Appendix A. Details of Analyses for Each of the Twelve Disasters

1. Darby No. 1 Mine Explosion – May 20, 2006

1	Locations of victims with respect to working face area (if applicable)	Four miners (three of whom perished) were working in B Left Section, roughly 1,000 feet inby the explosion point (which was behind the seals of sealed-off adjacent A Left Section). The three victims had traveled about 1,400 to 1,800 feet from the B Left Section before they perished.
2	Location of victims if not associated with a working face area	The two victims working outby who initiated the explosion behind the seals of A Left were killed instantly by the force of the explosion.
3	Location of victims with respect to fire or explosion point of origin	The two victims killed instantly were right at the explosion point on the outby side of the seals that were destroyed. The other three victims had escaped from their section and were found in the Mains roughly opposite and about 300 feet away from the area of destroyed seals leading into the A Left Section.
4	Would victims have been able to reach a station at 1,000 ft from the faces?	The four miners in B Left would have easily reached a station at 1,000 ft from the faces in the intake escapeway using SCSRs and a lifeline. As it was, they had traveled distances greater than 1,000 feet before they perished.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	Although the three victims from B Left had only traveled 1,400 to 1,800 feet from their section, the survivor had traveled nearly the full 2,000 feet to where a station at 2,000 ft from the faces might have been. With SCSRs and a lifeline, all four would have easily reached a station at 2,000 ft from the faces.
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	None – a station at 2,000 ft from the faces would have held several advantages in this situation.
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	The miners would have attempted escaped well beyond a station at 1,000 ft from the faces and would have either escaped entirely or would have easily reached a station at 2,000 ft from the faces. They would have needed to backtrack to a station at 1,000 ft from the faces. A station at 2,000 ft from the faces would have been subjected to significantly less force and would have been reached several hours sooner by rescuers than a station at 1,000 ft from the faces.
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	NO; no specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study
9	Effect of FLAME on a station at 1,000 ft from the faces	None
10	Effect of FLAME on a station at 2,000 ft from the faces	None
11	Effect of FLAME on a station per OTHER guidelines	N/A

12	Effect of FORCES on a station at 1,000 ft from the faces	Details of forces were not provided. There were stoppings severely damaged in the immediate vicinity of a station at 1,000 ft from the faces, though forces to achieve this could have been as little as 2 - 4 psi. Forces several hundred feet away were as high as 20 psi., so it can be reasonably be expected that a station that could withstand 15 - 20 psi would survive in this location.
13	Effect of FORCES on a station at 2,000 ft from the faces	There was significantly less stopping damage in this location indicating that forces were likely less than 2 - 4 psi.
14	Effect of FORCES on a station per OTHER guidelines	N/A
15	Time that rescuers would have made contact with trapped miners	Rescuers would have likely reached a station at 1,000 ft from the faces within 8 - 10 hours and a station at 2,000 ft from the faces within 3 hours after the explosion.
16	Would additional outby stations have been beneficial?	No; if the miners had been able to escape the immediate area somewhat beyond where a station at 2,000 ft from the faces would have been located, they could have made it safely to clean air.

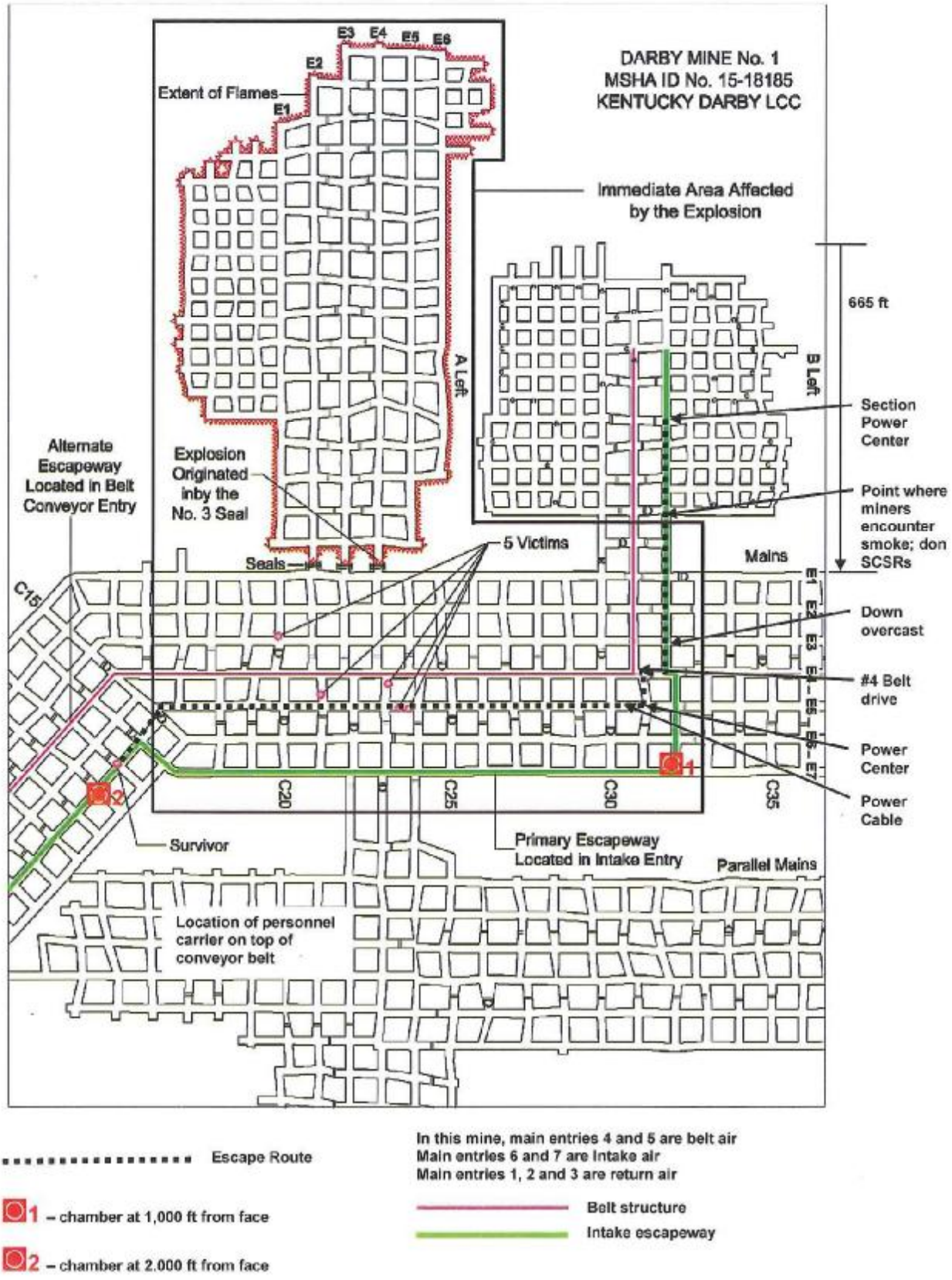

Figure 1. Darby Mine Map

Conclusions from the Darby Disaster:

- The explosion did not occur at a coal producing working face but rather about 1,000 ft outby behind a sealed off adjacent section. Two of the victims (killed instantly) were right at the point of origin because they ignited gas behind the seals.

- Stations at 1,000 ft or 2,000 ft from the faces would have been easily reachable by the miners from B Left section using SCSRs and lifelines. However, the location at 2,000 ft would have been preferable because the miners had already made it that far in their escape attempt, a station at 2,000 ft would have been subjected to significantly less force and rescuers would have reached it several hours sooner.

- Flames would not have affected either a station at 1,000 ft or 2,000 ft from the faces. However, forces up to 15 to 20 psi would have impacted a station at 1,000 ft from the faces and forces of about 2 to 4 psi or less would have impacted a station at 2,000 ft from the faces.

- Rescue teams would have likely reached a station at 1,000 ft from the faces within 8 to 10 hours and a station at 2,000 ft from the faces within 3 hours after the explosion.

- No specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study and outby stations would not have been relevant.

2. Aracoma Alma No. 1 Mine Fire – January 19, 2006

1	Locations of victims with respect to working face area (if applicable)	The No. 2 Section crew was in their working faces when the fire started
2	Location of victims if not associated with a working face area	N/A
3	Location of victims with respect to fire or explosion point of origin	The fire occurred at the No. 9 Headgate longwall belt storage, about 3,500 feet outby the working faces. The fire was located one entry off the intake escapeway but smoke contaminated the escapeway due to a removed stopping.
4	Would victims have been able to reach a station at 1,000 ft from the faces?	Yes, easily. A station at 1,000 ft from the faces would have been about 1,000 feet inby where the retreating miners first encountered heavy smoke, so they would have bypassed it initially but could have easily returned to it if they needed to after encountering the heavy smoke.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	Yes, easily. A station at 2,000 ft from the faces would have been quite close to where the retreating miners first encountered heavy smoke, so they could have either entered it at that point or bypassed it initially in favor of a full escape. Again, they could have easily returned to it if they needed to after encountering the heavy smoke.
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	None in this case – either station would have been easily reachable by the retreating miners and neither would have been more likely than the other to be affected by flames or heat from the fire.
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	Either station would have been easily reachable by the retreating miners. A station at 2,000 ft from the faces would have been reached slightly sooner by rescue crews than a station at 1,000 ft from the faces due to its location further outby
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	NO; no specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study
9	Effect of FLAME on a station at 1,000 ft from the faces	None
10	Effect of FLAME on a station at 2,000 ft from the faces	None
11	Effect of FLAME on a station per OTHER guidelines	N/A
12	Effect of FORCES on a station at 1,000 ft from the faces	N/A - this was a fire with no forces applicable
13	Effect of FORCES on a station at 2,000 ft from the faces	N/A - this was a fire with no forces applicable
14	Effect of FORCES on a station per OTHER guidelines	N/A
15	Time that rescuers would have made contact with trapped miners	A station at 2,000 ft from the faces would have been reached slightly sooner by rescue crews than a station at 1,000 ft from the faces due to its location further outby but either station would have been reached within 48 hours (probably much less).

16	Would additional outby stations have been beneficial?	No; if the victims had been able to escape the immediate area beyond where a station at 2,000 ft from the faces would have been located, they eventually would have made it safely to clean air (as did the miners that successfully escaped).

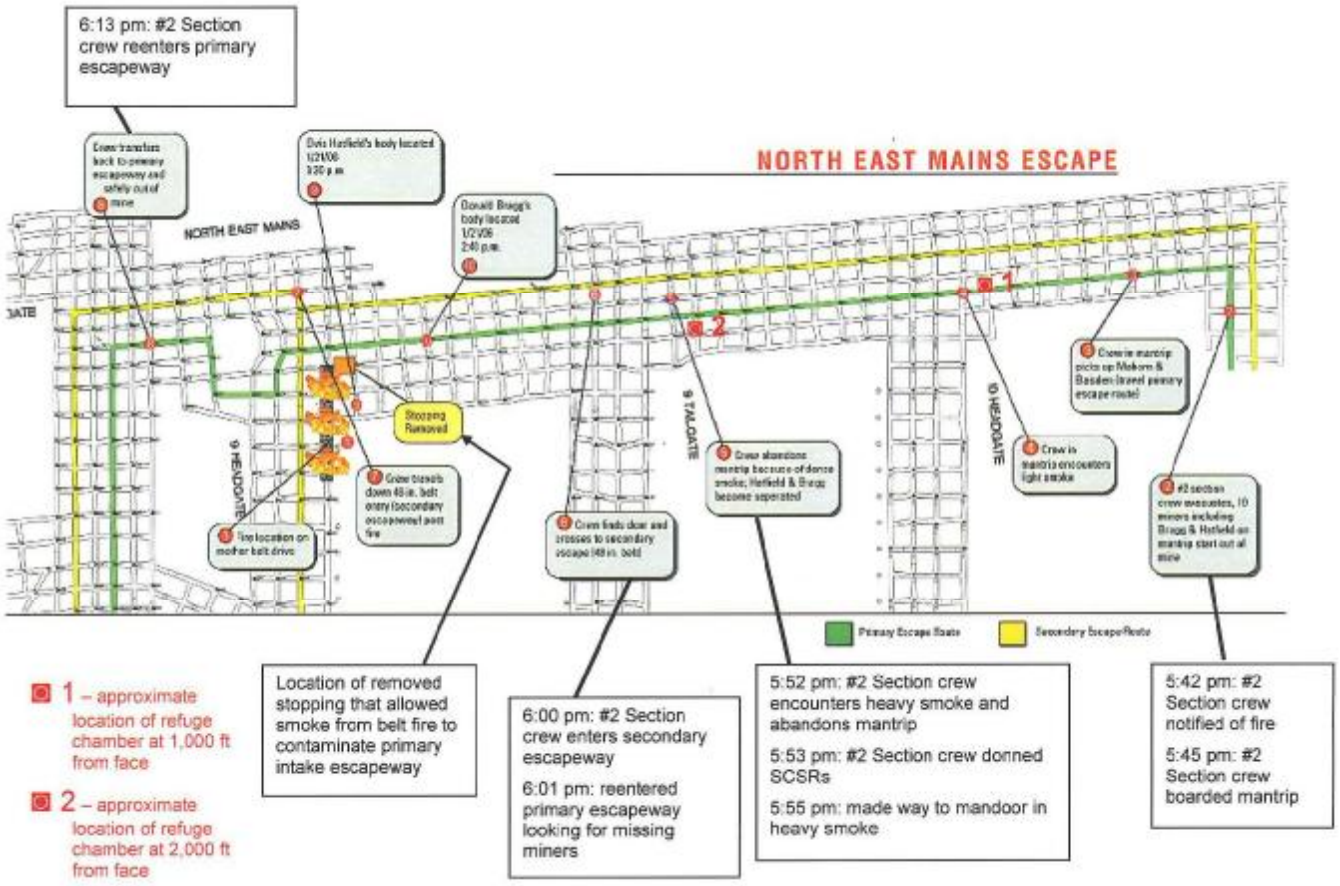

Figure 2. Alma Mine Map

Conclusions from the Alma No. 1 Mine Disaster:

- A station at 1,000 ft or 2,000 ft from the faces would have been easily reachable by the victims using SCSRs and lifelines. Rescue teams would have reached them at either station within 48 hours (and possibly much sooner).

