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UNITED STATES
DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION

COAL MINE SAFETY AND HEALTH

REPORT OF INVESTIGATION

Surface Coal Mine
Fatal Fall of Highwall
April 17, 2007

Job #3
Tri-Star Mining, Inc.
Barton, Allegany County, Maryland
MSHA I.D. No. 18-00713

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OVERVIEW

On Tuesday, April 17, 2007 at approximately 10:00 a.m., Dale Jones, a 51-year old excavator operator with 15 years of mining experience, and Michael Wilt, a 38-year old bulldozer operator with one year of mining experience, were fatally injured when a highwall failed in the 001 Pit (Caledonia Pit/419 Pit) of Tri-Star Mining, Inc., Job # 3 mine. The two miners were operating equipment in the pit bottom, between the highwall and the backfilled overburden/spoil. The collapse of the highwall released an estimated 44,000 cubic yards of rock and material, forming a cavity in the highwall approximately 230 feet high, 240 feet wide, and 40 feet deep. The total highwall height in the area was approximately 275 feet. Approximately 93,000 tons of rock and material filled the pit, completely covered both pieces of equipment, extensively damaged operator cabs, and trapped the miners inside.

Underground mining had previously been conducted in two coal seams at the 001 Pit. Extensive fracturing associated with geologic structures, and widespread subsidence above the underground mine workings were present throughout the exposed length of the highwall, including the accident site. The fatalities occurred because the ground control plan did not adequately address highwall conditions, and obvious hazards were allowed to exist. Examinations conducted on days prior to and the day of the accident were inadequate. In addition, training did not make miners aware of the hazards introduced by previous underground mining. Severe subsidence above both the Sewickley and Pittsburgh coal seams, resulting from extensive underground mining, caused the highwall to be extremely fractured. Pillar remnants in the Pittsburgh seam represented a severely weakened layer near the base of the highwall. The segment of the highwall that failed was oriented nearly parallel to a well developed joint set. The combination of these factors resulted in a very unstable highwall and resulted in the highwall failure.

GENERAL INFORMATION

The Job #3 mine included five separate pits (001-005) that were located up to 5 miles apart (see Appendix A for site map). The highwall failure occurred at the 001 Pit (also known as Caledonia Hill or Maryland Permit #419). The 001 Pit is located in Garrett and Allegany Counties, Maryland near the town of Barton. The Job #3 mine began operations on July 3, 1986 and extracts coal from multiple bituminous seams. The 001 Pit began operation in 1991, and produced coal from the Washington, Waynesburg, Sewickley (Tyson), Redstone, Pittsburgh (Big Vein), Morantown (Big Inch), Little Inch, and Little Pittsburgh seams. Limestone and sandstone was concurrently extracted in the 001 Pit and sold as crushed rock aggregate.

Fifteen miners and up to three other contractors worked in the 001 Pit and produced 800 to 1,000 tons of raw coal per day. One 12-hour production shift per day, 6 days per week were worked in the 001 Pit. Fifty-five surface miners and 16 other employees worked in 5 pits of the mine, and collectively produced approximately 2,100 tons of raw coal per day.

The principal officers/official for Tri-Star Mining, Inc. at the time of the accident were:

George Beener……………......... President/Co-owner
Stacy Miller……………………....Treasurer
Raymond Tighe…………….........Foreman

The last completed regular MSHA inspection of this operation was on July 27, 2006. There was a regular inspection on-going at the time of the accident. The mine Non Fatal Days Lost (NFDL) incidence rate was 2.01, compared to the national average of 4.82 for mines of the same type.

DESCRIPTION OF ACCIDENT

Victims Activities the Day of the Accident

Jones and Wilt arrived at the mine at approximately 5:30 a.m. The bulldozer assigned to Wilt was inoperative. Jones proceeded to the 001 Pit to begin work, and reported over the CB about 6:15 to 6:20 a.m. that the low wall (spoil/backfill) had sloughed off the previous night and needed to be removed from the pit before coal could be loaded. This was heard by Don Baker, truck driver. At 6:30 a.m. Jones reported on the CB to Raymond Tighe, mine foreman, that rocks had fallen from the highwall in the vicinity of the Little Inch/Morantown bench, located several hundred feet west of his location.

