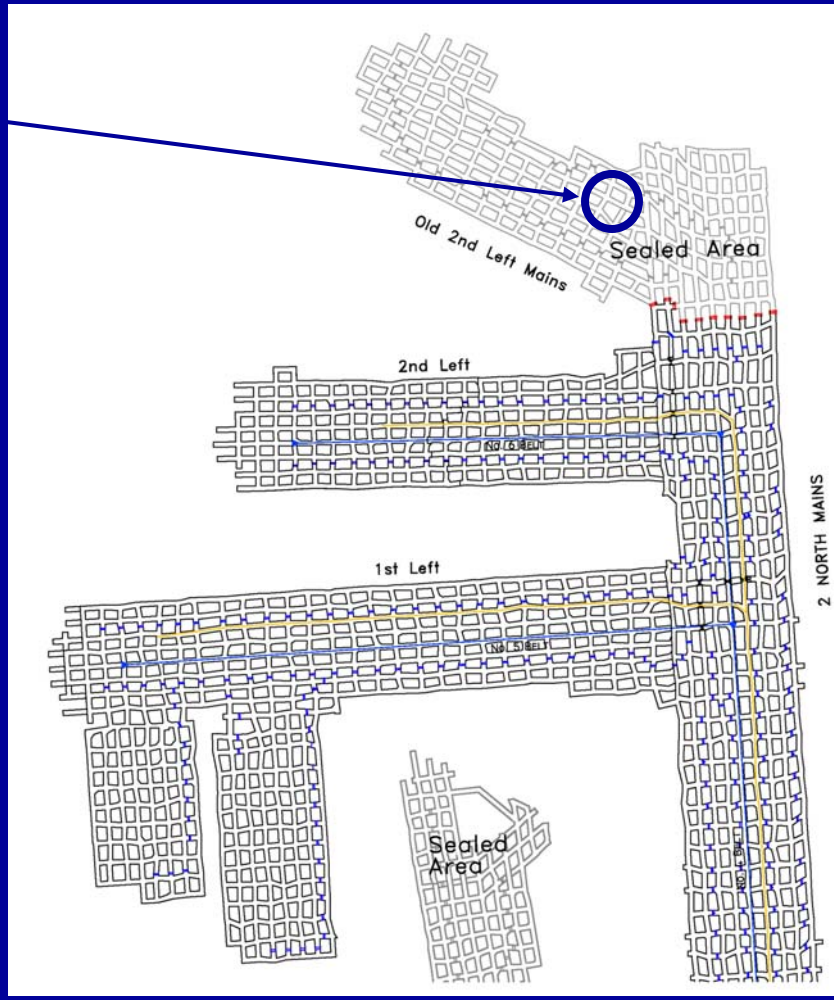
BEHIND THE SEALS-- POSSIBLE ROLE OF WIRE MESH and ABANDONED PUMP CABLE



- Wire roof mesh used for securing roof safely
- Represents several miles of continuous 8-guage wire
- Partially under water when explosion occurred
- Pump left at face (stuck)
- Pump cable extends back to site of explosion
- Pump control box was under water, connecting wire mesh to pump cable

IGNITION SOURCES

- **An anomaly in the mine roof was discovered near Spad 4010 in the sealed area. A sample of this anomaly was removed from the mine roof and sectionalized for analysis under a microscope. This analysis revealed fossil like characteristics. No evidence of lightning causing this anomaly was discovered.**