- Neither a station at 1,000 ft nor 2,000 ft from the faces would have been directly affected by flames or heat. There is no significant reason that either a station at 1,000 ft or 2,000 ft from the faces would have been preferred in this situation.

- No specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study and outby stations would not have been relevant.

- As with the Wilberg fire, the Alma fire was associated with a conveyor belt system. This again confirms the suggestion stations never be located within

escapeway crosscuts that are close to belt drives or other potential fire hot spots.

3. Sago Mine Explosion – January 2, 2006

1	Locations of victims with respect to working face area (if applicable)	11 victims were located within the 2nd Left Parallel section near the faces.
2	Location of victims if not associated with a working face area	The 12th victim was found in the track entry of the 2 North Mains about 450 ft outby the seals that were destroyed in the explosion.
3	Location of victims with respect to fire or explosion point of origin	The explosion occurred at the seals that sealed off the 2nd Left Mains, about 2,200 to 2,300 outby the 2nd Left Parallel section within the 2 North Mains.
4	Would victims have been able to reach a station at 1,000 ft from the faces?	Yes, easily for all 12 victims. In fact, the station would have been slightly inby where the miners abandoned their mantrip to begin a walking escape. Once they decided escape was not possible, they would have easily retreated to a station at 1,000 ft from the faces (in lieu of barricading as in the actual disaster).
5	Would victims have been able to reach a station at 2,000 ft from the faces?	A station at 2,000 ft from the faces would have been easily reachable by the 12th victim who was within the 2 North Mains (it would have been 3 crosscuts outby his position). The 11 victims within the 2nd Left Parallel section, however, would have had a much more difficult time reaching the station at 2,000 ft due to smoke and debris. The current regulations requiring each miner to have a second self-rescuer, requiring tethers to keep the crew together, and a lifeline to guide them would have improved the chances of a successful escape to a station at 2,000 ft from the faces.
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	As noted above, the station at 1,000 ft from the faces would have been within the working section, out of the direct line of fire of the explosion and easily reachable by all victims.
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	None – the station at 2,000 ft from the faces in this situation would have been out in the 2 North Mains in the line of fire of the explosion (though forces would have been low) and more difficult for the miners within the 2nd Left Parallel section to reach due to smoke and debris.
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	NO; no specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study
9	Effect of FLAME on a station at 1,000 ft from the faces	None; flame was confined almost entirely to the sealed area of 2nd Left Mains and extended only about 200 ft outby the damaged seals.
10	Effect of FLAME on a station at 2,000 ft from the faces	None; flame was confined almost entirely to the sealed area of 2nd Left Mains and extended only about 200 ft outby the damaged seals.
11	Effect of FLAME on a station per OTHER guidelines	N/A

12	Effect of FORCES on a station at 1,000 ft from the faces	Forces about 550 ft outby the seals were less than 5 psi. One victim of CO poisoning was found in the track entry about 550 ft outby the seals with no evidence of blunt force trauma. Forces at the face of the 2nd Left Parallel Section were estimated at 2 psi. Hence forces on a station at 1,000 ft from the faces would have been somewhere between 2 psi and 5 psi.
13	Effect of FORCES on a station at 2,000 ft from the faces	A station at 2,000 ft from the faces would have been located about 3 crosscuts outby where the victim was found about 550 ft outby the seals. Forces on a station at 2,000 ft from the faces would have been somewhere between 2 psi and 5 psi.
14	Effect of FORCES on a station per OTHER guidelines	N/A
15	Time that rescuers would have made contact with trapped miners	Rescuers would have easily reached a station at 2,000 ft from the faces within about 40 hours and a station at 1,000 ft from the faces within about 48 hours after the explosion based on the timeline of actual events.
16	Would additional outby stations have been beneficial?	Doubtful; it would have been difficult for the miners from 2nd Left Parallel section to make it to a station at 2,000 ft from the faces let alone to a further outby station.

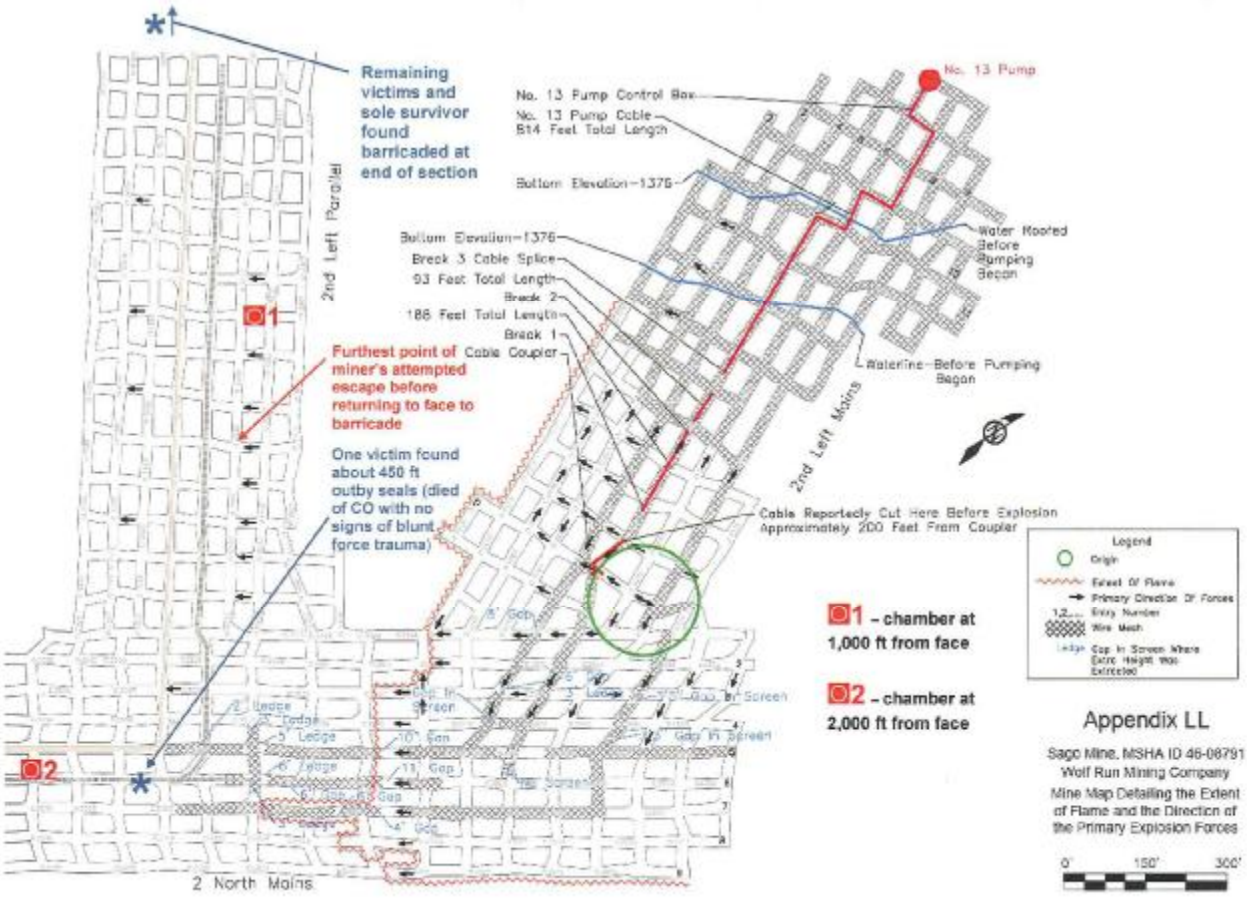

Figure 3. Sago Mine Map

Conclusions from the Sago Disaster:

- The explosion did not occur at a working face but rather at the seals that sealed off the 2nd Left Mains, about 2,200 to 2,300 outby the 2nd Left Parallel section where men were working.

- A station at 1,000 ft from the faces would have been easily reachable by all 12 miners affected by the explosion using SCSRs and lifelines. It would have been within the working section out of the direct line of fire of the explosion. Rescue teams would have reached them at the station within 48 hours.

- A station at 2,000 ft from the faces would have been much more difficult for the miners to reach due to smoke and debris and would have been in the line of fire of the explosion. The station at 1,000 ft from the faces would have been preferred in this situation.

- Neither a station at 1,000 ft nor 2,000 ft from the faces would have been impacted by flames but both would have been impacted by forces in the range of 2 to 5 psi.

- As with the analysis of the Scotia disaster, the Sago disaster shows the benefits of a station located some distance inside the working section away from the junction with the mains, providing protection from explosions occurring in the main entries.

- No specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study and outby stations would not have been relevant.

4. Pyro William Station Mine Explosion – September 13, 1989

1	Locations of victims with respect to working face area (if applicable)	Coal was not being mined in this case but equipment on a completed longwall panel was being recovered. Four of the victims (likely killed instantly) were located right on the face; the other six victims were located in the No. 3 recovery room about 250 feet outby the face.
2	Location of victims if not associated with a working face area	See above.
3	Location of victims with respect to fire or explosion point of origin	It is not certain where the explosion originated, though it most likely originated in the center entry (E2) of the 3 entries adjacent to the mined out longwall panel. This would have been about 450 ft inby the location of the four victims at the face and about 1,000 ft inby the six victims in the No. 3 recovery room.
4	Would victims have been able to reach a station at 1,000 ft from the faces?	The location of a station at 1,000 ft from the faces for this situation is difficult to pinpoint. The panel had finished mining and face equipment was being recovered and moved to the next adjacent panel to be mined. If a portable station would have been moved outby with each 1000 ft of advance, the final location for finishing the panel and panel recovery would have likely been in the 1st Main North Track entry, just outside the range of flame or forces. Lifelines would have clearly aided miners and would have likely prevented at least 4 fatalities.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	Locating a station at 2,000 ft from the faces would follow the same logic. It would also likely be in the 1st Main North Track Entry 1,000 ft further outby and in fresh air. It is unclear whether miners reaching a station at this location would have stopped to recuperate and regroup or would have continued their escape to the outside.
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	The report indicates that some of the six victims not killed instantly were severely injured, others appeared to become disoriented in the heat and smoke, and others removed their FSR's to communicate or help others and were overcome by smoke and CO. Hence it is likely that the closer station at 1,000 ft from the faces would have given them a significantly greater chance of survival than a station at 2,000 ft from the faces further outby.
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	None – see above. Neither a station at 1,000 ft from the faces nor a station at 2,000 ft from the faces would have been subjected to significant flame, heat or forces.
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	NO; no specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study
9	Effect of FLAME on a station at 1,000 ft from the faces	A station at 1,000 ft from the faces would have been just outside the zone of flame impact.
10	Effect of FLAME on a station at 2,000 ft from the faces	A station at 2,000 ft from the faces would have been well outside the zone of flame impact and in fresh air.
11	Effect of FLAME on a station per OTHER guidelines	N/A
12	Effect of FORCES on a station at 1,000 ft from the faces	A station at 1,000 ft from the faces would have been outside the zone of forces as evidenced by the lack of damage to ventilation stoppings at the location.
13	Effect of FORCES on a station at 2,000 ft from the faces	None (well outby the zone of forces)
14	Effect of FORCES on a station per OTHER guidelines	N/A

15	Time that rescuers would have made contact with trapped miners	Attempts to rescue and recover victims started almost immediately by survivors of the crew and by others underground who traveled to their location. There is no timeline for these efforts. Official rescue and recovery teams arrived and entered the mine by 12:23 pm. By this time, slightly more than 3 hours after the explosion, all victims had been recovered.
16	Would additional outby stations have been beneficial?	No; if the miners had been able to escape the immediate area somewhat beyond where a station at 1,000 ft from the faces would have been located, they could have made it safely to clean air.