Between approximately 7:30 and 8:00 a.m. Ryan Duckworth, mechanic, transported Wilt to a functional bulldozer. At 9:01 a.m., Wilt phoned Jeffrey Pyle, bulldozer operator, that he was boarding the bulldozer and heading for the pit. Shortly before, Derek Broadwater, rock truck driver, heard Jones on the radio asking Wilt to bring the bulldozer into the pit, and also requesting Tighe to go up on top to check the highwall.

Activities of the Mine Foreman the Day of the Accident

Tighe arrived at the mine at approximately 5:10 a.m. to unlock the fuel tanks and discuss work with Beener. Shortly after, Tighe traveled to the job site and instructed the bulldozer operators to clean the roads for the truck-and-shovel operation following rain during the night. Subsequently, Tighe left the 001 Pit for the 005 Pit, where he met Carol Ensminger, Inspector for the CMS&H District 3, Oakland field office conducting dust sampling. Later that morning, Tighe returned to the office and met with Beener, who directed him to escort the delivery of a rock drill from the Finzel, Maryland exit on I-68 to the mine at 10:00 a.m.

Tighe then headed for the east end of the 001 Pit, to the Bucyrus-Erie 295-BII shovel assigned to John Cook, while monitoring the mining operations on CB channel 16. When Tighe was coming back on the haul road between the coal yard and the rock crusher, Jimmy Gowans, loader operator for the Little Inch/Morantown pit floor, contacted Tighe and reported that shale was falling off the highwall near the Little Inch/Morantown pit floor. In response to requests by Gowan and Jones at approximately 9:00 a.m., Tighe went to the top of the highwall to check the area above their respective work locations.

Tighe conducted an examination of the top of the highwall between 9:10 and 9:20 a.m., beginning above the Morantown pit floor, where he observed cracking. Tighe then walked the highwall above where Jones and Wilt were working, and did not observe any cracks in this area. He then traveled to an abandoned highwall ramp, which connected the top of the highwall to the Sewickley seam, to better view the highwall above Jones and Wilt. He still could not see any cracks or hazards in the area above the highwall where he understood Jones and Wilt was working. Tighe talked with Jones to confirm where he was working, because he could not establish visual contact. He then informed Jones and Wilt you'll be alright to work over towards the low wall but not to go up on the Morantown seam pit floor because there was cracking in the highwall above this area. In response, Jones told Tighe they could not go into this area because the spoil ramp was not intact to allow access. Following the highwall examination and related communication with Jones, Tighe left the 001 Pit for the Finzel exit, approximately 12 miles away.

Other Miners Activities the Day of the Accident

Shortly before 10:00 a.m., Michael Sherwood, Rish Equipment Co. mechanic arrived on mine property for repair activities. Sherwood heard Jones and Wilt speaking on the CB, and contacted Jones at approximately 9:58 a.m. to determine the location of a dozer that was scheduled for repair. Sherwood traveled to the top of the spoil bank along the main haul road, above where Jones and Wilt were working in the bottom of the 001 Pit. Shortly thereafter, Sherwood could not establish further contact with Jones.

At approximately 10:00 a.m., David Dwire, rock truck driver, noticed a cloud of dust coming out of the 001 Pit while he was driving up the haul road, and at the request of John Cook, shovel operator, went to investigate. Dwire subsequently reported by CB that the highwall had collapsed on Jones and Wilt (see Appendix B, Figure 7 for their location). At approximately 10:01 a.m. Derrick Broadwater, truck driver, overhearing the CB conversation, called 911 from his cell phone to report the accident.

Cook overhead Dwire reporting the highwall collapse on the CB, and contacted Beener by company radio. Beener subsequently informed Ray Karlstrand, Maryland Bureau of Mines, and Mark Wilt, 005 Pit foremen, about the accident. Beener directed Mark Wilt to notify MSHA inspector Ensminger, who was informed at 10:10 a.m. Beener, Ensminger, and Karlstrand left the 005 Pit for the accident scene. Upon arrival, Kerry Beener, operations manager, reported that a PC750 LC Komatsu hydraulic excavator and a FD50 Fiatallis dozer had been working at the base of the highwall and had been buried by the collapsed material. Kerry Beener had directed a front-end loader and dozer to remove the fallen rock, but they had to be withdrawn from the pit due to unstable highwall conditions identified by Ensminger. Following delays due to adverse road conditions, the Bucyrus-Erie 295-BII shovel assigned to John Cook, was brought in to begin a rescue operation. The operation began at 6:19 p.m. on Tuesday, April 17, 2007 and continued until Friday, April 20, 2007, when Jones was recovered at 1:45 p.m. and Wilt at 4:15 p.m. During the operation, it is estimated that one-fourth of the failed material was removed from the accident location. The victims were examined by Tim Dayton, Allegany County Medical Examiner, prior to being transported to the Office of the Chief Medical Examiner, Baltimore, Maryland.