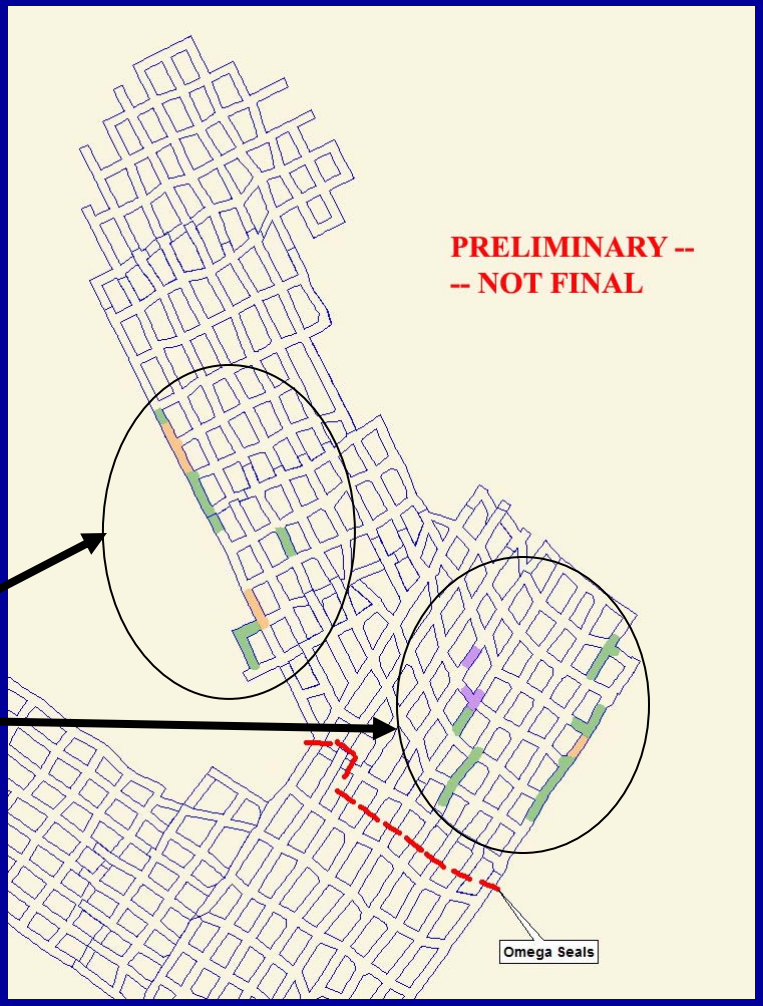
IGNITION SOURCES

- **Photo of roof “anomaly” near spad 4010.**

IGNITION SOURCES

- **Roof falls are also being investigated as a potential cause of the explosion.**

Location of roof falls behind the sealed area.



Seals

- **Since 1970, Federal regulations have required that underground areas either be ventilated or sealed.**
- **Section 75.335 states that "…Each seal...shall be constructed of solid concrete blocks..." It also states that "Alternative methods or materials may be used to create a seal if they can withstand a static horizontal pressure of 20 pounds per square inch..."**
- **20 psi was determined based on US Bureau of Mines research and explosion experience.**

Seals

- **Testing Plans for Omega Block Seals**
  - **Laboratory Analysis of Blocks**
    - **Compressive Strength Testing**
    - **Quality Control Evaluation**
  - **Analysis of Mortar Joint at Base of Seals**
    - **In-Mine Evaluation and collection of samples**
    - **Laboratory analysis of samples**
  - **Full Scale Explosion Testing**
    - **A series of full scale tests are being conducted at the Lake Lynn Laboratory, Experimental Mine**