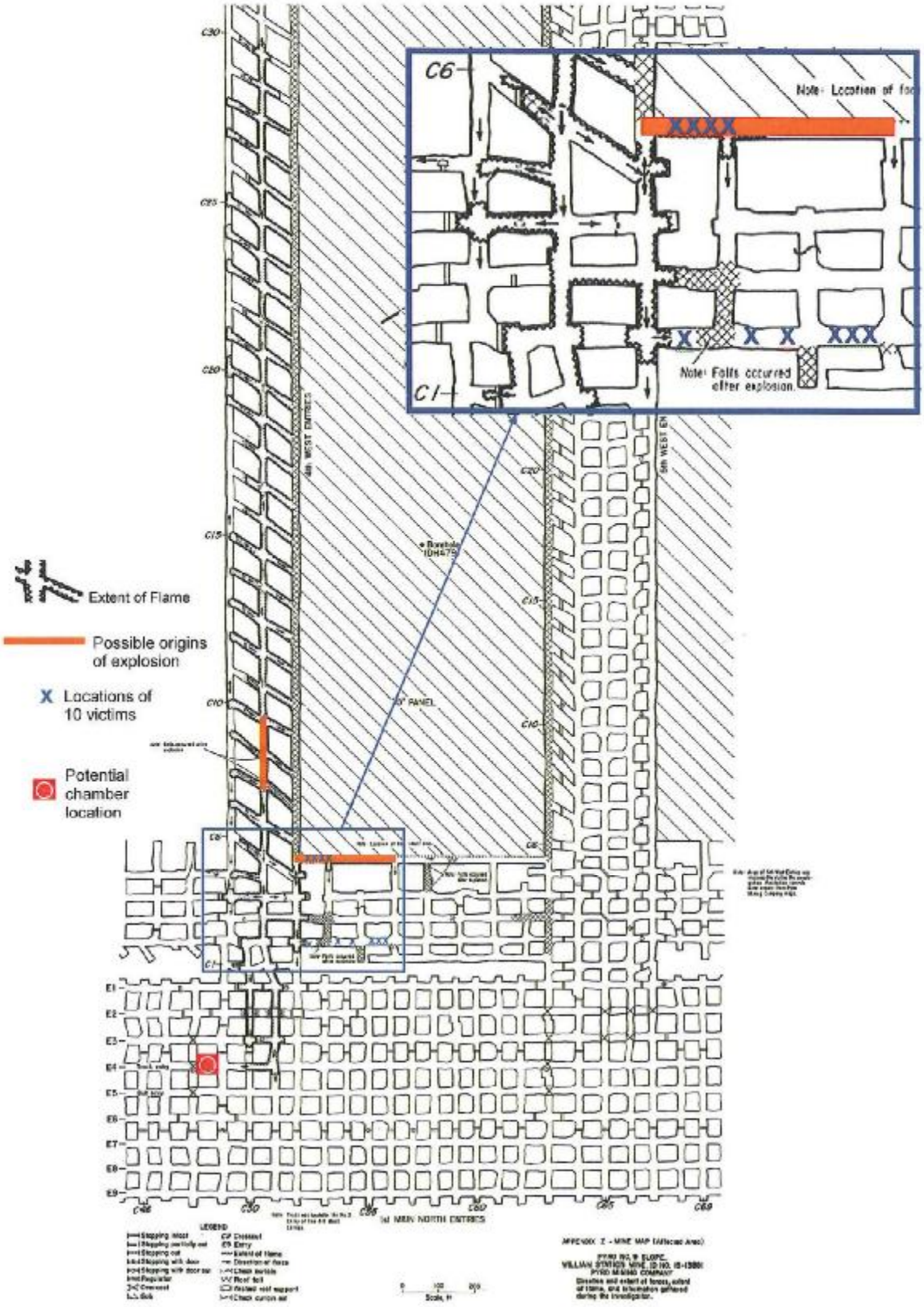

Figure 4. Pyro No. 9 Slope (William Station Mine) Mine Map

Conclusions from the Pyro William Station Disaster:

- Coal was not being mined in this case but equipment on a completed longwall panel was being recovered. It is not certain where the explosion originated, though it was most likely in the center entry of the 3 entries adjacent to the mined out longwall panel about 450 ft inby the longwall face.

- A station at 1,000 ft from the faces guidelines would have been reachable by at least four of the miners affected by the explosion using SCSRs and lifelines. Rescue teams would have reached them at the station within 3 hours (and possibly sooner).

- A station at 2,000 ft from the faces may also have been reachable by four of the miners and would have been in fresh air. However, given the potential injury and disorientation of the miners, the closer station at 1,000 ft from the faces would have given them a better chance of survival.

- Neither a station at 1,000 ft nor 2,000 ft from the faces would have been subjected to flame or explosion forces.

- No specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study and outby stations would not have been relevant.

5. Wilberg Mine Fire – December 19, 1984

1	Locations of victims with respect to working face area (if applicable)	- 13 victims from 1,500 to 1,900 feet from the longwall face: 9 in the "dogleg" and 4 in the belt entry - 10 victims were in the headgate (outby) at or within 200 feet of the longwall face - 3 victims were in the tailgate entry (outby) within 400 feet of the longwall face - 1 victim was located in the bleeder entries a considerable distance from the longwall face
2	Location of victims if not associated with a working face area	N/A
3	Location of victims with respect to fire or explosion point of origin	The fire source was about 2,200 feet outby the longwall face in the same direction that most of the miners had traveled, so 13 victims were within 300 to 700 feet of the fire; 10 victims in the headgate were about 2,000 feet from the fire; the remaining victims in the tailgate and bleeders were well away from the fire
4	Would victims have been able to reach a station at 1,000 ft from the faces?	YES; they passed the location of a station at 1,000 ft from the faces in their attempts to escape and would have easily been able to retreat back to it.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	YES; they ended up advancing to very near where a station at 2,000 ft from the faces would have been located. However, a station at 2,000 ft would have been located quite near the fire source and (though not directly affected by flames) might have been very hot.
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	In this case a station at 1,000 ft from the faces would have been safer due to its location considerably further from the source of the fire. Either station would have been readily reachable by the miners.
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	N/A - see above
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	NO; no specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study
9	Effect of FLAME on a station at 1,000 ft from the faces	N/A
10	Effect of FLAME on a station at 2,000 ft from the faces	N/A, though heat may have been a negative factor
11	Effect of FLAME on a station per OTHER guidelines	N/A
12	Effect of FORCES on a station at 1,000 ft from the faces	N/A - this was a fire with no forces applicable
13	Effect of FORCES on a station at 2,000 ft from the faces	N/A - this was a fire with no forces applicable
14	Effect of FORCES on a station per OTHER guidelines	N/A - this was a fire with no forces applicable

15	Time that rescuers would have made contact with trapped miners	Difficult to be certain (see report text); it's possible that mine personnel might have been able to reach miner's trapped in a station within 2 hours; failing that, rescue teams with oxygen should have been able to reach them within 14 hours, though the fire began to burn out of control at that point; the worst case scenario would have been at 32.5 hours (when rescue teams first reached the victims after the fire was brought back into control)
16	Would additional outby stations have been beneficial?	No; if the miners had been able to escape the immediate area somewhat beyond where a station at 2,000 ft from the faces would have been located, they could have made it safely to clean air.

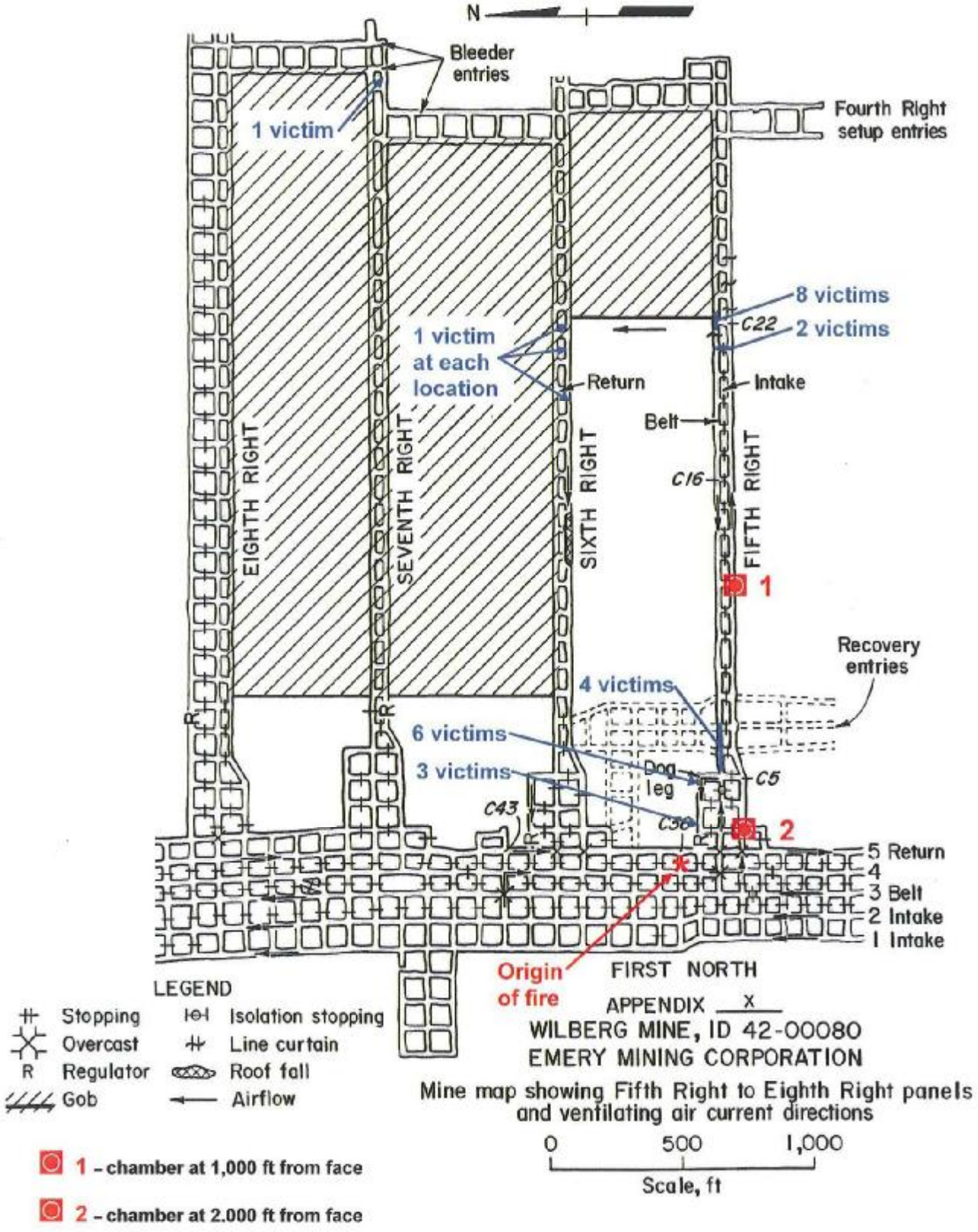

Figure 5. Wilberg Map

Conclusions from the Wilberg Disaster:

- A station at 1,000 ft from the faces would have been easily reachable by all miners affected by the fire using SCSRs and lifelines. Rescue teams would have reached them at the station within 32.5 hours (and possibly much sooner). A station at 1,000 ft from the faces would not have been affected by flame.

- A station at 2,000 ft from the faces would also have been easily reachable by all miners but would have been much closer to the source of the fire. Although not directly affected by flames, it could have been affected by heat. The station at 1,000 ft from the faces location would have been preferred in this situation.

- No specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study and outby stations would not have been relevant.

- Conveyor belt systems, especially belt drives, are potential friction hot spots and have been sources of mine fires in the past. A recommendation for station positioning is to avoid locating them within escapeway crosscuts that are close to belt drives or other potential fire hot spots. Past mine fires and explosions have also often destroyed ventilation overcasts so station locations near overcasts should also be avoided.