INVESTIGATION OF THE ACCIDENT

The Mine Safety and Health Administration (MSHA) was notified of the accident at 10:10 a.m. on Tuesday, April 17, 2007 when Mark Wilt notified Carol Ensminger. After the MSHA inspector at the mine was notified, Tina McKenzie, secretary for Tri-Star Mining, Inc. called the Department of Labor National Contact Center, Mine Safety and Health Emergency Line at 10:26 a.m. Additional MSHA personnel from the District 3 office were immediately dispatched to the mine upon notification. Personnel from the Mine Waste and Geotechnical Engineering Division, Technical Support, were requested and subsequently arrived at the mine. A 103(k) order was issued to insure the safety of all persons during the rescue/recovery of the victims and the accident investigation. The investigation was conducted in cooperation with the Maryland Department of Environment – Water Management Administration - Bureau of Mines, the mine owner and employees.

The accident scene was documented with photographs, sketches, maps, and measurements. Interviews were conducted of twenty-one persons having knowledge of the facts concerning the accident. A list of the persons who participated in the investigation is contained in Appendix B. Other documents and evidence were collected from Tri Star Mining Inc., their consultants, and the Maryland Bureau of Mines. The on-site portion of the investigation was completed on May 2, 2007.

DISCUSSION

Geology and Geotechnical Analysis

<u>Geology</u>

Coal mining in the 001 Pit is from the Washington, Waynesburg, Sewickley (Tyson), Redstone, Pittsburgh (Big Vein), Morantown (Big Inch), Little Inch, and Little Pittsburgh seams (see Appendix B Figure 1). In addition to the named coal seams, three rider seams occur consistently above the Pittsburgh seam, exposed along the length of the approximately 5,700-foot long highwall.

Two main joint sets are present throughout the 001 Pit, striking N 20-25° E and N 60-70° W, respectively (Figure 2). A joint is defined as a divisional plane or surface that divides a rock and along which there has been no visible movement parallel to the plane or surface or a fracture or parting that cuts through and abruptly interrupts the physical continuity of a rock mass. (1968 Bureau of Mines Dictionary of Mining, Mineral, and Related Terms) Joints in both sets were nearly vertical, and intersected at nearly right angles. Due to the S-shaped configuration of the pit, the relative orientation of the highwall changes with respect to the joints. In the middle and southeastern segments of the pit, both joint sets were at nearly 45° to the respective highwall trends. In contrast, the northwestern segment of the pit is oriented nearly parallel with the set of N 60-70° W-striking joints or the direction which these joints are running.