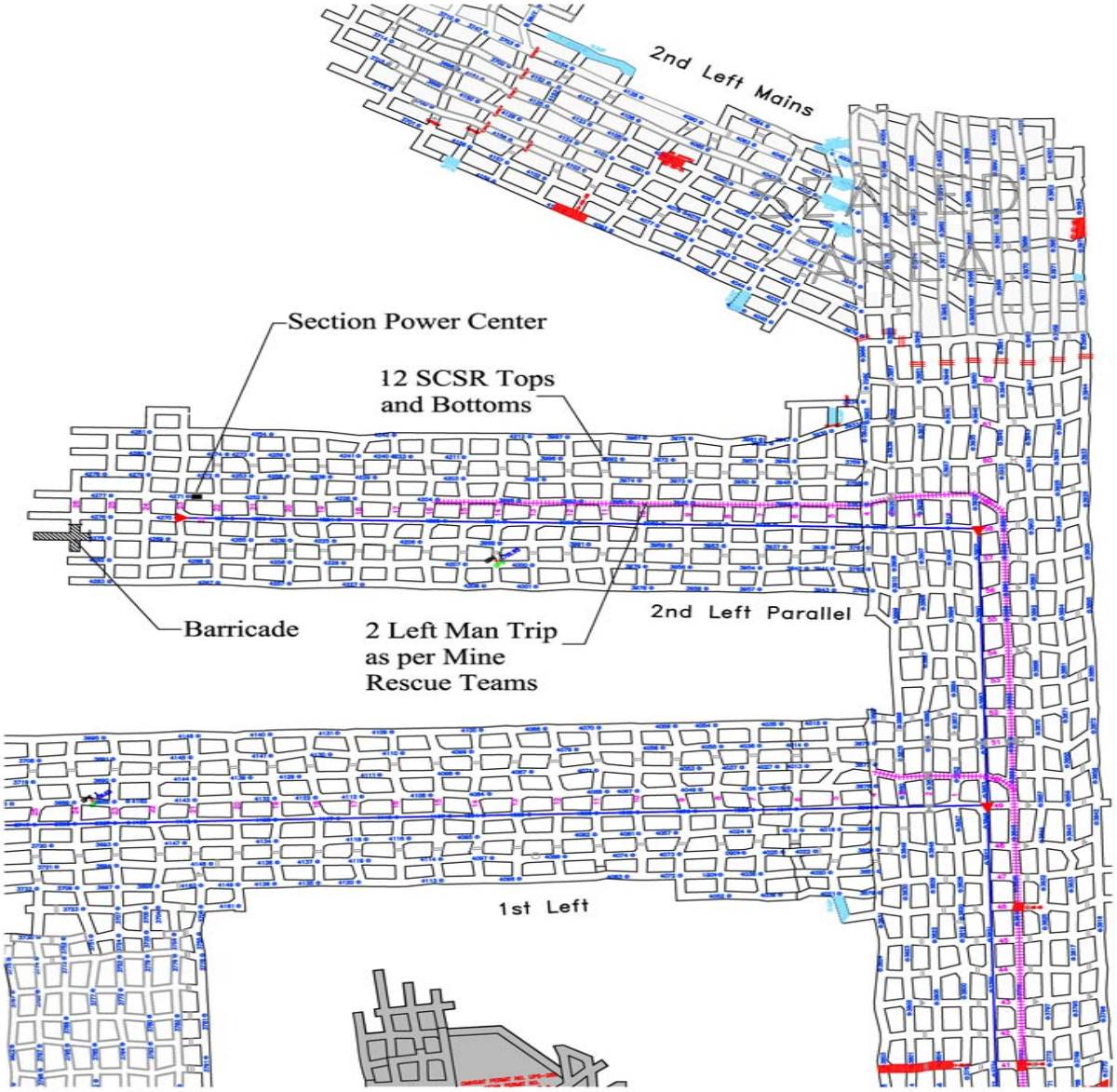
Seals

- **Full Scale Explosion Testing**
  - **A series of full scale tests will be conducted at the Lake Lynn Laboratory, Experimental Mine. The first test was conducted on April 15, 2006.**
    - **The 40” Omega Block Seal was exposed to a pressure of about 23 psi. The seal passed the test.**
    - **The hybrid Omega Block Seal was exposed to a pressure of about 25 psi. The seal passed the test.**
  - **Future tests are planned to evaluate seal construction, impact of standing roof support and higher pressures.**

Gas Detection Equipment and Self-Contained Self-Rescuers

- **Handheld gas detection equipment from the miners in 2nd Left**

- **SCSR's from the miners in 2nd Left**
- **SCSR's from the miners in 1st Left that escaped**


2nd Left Mains
Section Power Center
12 SCSR Tops
and Bottoms
Barricade
2 Left Man Trip
as per Mine
Rescue Teams
2nd Left Parallel
1st Left

Sago Mine Investigation Summary

- **Investigation On-going**
  - **Seals**
  - **Ignition sources**
  - **Interview**
  - **Evaluating evidence**
  - **Data analysis**