6. Scotia Mine Explosion – March 9 and 11, 1976

1	Locations of victims with respect to working face area (if applicable)	*March 9*: 13 of 15 victims in or near entrance of 2 Left off 2 Southeast Main and 2 victims in 2 Southeast Main inby 2 Left…..*1 victim* at No. 22 crosscut, No. 2 entry, 2 Southeast Main + *3 victims* in Nos. 1 and 2 entries, 2 Southeast Mains near entrance to 2 Left + *3 victims* along No. 4 entry in 2 Left + *6 victims* behind partial barricade in No. 5 entry of 2 Left Also….*2 victims* at explosion point between crosscuts 31 and 32 in entry No. 4 of Southeast Main (about 800 ft inby the working faces of 2 Left)
2	Location of victims if not associated with a working face area	*March 11*: all 11 victims were outby in Left Panel of Northeast Main in-line with the explosion that occurred inby within or near the entrance to 2 Left off 2 Southeast Main…..2 additional miners in Left Panel located nearby but just away from the direct line of the explosion escaped uninjured
3	Location of victims with respect to fire or explosion point of origin	*March 9*: 13 victims at working section about 800 ft outby the explosion point (which occurred inby); 2 victims right at the explosion point *March 11*: all 11 victims (and 2 survivors) were about 2,500 ft outby the explosion point
4	Would victims have been able to reach a station at 1,000 ft from the faces?	*March 9*: it appears likely that at least the 6 barricaded victims (and possibly also the 3 other victims within 2 Left) would have been able to reach either a station at 1,000 ft or 2,000 ft from the faces. The other 6 victims were likely injured too severely to attempt to reach a station. *March 11*: all victims were well outby either stations at 1,000 ft or 2,000 ft from the faces, so only outby stations would be relevant. In any event, injuries to all victims appeared too severe for any of them to attempt to reach any station.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	*March 9*: a station at 1,000 ft from the faces would have been better only IF some of the 9 victims for whom a station might have helped were injured or overcome sufficiently to need the closer-in location (the report does not discuss their condition in detail). *March 11*: N/A
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	*March 9*: because the explosion occurred inby, the flame would have impacted a station at 1,000 ft from the faces but not a station at 2,000 ft from the faces. Also, forces (already minimal) might have impacted a station at 2,000 ft from the faces less. *March 11*: N/A
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	*March 9*: because of the unusual location of the explosion inby and somewhat away from the working section, a station 200 ft or so inside 2 Left away from the junction with 2 Southeast Main would have been protected from the flame and explosion forces and very accessible to the miners. However, location strategies for unusual situations can't be predicted ahead of time and locations at 1,000 ft or 2,000 ft from the faces seem reasonable. *March 11*: in this case, stations would probably not have helped due to the severe injuries to the victims. However, if some injured victims had survived, though only enough to search for a station, this explosion shows the viability of maintaining outby stations each 1-hour travel time.
9	Effect of FLAME on a station at 1,000 ft from the faces	*March 9*: flame *would* have affected a station per at 1,000 ft from the faces guidelines (though details of the severity of the flame are not known)

10	Effect of FLAME on a station at 2,000 ft from the faces	*March 9*: flame *would not* have affected a station at 2,000 ft from the faces *March 11*: flame would likely *not* have affected outby stations at 1-hour travel distances.
11	Effect of FLAME on a station per OTHER guidelines	N/A
12	Effect of FORCES on a station at 1,000 ft from the faces	*March 9*: forces would have affected a station at both 1,000 ft and 2,000 ft from the faces, though potentially somewhat more to the closer station at 1,000 ft from the faces *March 11*: forces would likely *not* have affected outby stations at 1-hour travel distances.
13	Effect of FORCES on a station at 2,000 ft from the faces	
14	Effect of FORCES on a station per OTHER guidelines	N/A
15	Time that rescuers would have made contact with trapped miners	*March 9*: potentially minutes after the explosion to a station at 2,000 ft from the faces; 10+ hours to a station at 1,000 ft from the faces; *March 11*: about 12-13 hours after the explosion
16	Would additional outby stations have been beneficial?	No, but as noted above for the March 11 explosion, if some injured victims had survived, though only enough to search for a station, this explosion shows the viability of maintaining outby stations each 1-hour travel time.

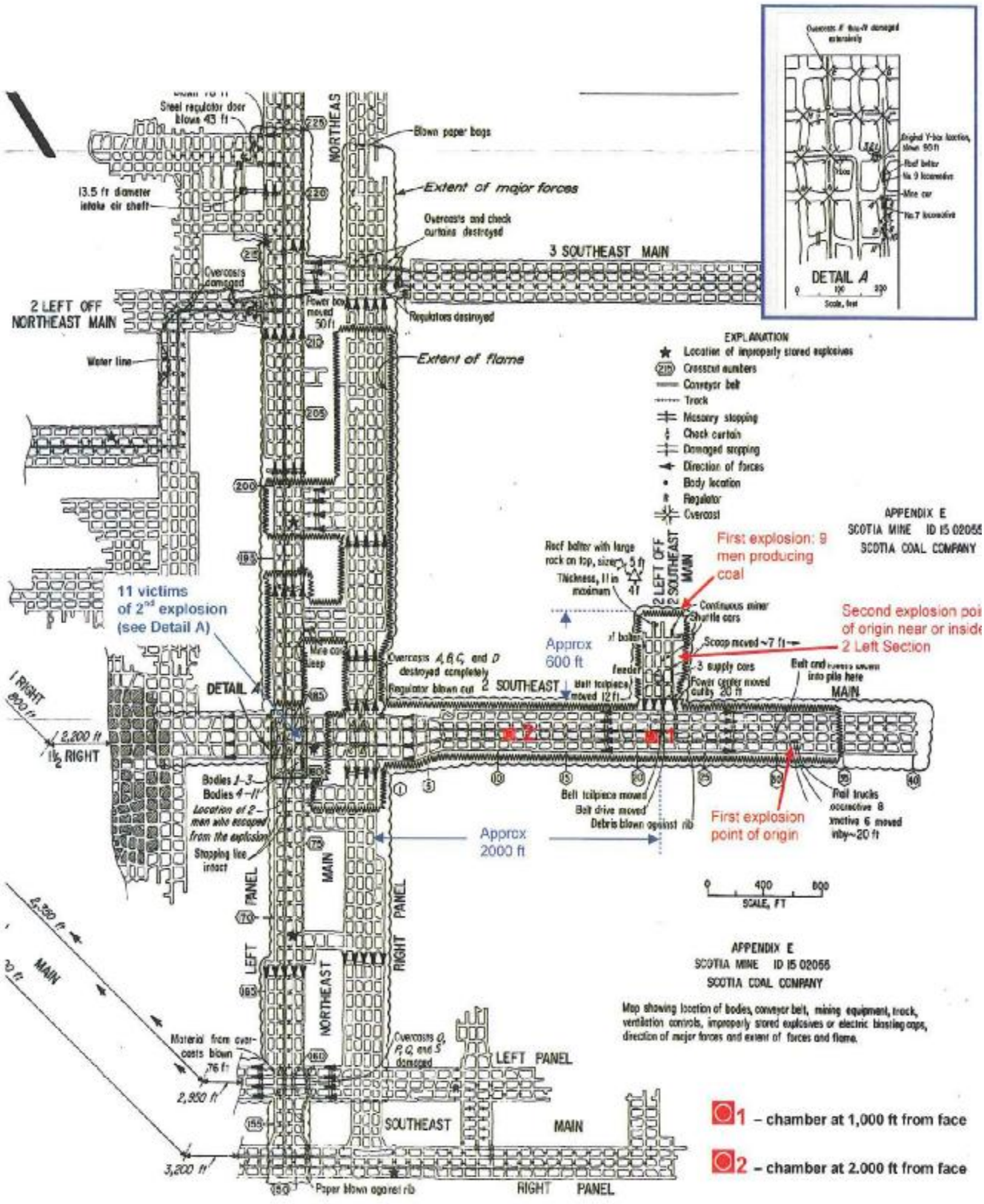

Figure 6. Scotia Mine Map

Conclusions from the Scotia Disaster:

- Neither the March 9 nor March 11 explosions occurred at the working sections. The March 9 explosion originated within the main entries about 800 ft inby the coal producing section off the mains. The March 11 explosion originated about 2,500 ft inby the location of the victims (who were working at an outby location).

- A station at 1,000 ft from the faces would likely have been reachable by at least 9 miners affected by the March 9 explosion using SCSRs and lifelines. Rescue teams would have reached them at the station within 10+ hours. A station at 1,000 ft from the faces ***would*** have been affected by flames.

- A station at 2,000 ft from the faces should also have been reachable by the 9 miners affected by the March 9 explosion (as long as they were not so severely injured as to be unable to travel the extra distance). Rescue teams would have reached them at the station within minutes. A station at 2,000 ft from the faces would ***not*** have been affected by flames.

- Both a station at 1,000 ft and 2,000 ft from the faces would have been affected by forces of the March 9 explosion; the closer station at 1,000 ft from the faces would likely have been subjected to somewhat higher forces.

- A station at 2,000 ft from the faces would have been the preferred location in the case of the March 9 explosion (unless the miners were injured so severely as to not be able to reach it). It would have been subjected to lesser explosion forces, would not have been impacted by flame and would likely have been reached much sooner by rescuers.

- All victims of the March 11 explosion likely died instantly or soon after the explosion and were probably too injured to reach any station. In any event, a station at 1,000 ft or 2,000 ft from the faces would have been located well inby the positions of the victims and not applicable. This is a case where, if the details of the explosion had been different, only outby stations could have helped the miners.

- Regarding possible station locations for working sections other than as specified at 1,000 ft or 2,000 ft from the faces, the March 9 Scotia disaster was similar to the Sago disaster in that miners within a working section off main entries were trapped inside their sections due to an explosion that occurred out in the main entries inby their location. In these cases, it would have been preferable to maintain a refuge station some distance inside their sections away from the junction with the mains. Although it is not possible to predict ahead of time that a disaster of this nature might occur, it might be a sensible protocol to establish a station within a dead-ended working section just as soon as possible after the section has advanced deeply enough to

accommodate it. Other than that, no specific rationale for a station location different from either at 1,000 ft or 2,000 ft from the faces surfaced in this study.

7. Oakwood Red Ash No. 4 Mine Explosion – September 25, 1973

1	Locations of victims with respect to working face area (if applicable)	N/A – see below
2	Location of victims if not associated with a working face area	The two men affected by the explosion were traveling in an abandoned section of the mine to look for abandoned mining equipment and examine the area; the active working areas were 6,000 feet away (not relevant to the explosion).
3	Location of victims with respect to fire or explosion point of origin	The two victims were right at the point of origin because the vehicle they were traveling in ignited gas.
4	Would victims have been able to reach a station at 1,000 ft from the faces?	It is likely that if a station had existed in the area before it had been mined out, it would have been relocated and so not available to the victim. If, however, a station had remained, if the men had been able to don and use SCSRs and if the extent of their injuries had not been too severe, they would have likely been able to reach a station at 1,000 ft from the faces.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	Ditto the discussion for stations at 1,000 ft from the faces above. Since the report doesn't discuss the extent of injuries to the victims, it is not possible to speculate on whether the miners could have reached either a station at 1,000 ft or 2,000 ft from the faces.
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	If a station at 1,000 ft from the faces had remained in the abandoned area, it would have been much closer to the victims than a station at 2,000 ft from the faces. This could have been important depending on the extent of injuries to the victims.
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	If a station at 2,000 ft from the faces had remained in the abandoned area, it would have been further away and so would have ***not*** been subjected to the flame from the explosion whereas a station at 1,000 ft from the faces would have. Both stations would have been subjected to the forces of the explosion, though the forces were minimal (and would have likely impacted a station at 2,000 ft from the faces even less than a station at 1,000 ft from the faces).
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	N/A since the explosion occurred well away from active working areas.
9	Effect of FLAME on a station at 1,000 ft from the faces	Flame ***would*** have impacted a station at 1,000 ft from the faces
10	Effect of FLAME on a station at 2,000 ft from the faces	Flame ***would not*** have impacted a station at 2,000 ft from the faces
11	Effect of FLAME on a station per OTHER guidelines	N/A
12	Effect of FORCES on a station at 1,000 ft from the faces	Forces ***would*** have impacted a station at 1,000 ft from the faces, though forces were minimal
13	Effect of FORCES on a station at 2,000 ft from the faces	Forces ***would*** have impacted a station at 2,000 ft from the faces, though forces were minimal. In any event, they would have likely impacted a station at 2,000 ft from the faces even less than a station at 1,000 ft from the faces.

14	Effect of FORCES on a station per OTHER guidelines	N/A
15	Time that rescuers would have made contact with trapped miners	Within less than 21 hours (had a station existed in the area)
16	Would additional outby stations have been beneficial?	Doubtful, since an outby station would have likely been located well away from the abandoned area. Since the report doesn't discuss the extent of injuries to the victims, it is not possible to speculate on whether the miners could have reached an outby station.