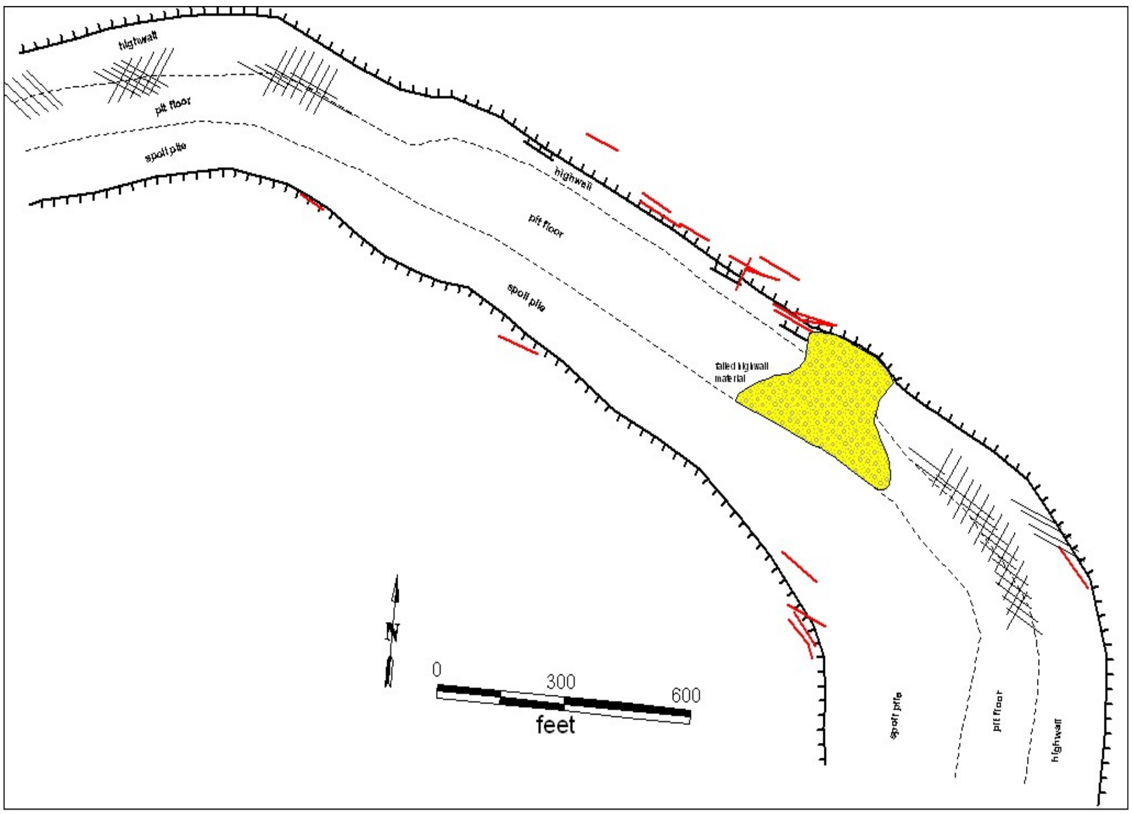


Figure 2. Outline of the 001 Pit in the vicinity of the slide (yellow), showing joint orientations (thin black lines) and trends of tension cracks (thick red lines) on the top of the highwall and spoil bank.

At the time of the investigation, numerous open cracks were observed at the top of the northwest-trending segment of the highwall in the thin layer of unconsolidated overburden, and nearly parallel to the N 60-70° W-striking joint set. Open aperture tension cracks are commonly developed in swarms within 20 feet of the berm at the top of the highwall, with individual cracks located 12-24 inches apart.

The N 77-90° W trend of tension cracks is very similar to the strike of the N 60-70° W joints. (See Appendix B, Figures 3, 4, and 5 for photographs)

Previous Mining

Caledonia Hill, the location of the 001 Pit, had been subjected to extensive surface and underground mining for nearly 120 years. Digital mine maps indicated that mining was performed in the Pittsburgh seam in 1888, in the Sewickley and Pittsburgh, from the 1920's, and second mining reportedly from 1930's to 1940's. Surface mining was performed on Caledonia Hill to extract the highest, Waynesburg and Washington seams, which caused Caledonia Hill to be topped with strip spoil.

Underground workings in the Sewickley and Pittsburgh seams are exposed in the 001 Pit highwall, and are associated with subsidence features (Figure 6). Subsidence features observed in the highwall correspond with workings of the Caledonia Coal Co., and on property belonging to the Swanton Coal Co. The rock in the highwall above the old mining works was highly fractured due to subsidence. Several pillars that could be observed in the higher Sewickley coal seam had retained their rectangular profiles, preserving square pillar corners, but the entries had been completely filled with caved shale and sandstone from the immediate roof (See Appendix B Figure 8 for photograph). In the slide area, extensive subsidence indicated that mining had left little coal in the Sewickley coal seam. The strata exhibited total roof to floor convergence across extensive expanses of complete coal extraction. As viewed from the spoil bank, a very small remnant pillar on the Sewickley Limestone was the only indication that the Sewickley coal seam had been present. At the top of the highwall, large joint-bounded blocks had separated from the rock face, exhibiting apertures of up to 40 feet, and were localized above areas of high extraction in the underlying Sewickley seam.

Figure 6. Concave indentations (red arcs) defined by joint-bounded blocks in sandstone overlie subsided rooms in the Pittsburgh seam. Subsidence damage extends along the highwall through the slide area.

The most severe subsidence features were developed above the Pittsburgh seam, near the bottom of the pit. Possibly due to numerous episodes of second mining, and greater overburden depths, the Pittsburgh seam exhibited extreme convergence and deformation, with crushed and sheared coal pillars and rooms that were completely filled with broken subsided strata (rubble). The immediate roof above the Pittsburgh seam rooms was commonly characterized by downward-bowed strata. Convergence was so extreme that wood posts were encased in highly compacted rubble in former rooms, and remained hanging in the highwall face after being exposed by mining (See Appendix B Figure 9 for photograph). The coal pillars in the northwestern segment of the highwall had completely failed and turned to rubble, and were incapable of carrying significant load.