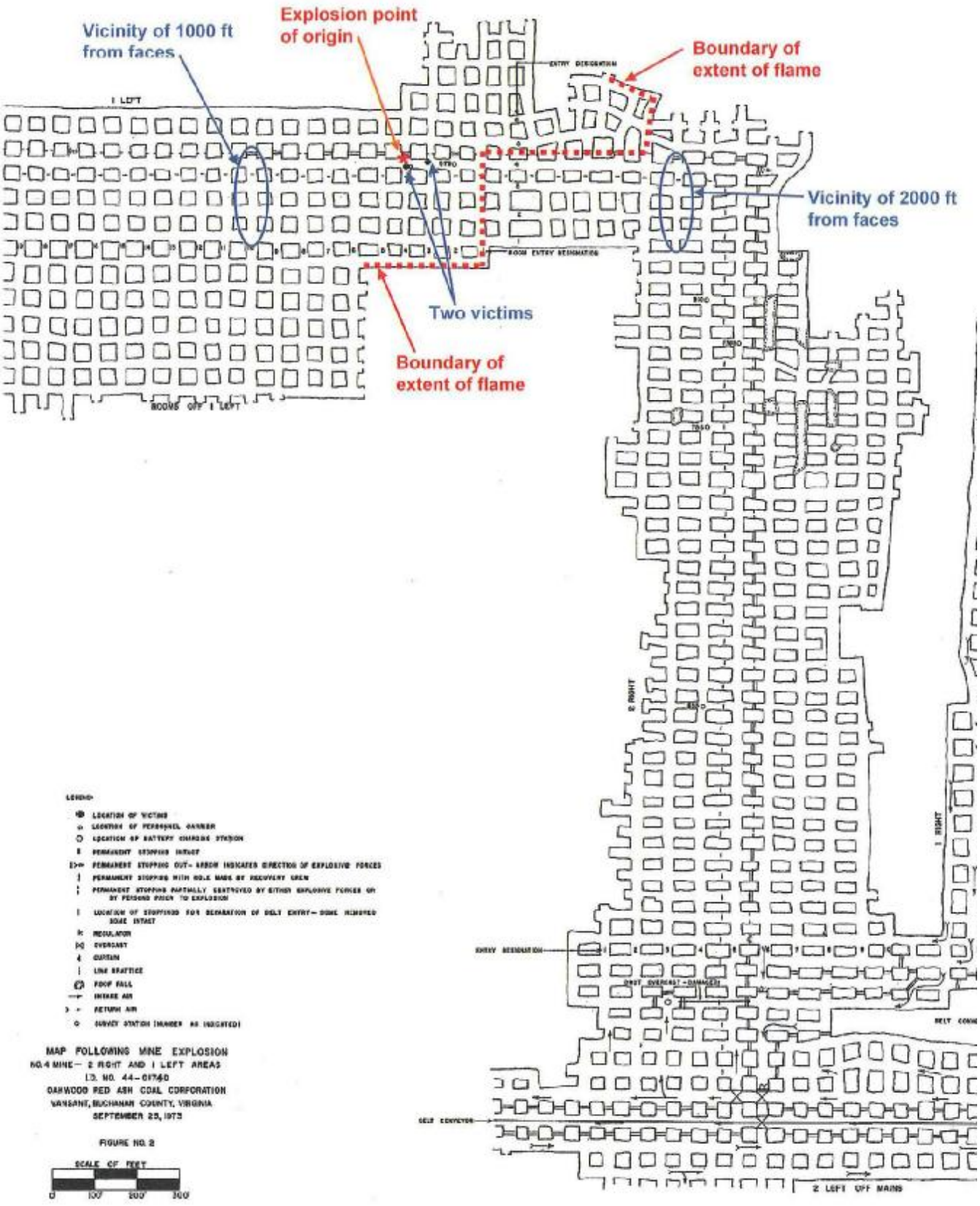

Figure 7. Oakwood Red Ash No. 4 Mine Map

Conclusions from the Oakwood Red Ash No. 4 Mine Disaster:

- The explosion did not occur at a coal producing working face but rather in an abandoned area of the mine where two miners were searching for abandoned mining equipment. They were right at the point of origin because the vehicle they were traveling in ignited gas.

- Stations at 1,000 ft or 2,000 ft from the faces would likely not have existed any longer in this area of the mine and so would not have been applicable in this case. If, however, a station had remained, if the men had been able to don and use SCSRs and if the extent of their injuries had not been too severe, they would have likely been able to reach either a station at 1,000 ft or 2,000 ft from the faces (or an outby station if one had been located in the vicinity).

- If a station at 1,000 ft from the faces had remained in the area, it would have been impacted by both flame and forces (though forces would have been minimal). A station at 2,000 ft from the faces would not have been impacted by flame but would have been impacted minimally by forces.

- No specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study.

- This disaster suggests that it could be important to maintain stations either at 1,000 ft or 2,000 ft from the faces for abandoned or mined out areas of mines as long as there is likelihood that miners will still need to access those areas, particularly since they may not be as well ventilated as more active working sections.

8. Itmann No. 3 Mine Explosion – December 16, 1972

1	Locations of victims with respect to working face area (if applicable)	All 8 miners affected (5 killed and 3 injured) were traveling out of the mine on a mantrip at shift's end and were about 1,000 feet away from their working faces when a dislodged trolley pole on their mantrip caused the explosion.
2	Location of victims if not associated with a working face area	N/A
3	Location of victims with respect to fire or explosion point of origin	All 8 affected miners were right at the point of the explosion.
4	Would victims have been able to reach a station at 1,000 ft from the faces?	By coincidence only, the explosion occurred at a point about 1,000 feet from the faces and so very nearby a potential location of a station at 1,000 ft from the faces. Given this fact and the severe injuries of the 3 miners not killed instantly, it is assumed that 2 of the injured miners probably would have been able to reach a station if it had been clearly marked. The third injured miner appeared too severely injured to have made it to a station even close by.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	No, given the severity of their injuries it is unlikely that any of the 3 injured miners could have traveled the approximate 1,000 ft to a station at 2,000 ft from the faces.
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	A station at 1,000 ft from the faces would have been adjacent to the injured miners. However, this was a coincidence and the explosion could have occurred just as easily next to a station at 2,000 ft from the faces, or to some other location not near a station at all.
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	None – a station at 2,000 ft from the faces would have been too far away to help the severely injured miners.
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	NO; no specific rationale for a station location different from either at 1,000 ft or 2,000 ft from the faces surfaced in this study given the impossibility of predicting where a random explosion might occur in a case such as this.
9	Effect of FLAME on a station at 1,000 ft from the faces	Flame extended about 650 ft inby and outby the site of the explosion in the intake track entry and lesser distances in the adjacent intake entry. It would have impacted a nearby station at 1,000 ft from the faces with temperatures likely less than 450 Deg F.
10	Effect of FLAME on a station at 2,000 ft from the faces	Flame would not have reached a station at 2,000 ft from the faces in this instance.
11	Effect of FLAME on a station per OTHER guidelines	N/A
12	Effect of FORCES on a station at 1,000 ft from the faces	There was stopping damage in the immediate vicinity of the explosion. The lack of physical trauma on the victims and the limited extent of stopping damage would indicate forces in the 2 - 4 psi range at a station at 1,000 ft from the faces.

13	Effect of FORCES on a station at 2,000 ft from the faces	There was minimal stopping damage at the location of a station at 2,000 ft from the faces, indicating pressures of less than 2psi.
14	Effect of FORCES on a station per OTHER guidelines	N/A
15	Time that rescuers would have made contact with trapped miners	Rescuers would have reached a station at 2,000 ft from the faces within 4 1/2 hours and a station at 1,000 ft from the faces within 5 hours after the explosion.
16	Would additional outby stations have been beneficial?	No; given the extent of their injuries, the miners would not have been able to make it to an outby station.

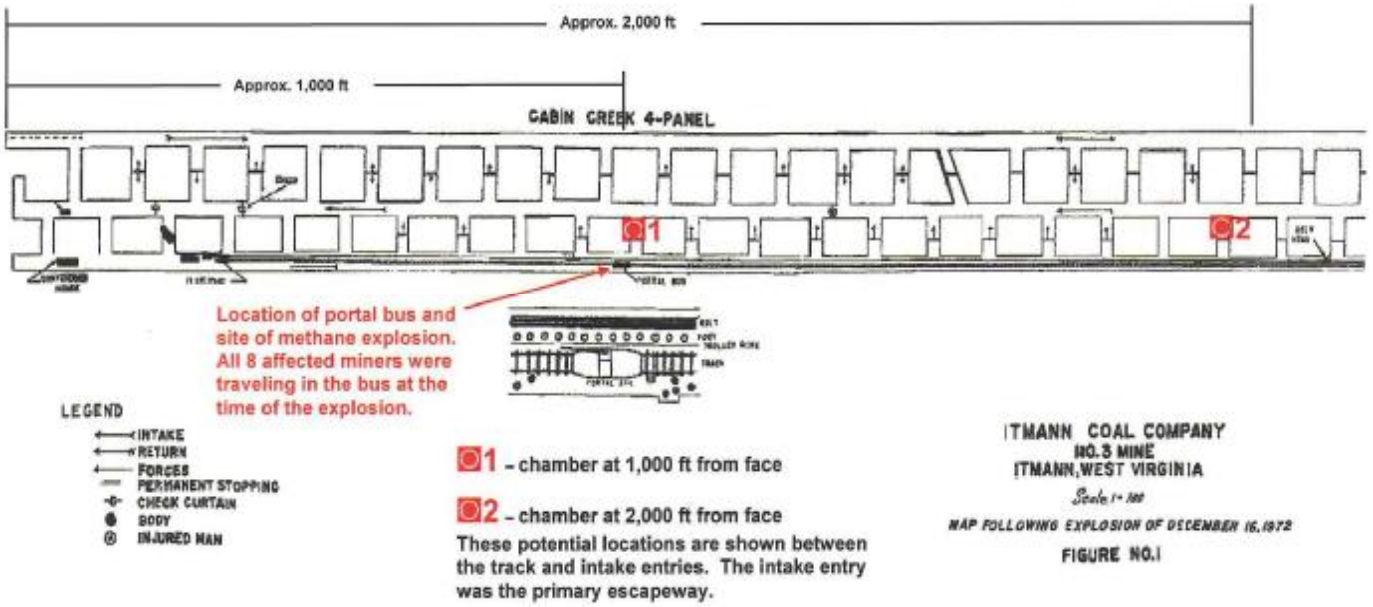

Figure 8. Itmann No. 3 Mine Map

Conclusions from the Itmann Disaster:

- The explosion did not occur at a coal producing working face but rather along the travelway from the face out of the section (at a point about 1,000 feet outby the face). All miners affected by the explosion were right at the point of the explosion because a dislodged trolley pole on their mantrip caused it.

- By coincidence only, the explosion occurred at a point about 1,000 feet from the faces and so very nearby a potential location of a station at 1,000 ft from the faces. Given the severe injuries of the 3 miners not killed instantly, it is assumed that 2 of them may have been able to reach the station. The third injured miner appeared too severely injured to have made it to the station. None of the miners would have been able to reach a station at 2,000 ft from the faces. Rescue teams would have reached the station at 1,000 ft from the faces within 5 hours.

- The station at 1,000 ft from the faces location would have needed to be flame resistant and withstand forces in the 2 to 4 psi range.

- No specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study given the impossibility of predicting where a random explosion might occur in a case such as this.

9. Blacksville No. 1 Mine Fire – July 22, 1972

1	Locations of victims with respect to working face area (if applicable)	Victims from A-2 Section were found 600 to 800 feet outby their working longwall face; the victims from A-3 Section were found nearly 3,000 feet outby their longwall development face.
2	Location of victims if not associated with a working face	N/A
3	Location of victims with respect to fire or explosion point of origin	The fire was located in the track entry of the 3 North Mains between the A-1 and A-2 Sections. In attempting to escape, the crews from both the A-2 and A-3 sections were advancing in the direction of the fire. The A-2 crew was found about 1,200 feet inby the fire and the A-3 crew was found about 500 feet inby the fire.
4	Would victims have been able to reach a station at 1,000 ft from the faces?	The victims in Section A-2 were found about 400 ft inby where a station at 1,000 ft from the faces would have been located. The report did not indicate if they had used self-rescuers or if they had advanced beyond this point and were forced to retreat by the intensity of the fire. It is likely that if they had used SCSRs and a lifeline, they would have been able to reach a station at 1,000 ft from the faces. The A-3 crew would have easily reached a station at 1,000 ft from the faces. They had advanced about 1,500 feet beyond its location before they perished and, with SCSRs and a lifeline, should have been able to retreat back to it if necessary due to the intensity of the fire.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	A station at 2,000 ft from the faces would have been outby the mouth of the Section in the 3 North Mains very close to the source of the fire and not viable for the A-2 Section crew. A station at 2,000 ft from the faces would have been easily reachable by the A-3 crew (they had already passed its location before they perished).
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	In Section A-2, a station at 1,000 ft from the faces could have saved the victims but a station at 2,000 ft from the faces would not have been viable due to its location outby the mouth of the section and very close to the fire. In Section A-3, a station at 1,000 ft from the faces would not have been subjected to significant forces or flame whereas a station at 2,000 ft from the faces would have been exposed to heat and at least some force from the explosion on July 24.
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	In Section A-3, a station at 2,000 ft from the faces would have been much closer to the point where the miners perished since they had advanced about 2,500 feet from their work area (less distance to backtrack if forced to seek refuge).
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	NO; no specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study
9	Effect of FLAME on a station at 1,000 ft from the faces	In Section A-2, heat and flame would have impacted a station at 1,000 ft from the faces. In Section A-3, a station at 1,000 ft from the faces would have likely been far enough away to not be impacted.
10	Effect of FLAME on a station at 2,000 ft from the faces	In Section A-2, a station at 2,000 ft from the faces would have been very close to the fire and certainly impacted by heat and flame. In Section A-3, a station at 2,000 ft from the faces would also have likely been impacted by heat and flame.
11	Effect of FLAME on a station per OTHER guidelines	N/A

12	Effect of FORCES on a station at 1,000 ft from the faces	In Section A-2, a station at 1,000 ft from the faces would likely have been exposed to overpressure generated by the explosion inby the fire. No data is provided in the report; however, MSHA's description indicates that the forces were likely only a few psi. In Section A-3, forces would have been even lower on a station at 1,000 ft from the faces.
13	Effect of FORCES on a station at 2,000 ft from the faces	In Section A-3, a station at 2,000 ft from the faces would have likely been exposed to forces similar to those of the station at 1,000 ft from the faces in Section A-2 (see above).
14	Effect of FORCES on a station per OTHER guidelines	N/A
15	Time that rescuers would have made contact with trapped miners	Rescuers would not have been able to reach the stations from underground due to the intensity of the fire. Stations would have been viable if their locations were pre-surveyed. A flame resistant, explosion proof station with 96 hours of breathable air would give rescuers adequate time to at least drill a hole to the station large enough to supply air, water, and food. This would provide the time required for rescuers to either reach the miners from another direction underground or to drill an escape shaft from the surface.
16	Would additional outby stations have been beneficial?	No; if the miners had been able to escape the immediate area somewhat beyond where the fire was burning, they could have made it safely to clean air.

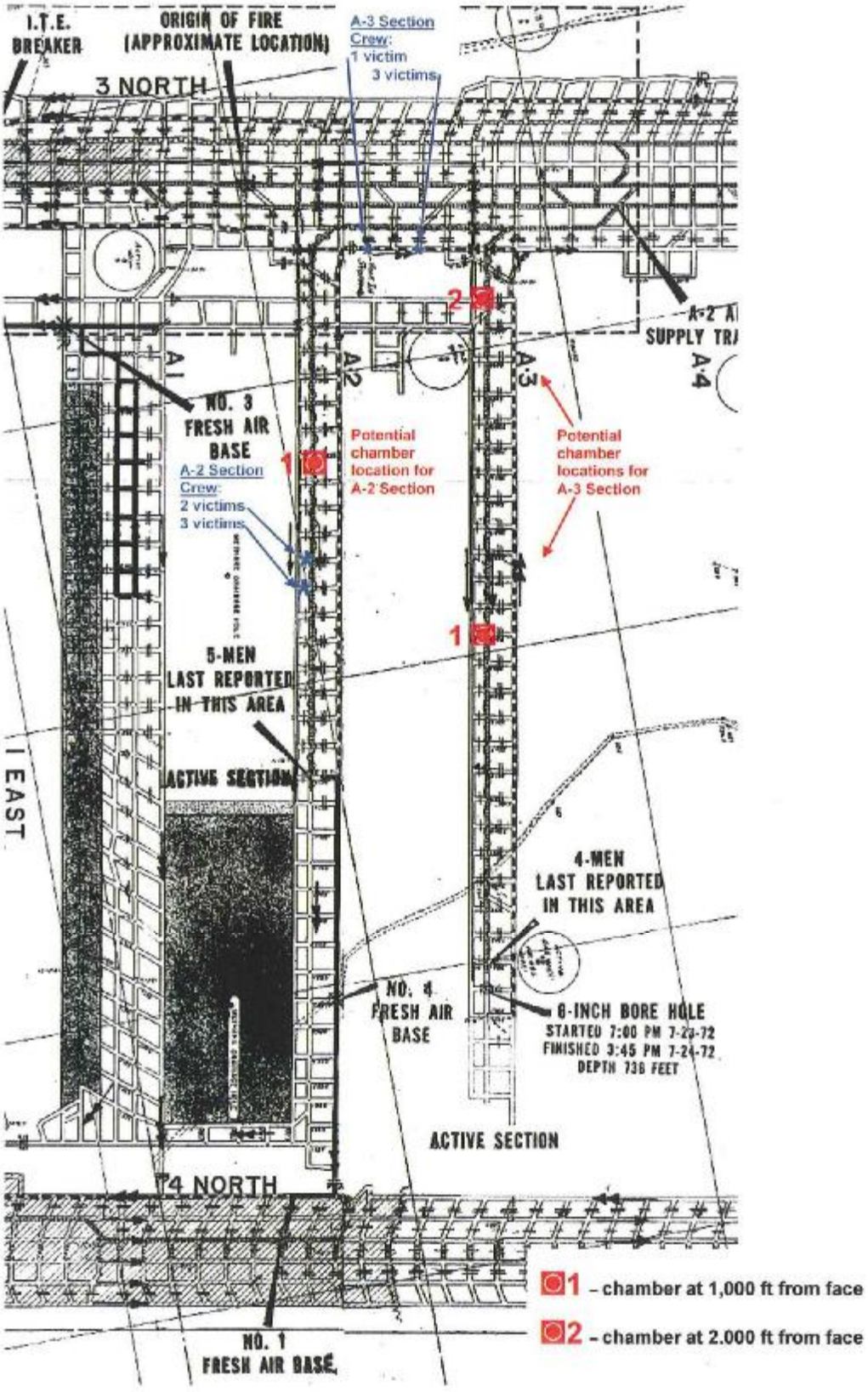

Figure 9. Blacksville No. 1 Mine Map

Conclusions from the Blacksville No. 1 Mine Disaster:

- A station at 1,000 ft from the faces should have been reachable by all miners affected by the fire using SCSRs and lifelines. For A-2 Section, a station at 1,000 ft from the faces would have been impacted by heat, flame and forces; for A-3 Section, a station would have been impacted by minor explosion forces but likely not by flame or heat.

- A station at 2,000 ft from the faces for the A-3 Section would have been easily reachable by the miners in that section. However, a station at 2,000 ft from the faces for the A-2 section would have been close to the source of the fire and not viable for the miners in that section; also, it would have been subjected to forces from the explosion. For A-3 Section, a station at 2,000 ft from the faces would have been somewhat impacted by heat, flame and forces.

- No specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study and outby stations would not have been relevant.

- This fire occurred in the track entry on equipment being moved in the entry. Fires and explosions have occurred in track entries in the past due to the prevalence of equipment, supplies and moving electrical and mechanical systems along the track. Although MSHA regulations preventing the movement of equipment while miners are located inby will prevent similar disasters in most cases, another suggestion for station positioning might be to avoid locating them within or off track entries when other options are available.

10. Nemacolin Mine Fire – March 26, 1971

1	Locations of victims with respect to working face area (if applicable)	One victim was found right at his face work area next to a roof bolter; the other victim was found about 1,100 feet outby the faces
2	Location of victims if not associated with a working face area	The second victim (who was found 1,100 feet outby) was originally working on installation of a stopping somewhere on the right side of the section (report does not say how far he was from faces or fire)
3	Location of victims with respect to fire or explosion point of origin	The fire was 3 crosscuts (about 300+ ft) outby the faces. The victim near his roof bolter was 4 entries to the left and 3+ crosscuts inby the fire; the second victim was at an undisclosed location on the right hand side of the section installing a stopping (not sure how close to the fire)
4	Would victims have been able to reach a station at 1,000 ft from the faces?	With SCSRs and lifelines, both miners would have likely reached a station at 1,000 ft from the faces but presumably would not have stopped there because they would have reached it while the air was still good and they would have continued to escape the mine.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	-- Ditto for a station at 2,000 ft from the faces --
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	None in this situation (presuming neither of the two victims was sufficiently injured or disoriented to require aborting an escape attempt to take refuge in a station)
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	None in this situation since it is very likely that a station would not have been used in lieu of escaping the mine. Generally speaking, in the case of fires, the further a station is located from the source of the fire the better the chances of it not being affected by flames or thick smoke and the less time it would take for rescuers to arrive there (though this is balanced by the greater risk and time required for miners to reach the station).
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	NO; no specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study
9	Effect of FLAME on a station at 1,000 ft from the faces	Flame would not have impacted a station at 1,000 ft from the faces
10	Effect of FLAME on a station at 2,000 ft from the faces	Flame would not have impacted a station at 2,000 ft from the faces
11	Effect of FLAME on a station per OTHER guidelines	N/A
12	Effect of FORCES on a station at 1,000 ft from the faces	N/A - this was a fire with no forces applicable
13	Effect of FORCES on a station at 2,000 ft from the faces	N/A - this was a fire with no forces applicable
14	Effect of FORCES on a station per OTHER guidelines	N/A

15	Time that rescuers would have made contact with trapped miners	Difficult to say based on the report. Aside from attempts of some of the miners already on the section to locate their missing comrades, no actual mine rescue efforts under oxygen were made before the fire got out of hand to the point where it was necessary to flood the section. Had stations existed and had the victims made their way to a station, it is likely that rescuers would have been able to reach the station in well under the 5 hours that transpired before the mine was evacuated due to dangerous air conditions.
16	Would additional outby stations have been beneficial?	No; if the miners had been able to escape the immediate area somewhat beyond where a station at 1,000 ft from the faces would have been located, they could have made it safely to clean air.

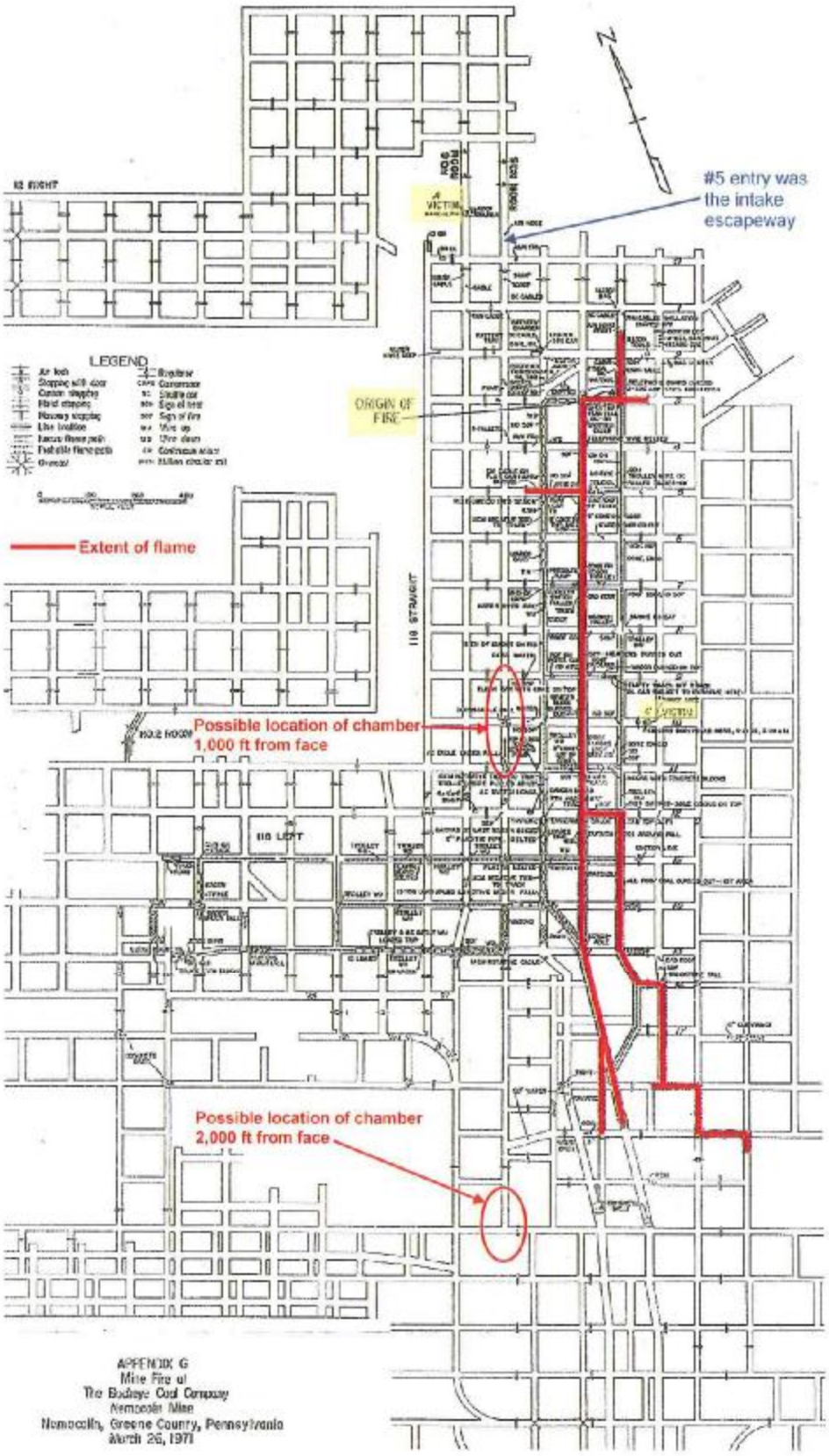

Figure 10. Nemacolin Mine Map

Conclusions from the Nemacolin Disaster:

- A station either at 1,000 ft or 2,000 ft from the faces would have been easily reachable by both miners using SCSRs and lifelines. However, they would have found good air in the process and likely continued on to escape the mine (same as the other miners who successfully escaped). If they ***had*** chosen to stay in a station, rescue teams would have likely reached them in well under the 5 hours that transpired before the mine was evacuated due to dangerous air conditions.