The extensive jointing present in the highwall provides existing planes of weakness that have increased the severity of the subsidence. The combination of joints and subsidence allowed joint-bounded blocks of the immediate and main roof to drop into the underlying rooms. Joints above Pittsburgh seam mine rooms are heavily iron stained and exhibit wider apertures than in the surrounding rock mass. Although shale layers commonly do not have joints that are as well developed as those found in adjacent sandstone, the shale immediate roof of the respective coal seams is commonly broken into rubble, and has sagged into the underlying mine entries. The rubble is stained with white, flour-like precipitant from circulating groundwater. Water was observed seeping from old works in the Sewickley and Pittsburgh seams exposed in the highwall. The iron staining and water seepage indicated that the highly fractured and jointed rock mass in the highwall freely transmitted ground water.

Spoil Bank

The spoil from the mining operation was truck dumped across a long, narrow area that is roughly parallel with, and south and west of the highwall (See Appendix B Figure 7). The pit bottom is constrained on the north and east side by the active highwall and on the south and west side by the spoil bank. The spoil bank height varies, but was estimated to be 270 feet at its highest point in the area across from the highwall failure. The base of the spoil bank is in places underlain by up to 50 feet of unmined rock that is referred to as the low wall. Roads and ramps were located on the spoil bank in various areas, primarily near the top of the bank. The slope angle of the spoil bank varied greatly from location to location, but in the area of active mining, the slope tended to be much steeper through the bottom 150 feet and flatter through the upper 120 feet. The largest angle measured on the lower slope of the spoil bank was approximately 60 degrees. The spoil contained a large percentage of fine material and it was estimated that the spoil angle of repose was 36 degrees. The average angle of the spoil bank, combining the flatter upper and steeper lower sections, was estimated to be 42 degrees.

There was a tendency for the spoil to slough off the steeper zones, and accumulate in the pit bottom. The sloughed spoil would then reportedly be cleaned up from the pit floor, thereby maintaining steeper lower slopes. The process of continuously cleaning the pit floor to expose the coal benches maintained the over-steepened slope of the spoil bank, and resulted in further sloughing. Numerous, high-angle scarps (nearly vertical cuts in the slope) were present in the spoil banks along the steeper areas, representing thin rotational failures of the steeply piled spoil.

Highwall Failure Mechanism

During several field visits to the mine, GPS, laser range-meters, and hand levels were used to document the positions of the highwall, spoil bank, and failure area in order to determine the height and inclination of the highwall, as well as to determine the dimensions of the slide. The profiles were subsequently used to evaluate geotechnical controls on the slide area.

The profiles indicated that the overall highwall slope in the vicinity of the slide was approximately 60°, and that other portions of the highwall to the southeast were more steeply inclined at 65°. The Sewickley Limestone represents a natural break in the profile, with approximately 140 feet of highwall below exhibiting a profile of 70-75°, and over 110 feet of highwall above exhibiting a profile of 40-50°. Although the limestone layers, including the Sewickley and Waynesburg, created ledges, they had become so filled with sloped, sloughed material that no flat surface remained, which negated any effectiveness as a rock fall control measure.

The highwall failure area measured 240 feet wide near the top, 40 feet deep at the top of the rubble pile, and extended through the entire height of the highwall above the Pittsburgh seam. Based on these observations and interviews, it was concluded that the base of the failure was likely at the Pittsburgh coal seam horizon. The highwall failure likely originated at the Pittsburgh coal seam and would have been progressive as evidenced by the outward movement of the pillar remnants. This failure mechanism would probably have resulted in cracking parallel with the joint set above the slide area prior to the failure but may have been masked by the depth of old strip spoil from previous mining.

The foreman observed a new crack between 100 to 150 feet west of where the failure occurred. The foreman would have been in a position to observe pillar and/or other movement in the highwall from progressive failure had he gone into the pit after seeing this crack.