- Flames would not have affected a station at either 1,000 ft or 2,000 ft from the faces.

- No specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study and outby stations would not have been relevant.

11. Finley No. 15 and 16 Mine Coal Dust Explosions – December 30, 1970

1	Locations of victims with respect to working face area (if applicable)	No. 15 Mine: 21 miners located at various places in the 2nd Right section No. 16 Mine: 17 miners located at various places in the 1st Left section. Most of the miners in each section were near the faces.
2	Location of victims if not associated with a working face area	Some of the 38 victims were located considerable distances away from their active faces elsewhere in their sections. Location relative to the working areas is not particularly relevant given that 33 miners died instantly from the explosion.
3	Location of victims with respect to fire or explosion point of origin	No. 15 Mine: victims ranged from 600 to 1,500 feet from the point of origin No. 16 Mine: victims ranged from 150 to 400 feet from the point of origin
4	Would victims have been able to reach a station at 1,000 ft from the faces?	The report does not give details on the extent of injuries of the 5 miners that initially survived the explosion so it is unclear if they could have reached a station if SCSRs had been available. Also, the seam height was less than 36 inches so travel speed would have been severely impacted. Note that a single station would have serviced both mines active faces.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	A station at 2,000 ft from the faces would likely not have been provided because it would have been located within about 400 feet of the mine portals.
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	N/A
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	N/A
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	NO; no specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study
9	Effect of FLAME on a station at 1,000 ft from the faces	A station at 1,000 ft from the faces would have been within 1000 feet of where the explosion occurred and within the area showing destroyed stoppings and flame spread. This would indicate that a station in this location would have needed to be explosion proof and flame resistant.
10	Effect of FLAME on a station at 2,000 ft from the faces	N/A
11	Effect of FLAME on a station per OTHER guidelines	N/A
12	Effect of FORCES on a station at 1,000 ft from the faces	A station at 1,000 ft from the faces would have needed to be explosion proof (see Item No. 9 above).
13	Effect of FORCES on a station at 2,000 ft from the faces	N/A
14	Effect of FORCES on a station per OTHER guidelines	N/A

15	Time that rescuers would have made contact with trapped miners	Rescue teams from the Bureau of Mines and State entered No. 15 Mine at 3:00 pm and No. 16 Mine at 4:00 pm on 12/30. The first bodies were reached by 7:00 pm on 12/30, about 6.5 hours after the explosion. All rescuers and bodies were out of the mine by 10:00 am on 12/31, about 21.5 hours after the explosion.
16	Would additional outby stations have been beneficial?	N/A – the mine portals were only about 2,400 ft away from the working faces.

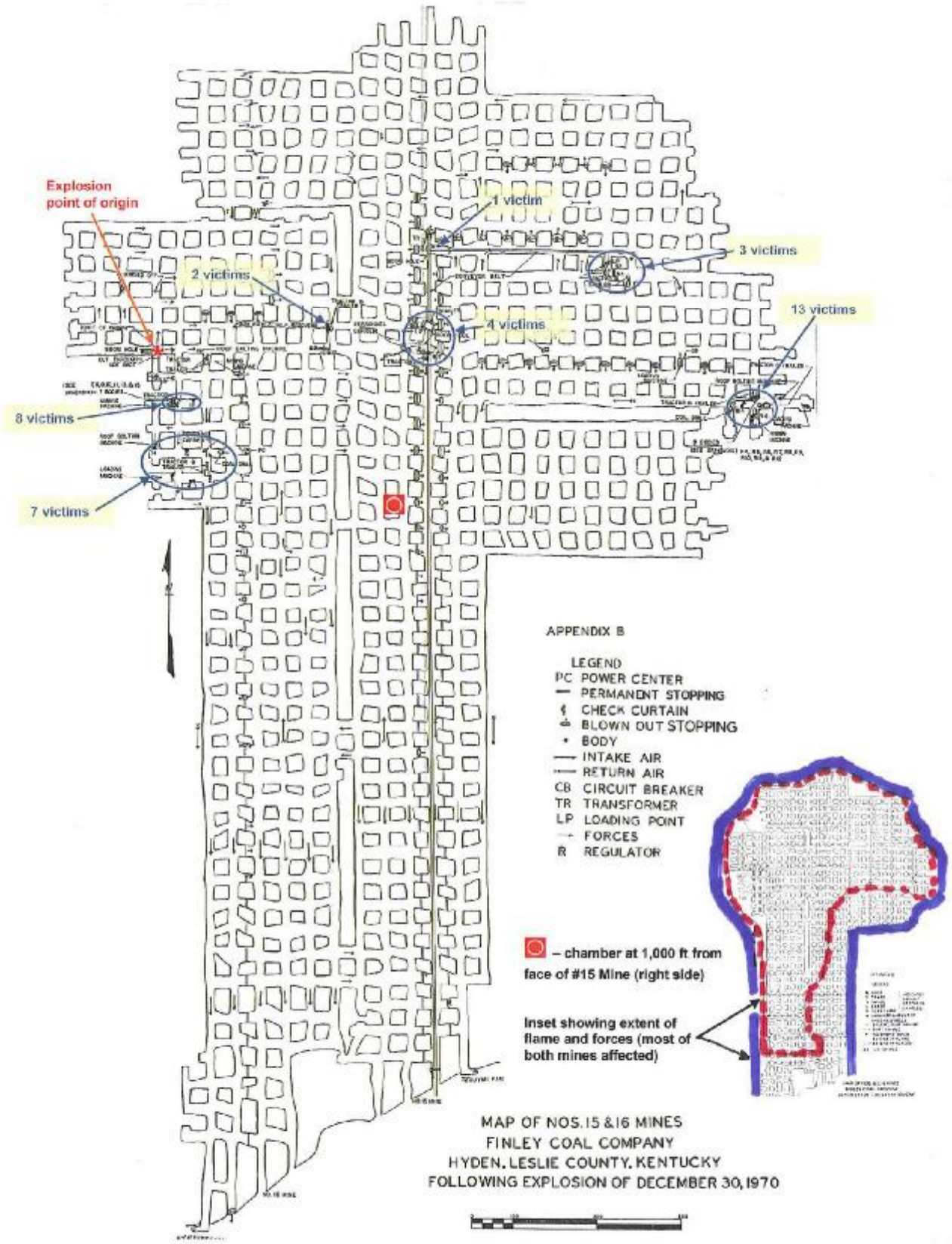

Figure 11. Finley Mines No. 15 and 16 Mine Map

Conclusions from the Finley Disaster:

- The explosion did not occur right at a coal producing working face but rather nearby at a site being prepared for a new belt tailpiece. This was just off to the side of the 1st Left section of No. 16 Mine but was about 1,500 feet from the 2nd Right section of No. 15 Mine.

- The report does not give details on the extent of injuries of the 5 miners that initially survived the explosion so it is unclear if they could have reached a station at 1,000 ft from the faces if SCSRs had been available. If so, the station would have needed to be explosion proof and flame resistant. Rescuers would have reached them within about 6.5 hours after the explosion.

- A station at 2,000 ft from the faces would likely not have been provided because it would have been located within about 400 feet of the mine portals.

- No specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study and outby stations would not have been relevant.

12. Pyro No. 2 Mine Explosion – November 30, 1970

1	Locations of victims with respect to working face area (if applicable)	N/A – see below
2	Location of victims if not associated with a working face area	The two men affected by the explosion (a surveyor and his assistant) were traveling in a recently mined out section of the mine to take measurements of the area; the active working areas were some distance away (not defined in the report and not relevant to the explosion)
3	Location of victims with respect to fire or explosion point of origin	The two men (only one a victim) were right at the point of origin because one of the men ignited gas by attempting to light a cigarette.
4	Would victims have been able to reach a station at 1,000 ft from the faces?	The lone victim would have been able to reach fresh air and evacuate the mine if he'd had an SCSR to don; he would not have used a station. It is likely that if a station had existed in the area before it had been mined out, it would have been relocated and so not available to the victim.
5	Would victims have been able to reach a station at 2,000 ft from the faces?	-- See above --
6	Factors in favor of a station at 1,000 ft versus 2,000 ft from the faces	N/A since the explosion occurred well away from active working areas
7	Factors in favor of a station at 2,000 ft versus 1,000 ft from the faces	N/A since the explosion occurred well away from active working areas
8	Would a station at a location other than 1,000 ft or 2,000 ft from the faces have been better?	N/A since the explosion occurred well away from active working areas
9	Effect of FLAME on a station at 1,000 ft from the faces	N/A – even if a station had remained within 1000 ft of the mined out area, the explosion was confined to a very localized region within the area
10	Effect of FLAME on a station at 2,000 ft from the faces	N/A – even if a station had remained within 2000 ft of the mined out area, the explosion was confined to a very localized region within the area
11	Effect of FLAME on a station per OTHER guidelines	N/A
12	Effect of FORCES on a station at 1,000 ft from the faces	N/A – even if a station had remained within 1000 ft of the mined out area, the explosion was confined to a very localized region within the area
13	Effect of FORCES on a station at 2,000 ft from the faces	N/A – even if a station had remained within 2000 ft of the mined out area, the explosion was confined to a very localized region within the area
14	Effect of FORCES on a station per OTHER guidelines	N/A
15	Time that rescuers would have made contact with trapped miners	N/A, since stations would not have been relevant to this situation (rescuers arrived to retrieve the victim in little over an hour after the explosion)
16	Would additional outby stations have been beneficial?	No; if the sole victim had been able to escape the immediate area, he could have made it safely to clean air.

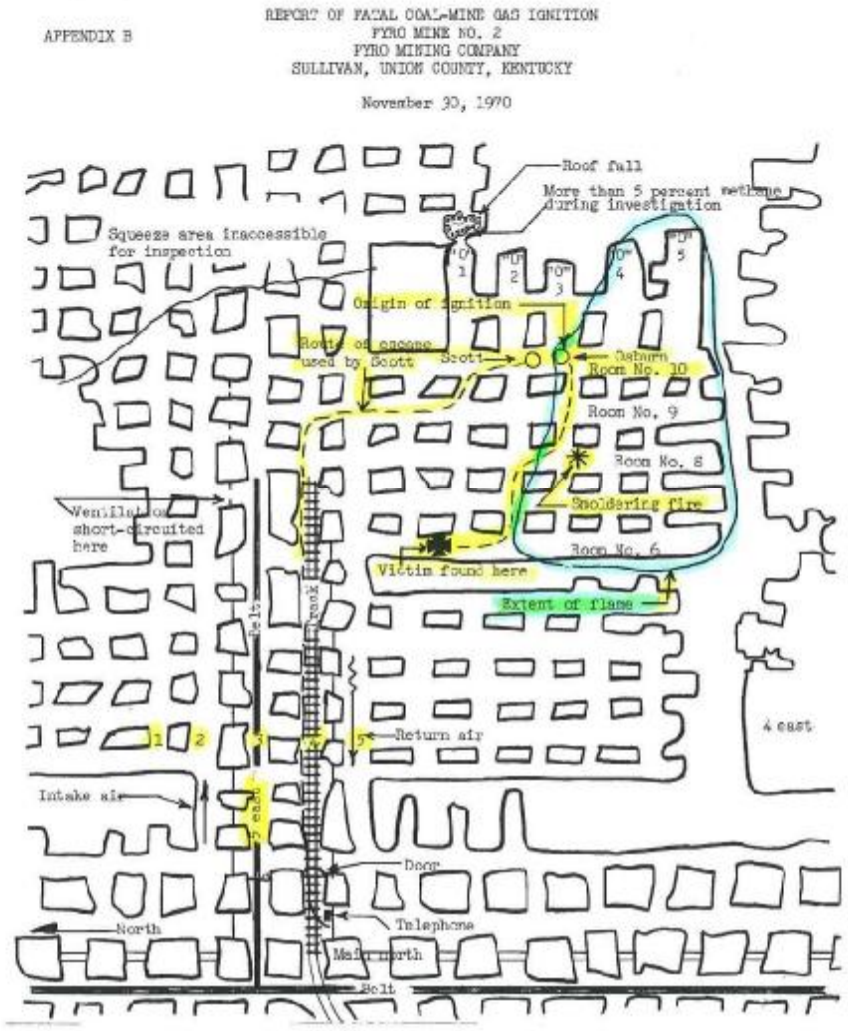

Figure 12. Pyro No. 2 Mine Map

Conclusions from the Pyro No. 2 Disaster:

- The explosion did not occur at a coal producing working face. It occurred in a mined out area being measured by a surveyor and his assistant, but it did occur in their immediate vicinity because gas was ignited by lighting a cigarette.