There had been rain and snow in the area for several days before the failure. The three National Weather Service rain gage stations closest to the mine are in Frostburg, MD (~10 miles), Cumberland, MD (~17 miles), and Romney, WV (~20 miles). The three rain stations reported between 0.17 and 0.27 inches of precipitation for the 24 hour period on the day of the accident. They also reported between 0.11 and 0.83 inches of precipitation on April 16, 2007, and between 1.47 and 1.83 inches of precipitation on April 15, 2007. Water seeped into the highwall strata from this precipitation and from ponded water above the highwall. There was no evidence of large amounts of water seeping from the failed area. Rainfall was not determined to be a major factor in the highwall failure, but it is likely that it contributed to the highwall instability by lubricating the rock along the open joints and fractures and by building small hydrostatic pressures near the back of the failure zone.

Several conditions contributed to the highwall failure:

- The highwall orientation was roughly parallel with a very well developed joint set, oriented N 60-70º W, which created a weak boundary at the back of the slide area,

- Fractured rock resulting from mine subsidence over the Sewickley and Pittsburgh coal seams, combined with the presence of a perpendicular joint set, oriented N 20-25º E, created weak boundaries on the sides of the failure area,

- The Pittsburgh coal seam, together with overlying and underlying shale, was highly fractured due to mine subsidence and only very small, irregularly-sized and -shaped pillar remnants remained, creating an extremely weak zone in this area, and

- Rainfall and snowmelt from the three days leading up to the accident lubricated the fractures and joints, and exerted small hydrostatic pressures on the failing zone, particularly near the back of the slide and near the bottom of the wall.

Damage from blasting was considered but no remnant blast holes or fracture patterns consistent with blasting were observed in the highwall. It was concluded that any damage from blasting was insignificant compared to the extensive fracturing already present from subsidence and jointing. Therefore, blasting was ruled out as a contributing factor.

Ground Control Plan

The ground control plan in place at the time of the accident had been submitted on February 26, 2002 for three pits, including 001, 002, and 003. The ground control plan was submitted by Beener, and acknowledged by MSHA on March 13, 2002.

The information in the ground control plan that relates to highwall design is limited to the average height and angle of the highwall, the spacing and width of benches, the slope of ground to be mined, and the average width of the pit. The plan does not include supporting data for the values used in the highwall design. As indicated on the submitted ground control plan, the slope of ground to be mined was reported as 2-10°. The average highwall height was listed as 125 feet, with an angle of 85°. The plan specified that if the highwall required benches and benches were to be used, they would be 10 feet wide and spaced vertically 80 feet apart. The average pit width was listed as 120 feet. The plan stated that shovels, track hoes, loaders, and dozers will be used to maintain and scale the highwall, and that if necessary, the highwall will be scaled by hand in a safe fashion or will be "dangered off." The ground control plan included only a single line for spoil bank dimensions, and recorded that the maximum height and angle of deposited spoil are "not applicable".

The operator failed to establish an adequate ground control plan for the conditions present at the mine. Additionally, the company failed to follow the ground control plan in effect at the time of the accident, though it was determined to be inadequate for control of the highwall conditions. The configuration of the highwall as depicted in the ground control plan would have resulted in a steeper, less stable configuration for the highwall, and would still have allowed highwall failure due to mine subsidence and the presence of joint sets.

Observations and evidence collected at the 001 Pit during the accident investigation revealed a number of discrepancies between the ground control plan submitted by the operator and the evidence and observations at the 001 Pit:

- The values submitted by the operator in the "Pit Information" section did not reflect the actual conditions observed in the pit: 1) the slope of Caledonia Hill is considerably steeper than the 10° indicated on the submitted plan; 2) the highwall was 250 to 275 feet high, and in most areas far exceeded the 125 feet average listed in the submitted plan; 3) the benches observed in the highwall were typically too narrow, filled with debris, and not provided every 80 feet of height. The mine foreman stated that they tried to put benches at the coal seams and they sheared off. The company no longer tries to leave benches because of this. However, just east of the failure area an inclined ramp extended down to the Sewickley seam and acted as a bench. Small flat areas along the highwall resembled five to ten feet wide filled benches. These flat areas were typically above the two competent limestone layers. The flat areas were not consistent along the highwall and were not at 80 foot intervals. These flat areas were not adequate as benches since they were too narrow and filled with debris. 4) one of the pit widths was very narrow and only measured 90 feet of width; 5) despite using a mining method that necessitated the handling of large volumes of spoil, no value was provided for the maximum height or angle of deposited spoil.

- The MSHA acknowledgement letter dated March 13, 2002, stated: "Please note that Section 77.1200 requires in part that an accurate map be maintained that will show the location of all abandoned areas and the location of underground mine workings. When surface operations intersect old underground works, extra care must be taken to assure the safety of miners working near the highwall." Despite having this knowledge, the operator failed to identify the heavily deep mined Sewickley and Pittsburgh coal seams in the ground control plan.