- Stations at either 1,000 ft or 2,000 ft from the faces would not have been applicable in this case. The lone victim would have been able to reach fresh air and evacuate the mine if he'd had an SCSR to don; he would not have used

a station. It is likely that if a station had existed in the area before it had been mined out, it would have been relocated and so not available to the victim.

- Based on the above, no specific rationale for a station location different from either 1,000 ft from the faces or 2,000 ft from the faces surfaced in this study and outby stations would not have been relevant.

Appendix B. Bibliography of Mine Disasters Study

The following reports, all provided by the MSHA Library in Beckley, WV, were used in the review of past mining disasters:

No.	Date of Disaster	Mine	Report Title
1	Apr 02, 1970	Compass No. 2 Mine	Report of Coal-Mine Explosion, Compass No. 2 Mine, Clinchfield Coal Company (Division of the Pittston Company), Dola, Harrison County, West Virginia, April 2, 1970
2	Apr 10, 1970	Homer City Mine, Helen Mining Co.	Report of Coal Mine Explosion, Homer City Mine, The Helen Mining Company, Homer City, Indiana County, Pennsylvania, April 10, 1970
3	Nov 30, 1970	Pyro No. 2 Mine	Report of Fatal Coal-Mile Gas Ignition, Pyro Mine No. 2, Pyro Mining Company, Sullivan, Union County, Kentucky, November 30, 1070
4	Dec 30, 1970	Finley Nos. 15 and 16 Mines	Official Report of Major Mine Explosion Disaster, Nos. 15 and 16 Mines, Finley Coal Company, Hyden, Leslie County, Kentucky, December 30, 1970
5	Mar 26, 1971	Nemacolin Mine	Report of Coal Mine Fire, Nemacolin Mine, The Buckeye Coal Company, Nemacolin, Greene County, Pennsylvania, March 26, 1971
6a	July 22, 1972	Blacksville No. 1 Mine	Preliminary Report of Major Coal Mine Fire Disaster and Sealing Operations, Blacksville No. 1 Mine, Consolidation Coal Company, Blacksville Division, Blacksville, Monongalia County, West Virginia, July 22, 1972
6b	July 22, 1972	Blacksville No. 1 Mine	Final Report of Major Coal Mine Fire Disaster and Recovery Operations, Blacksville No. 1 Mine, Consolidation Coal Company, Blacksville Operations, July 22, 1972
7	Dec 16, 1972	Itmann No. 3 Mine	Official Report of Major Mine Explosion Disaster, Itmann No. 3 Mine (ID. 46-01576), Itmann Coal Company, Itmann, Wyoming County, West Virginia, December 16, 1972
8	Sep 25, 1973	No. 4 Mine, Oakwood Red Ash Coal	Official Report Coal Mine Explosion, No. 4 Mine, Oakwood Red Ash Coal Corporation, Vansant, Buchanan County, Virginia, September 25, 1973
9	Mar 09 and Mar 11, 1976	Scotia Mine	Report of Investigation, Underground Coal Mine Explosions, Scotia Mine – ID 15-02055; Scotia Coal Company, Ovenfork, Letcher County, Kentucky, March 9 and 11, 1976
10	Mar 01, 1977	Porter Tunnel Mine, Kocher Coal	Report of Investigation, Underground Coal Mine Inundation (Water), Porter Tunnel Mine – ID 36-01892, Kocher Coal Company, Tower City, Schuylkill County, Pennsylvania, March 1, 1977
11	Apr 04, 1978	Moss No. 3 Portal A Mine	Report of Investigation, Underground Coal Mine Inundation (Blackdamp), Moss No. 3 Portal A Mine (I.D. 44-01642), Clinchfield Coal Company, Duty, Dickenson County, Virginia, April 4, 1978

No.	Date of Disaster	Mine	Report Title
12	Nov 07, 1980	Ferrell No. 17 Mine	Interim Report of Investigation, Underground Coal Mine Explosion, Ferrell No. 17 Mine – ID No. 46-02493, Westmoreland Coal Company, Uneeda, Boone County, West Virginia, November 7, 1980
13	Apr 15, 1981	Dutch Creek No. 1 Mine	Report of Investigation, Underground Coal Mine Explosion, Dutch Creek No. 1 Mine – I.D. No. 05-00301, Mid-Continent Resources, Inc., Redstone, Pitkin County, Colorado, April 15, 1981
14	Dec 07, 1981	No. 11 Mine, Adkins Coal	Report of Investigation, Underground Mine Coal Dust Explosion, No. 11 Mine (ID No. 15-02290), Adkins Coal Company, Kite, Knott County, Kentucky, December 7, 1981
15	Dec 08, 1981	No. 21 Mine, Grundy Mining	Report of Investigation, Underground Coal Mine Explosion, No. 21 Mine – I.D. No. 40-00524, Grundy Mining Company, Incorporated, Whitwell, Marion County, Tennessee, December 8, 1981
16	Jan 20, 1982	RFH No. 1 Mine	Report of Investigation, Underground Coal Mine Dust Explosion, No. 1 Mine (ID No. 15-12624), RFH Coal Company, Craynor, Floyd County, Kentucky, January 20. 1982
17	Jun 21, 1983	McClure No. 1 Mine	Report of Investigation, Underground Coal Mine Explosion, McClure No. 1 Mine – I.D. No. 44-04251, Clinchfield Coal Company, McClure, Dickenson County, Virginia, June 21, 1983
18	July 03, 1983	Homer City Mine	[Cover page missing]; report pertains to a methane and coal dust explosion at the Homer City Mine, The Helen Mining Company, Homer City, Indiana County, Pennsylvania on July 3, 1983.
19	Dec 19, 1984	Wilberg Mine	Report of Investigation, Underground Coal Mine Fire, Wilberg Mine, I.D. No. 42-00080, Emery Mining Corporation, Orangeville, Emery County, Utah, December 19, 1984
20	Dec 11, 1985	No. 2 Slope Mine, M.S.W. Coal Co.	Report of Investigation (Underground Coal Mine), Underground Coal Mine Explosion, No. 2 Slope Mine (ID 36-06279), M.S.W. Coal Company, Carlstown, Schuylkill County, Pennsylvania, December 11, 1985
21	Feb 06, 1986	Loveridge No. 22 Mine	Report of Investigation (Surface Area of Underground Mine), Multiple Fatal Suffocation Accident, Loveridge No. 22 (ID No. 46 01433, Consolidation Coal Company, Fairview, Marion County, West Virginia, February 6, 1986
22	Aug 09, 1986	Pyro No. 9 Slope	Report of Investigation (Underground Coal Mine), Fatal Mine Explosion, Pyro No. 9 Slope, Wm. Station (I.D. No. 15-13881), Pyro Mining Company, Sturgis, Union County, Kentucky, August 9, 1986
23	Jan 08, 1987	Dutch Creek No. 2 Mine	Report of Investigation (Underground Coal Mine), Fatal Methane/Air Ignition Accident Investigation, Dutch Creek No. 2 Mine (ID No. 05-00469), Mid-Continent Resources, Inc., Redstone, Pitkin County, Colorado, January 8, 1987 (Injury), January 28, 1987 (Death)

No.	Date of Disaster	Mine	Report Title
24	Dec 26, 1987	No. 1 Mine, Double R Coal	Report of Investigation (Underground Coal Mine), Underground Coal Mine Explosion, No. 1 Mine (ID No. 44-05186), Double R Coal Company, Inc., Duty, Dickenson County, Virginia, December 26, 1987
25	Sept 13, 1989	Pyro No. 9 Slope	Report of Investigation, Underground Coal Mine Explosion, Pyro No. 9 Slope, William Station Mine – I.D. No. 15-13881, Pyro Mining Company, Sullivan, Union County, Kentucky, September 13, 1989
26	Jan 16, 1991	No. 1 Mine, Fire Creek Inc.	Accident Investigation Report (Underground Coal Mine), Explosion, No. 1 Mine (ID No. 46-07512), Fire Creek, Inc., Superior, McDowell County, West Virginia, Janaury 16, 1991
27	Mar 19, 1992	Blacksville No. 1 Mine	Report of Investigation, Underground Coal Mine Explosion, Blacksville No. 1 Mine – I.D. No. 46-01867, Consolidation Coal Company, Blacksville, Monongalia County, West Virginia, March 10, 1992
28	Dec 07, 1992	No. 3 Mine, Southmountain Coal Co.	Report of Investigation, December 7, 1992, Underground Coal Mine Explosion, #3 Mine – ID. No. 44-06594, Southmountain Coal Co., Inc., Norton, Wise County, Virginia
29	Nov 30, 1993	Elmo No. 5 Mine	Report of Investigation, November 30, 1993, Underground Coal Mine Explosion, Elmo #5 Mine – I.D. No. 15-16856, A.A.&W. Coals, Inc., Feds Creek, Pike County, Kentucky
30	Mar 10, 1996	No. 4 Mine, Jim Walter Resources	Report of Investigation, Other Fatal (Asphyxiation), March 10, 1996, No. 4 Mine, Jim Walters Resources, Incorporated, Brookwood, Tuscaloosa County, Alabama, I.D. No. 01-01247
31	July 31 to Aug 01, 2000	Willow Creek Mine	Report of Investigation, Underground Coal Mine Explosions, July 31 – August 1, 2000, Willow Creek Mine – MSHA ID. No. 42-02113, Plateau Mining Corporation, Helper, Carbon County, Utah
32	Sep 23, 2001	No. 5 Mine, Jim Walter Resources	Report of Investigation, Fatal Underground Coal Mine Explosions, September 23, 2001, No. 5 Mine, Jim Walter Resources, Inc. Brookwood, Tuscaloosa County, Alabama, ID No. 01-01322
33	July 24, 2002	Quecreek No. 1 Mine	Report of Investigation, Underground Coal Mine Nonfatal Entrapment, July 24, 2002, Quecreek #1 Mine, ID No. 36-08746, Black Wolf Coal Company, Inc., Quecreek, Somerset County, Pennsylvania
34	Jan 02, 2006	Sago Mine	Report of Investigation, Fatal Underground Coal Mine Explosion, January 2, 2006, Sago Mine, Wolf Run Mining Company, Tallmansville, Upshur County, West Virginia, ID No. 46-08791
35	Jan 19, 2006	Aracoma Alma Mine No. 1	Report of Investigation, Fatal Underground Coal Mine Fire, January 19, 2006, Aracoma Alma Mine #1, Aracoma Coal Company, Inc., Stollings, Logan County, West Virginia, I.D. No. 46-08801
36	May 20, 2006	Darby Mine No. 1	Report of Investigation, Fatal Underground Coal Mine Explosion, May 20. 2006, Darby Mine No. 1, Kentucky Darby LLC, Holmes Mill, Harlan County, Kentucky, ID No. 15-18185

No.	Date of Disaster	Mine	Report Title
37	Oct 23, 2006	R&D Coal Co., Inc. Mine	Report of Investigation, Underground Coal Mine Fatal Methane Explosion, October 23, 2006, R&D Coal Company, Inc. Mine, R&D Coal Company, Inc., Lincoln, Schuylkill County, PA. ID No. 36-02053

38	Various	Various	Historical Summary of Mine Disasters in the United States, Volume II – Coal Mines – 1959-1998, U. S. Department of Labor, Elaine L. Chao, Secretary, 1998, Reprinted 2001; sections reviewed as part of the analysis in this project were:
			- Section 1, Historical Summary of Coal Mine Explosions in the United States, 1959-81, Scotia Mine, p. 13
			- Section 4, Summaries of Coal Mine Disasters Between 1958 and 1998:
			  - Nemacolin Mine, p. 60
			  - Scotia Mine, p. 88
			  - No. 2 Mine, P and P Coal Company, p. 97
			  - No. 5 Mine, Grays Knob Coal Company, p. 111
			  - Greenwich Collieries No. 1 Mine, p. 122
			  - No. 3 Mine, R and R Coal Company, p. 123
			  - No. 3 Mine, Granny Rose Coal Company, p. 131

The disaster reports listed above, not available for download from MSHA's website (at http://www.msha.gov/TRAINING/LIBRARY/library.HTM), were obtained as hard copy from:

Melody E. Bragg, Technical Information Specialist
Technical Information Center and Library
National Mine Health and Safety Academy
1301 Airport Road
Beaver, WV 25813-9426

During the course of this project, we also visited the following contacts at the MSHA District 9 headquarters in Denver Colorado as well as two western coal mines to discuss strategies for employing refuge chambers in underground mines:

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