- Although a cut sequence was provided, no drawing that indicated the methods of mining and means of stabilizing spoil was included with the plan.

- Blasting was not conducted as shown in Attachment IV-5.1 of the submitted Ground Control Plan :

  - Blasting records indicated that the blasting pattern exceeded the 12 x 12-foot pattern indicated in the submitted ground control plan.

  - Attachment IV-5.1 as submitted in the Ground Control Plan also indicated a "Blasting Sequence" (delay pattern) that directed blast forces toward two free faces. Blasting logs documented that there were not two faces for the blasts conducted 2/2/07, 2/7/07, and 2/8/07.

  - The blasting logs did not include enough detail to determine the location of the blasts. Therefore, the effect that individual blasts had on the highwall in the area of the failure could not be determined.

The ground control plan did not adequately provide for the control of the highwall. The submitted ground control plan did not account for the adverse effects of joints oriented parallel to the highwall, the effect of highly fractured rock associated with subsidence over existing underground workings, nor for the highly weakened state of the failed pillars, roof, and floor in the Pittsburgh coal seam horizon. The extensively fractured rock not only represented a hazard in terms of overall highwall stability, but also in terms of smaller scale rock fall hazards. Analyses indicated that the proposed 10-foot wide benches were inadequate as a rock catching device, and would result in an overall highwall angle that was too steep to allow an adequate safety factor against highwall failure. Furthermore, 10 feet is too narrow to allow machinery to clean the bench.

<u>Maps</u>

Section 77.1200 requires that the operator shall maintain an accurate and up-to-date mine map. MSHA requested, during the investigation, that the operator provide the 77.1200 map. The map received was deficient in that it did not show the deep mine workings within 1,000 feet of the active area of the mine nor two permanent elevation bench marks and two permanent baseline points. Furthermore, no statement was provided to indicate that a search had been conducted for underground mine maps. Section 77.1201 requires mine maps shall be made or certified by an engineer or surveyor registered by the state in which the mine is located. The map provided was not certified as required.

The development and maintenance of mine maps as specified in 77.1200 and 77.1201 would have required an engineer or surveyor to gather information to maintain the map accurate and up-to-date with the current mining configuration. The operator was aware that the Sewickley and Pittsburgh coal seams had been deep mined but failed to locate and show the underground mines on the map. The level of involvement of these professionals may have alerted all involved to the height and conditions of the highwall as related to the requirements of the ground control plan. An accurate and up-to-date mine map should have alerted the operator to the conditions.

Examinations

Mine foreman Tighe examined the pit on the far eastern side, where the Bucyrus-Erie 295-BII Shovel was operating. The mine foreman also conducted an inspection on top of the highwall above the Morantown bench, where material was reported falling off of the highwall. He discovered cracking 100 to 150 feet west of the highwall failure area, but did not identify evidence of cracking directly above the failure area. The foreman notified workers in the pit of the cracked area west of their work location, and directed them not to work below that area. He traveled to the top of the old roadway ramp for an improved view of the highwall above the victims, but observed no problems. Tighe did not travel into the pit area where the victims were working the morning prior to the accident. An adequate examination would have involved traveling to the pit floor active working area to ensure the pit was safe to work in.

The Daily and Onshift Report (Examination Record) for the day shift on 4/17/07 conducted by the foreman documents the condition of the highwall as "Fair". Examination records signed by the foreman dating back to 3/7/07 document the condition of the highwall as "Fair." No hazardous conditions were documented.

The foreman stated that when he conducted an examination he looked for cracking at the top of the highwall, pillars pushing out from the Pittsburgh seam destabilizing the highwall, loose fractured rock hanging on the face of the highwall, and benches filled with broken material. On 4/17/07, the foreman, despite being notified that rocks were falling above the Morantown pit and observing cracks in the area, did not record these conditions in the examination book. Neither did the foreman travel to the work site in the pit to examine the highwall face.

The condition of the Pittsburgh seam pillar remnants is an important component of the highwall stability. The observation of the movement of these pillar remnants is an essential part of the highwall examination in areas where the Pittsburgh seam is exposed. The movement of these pillar remnants could not be adequately observed from the top of the highwall.

The daily examination program of the operator was inadequate. Numerous obvious and extensive hazardous geologic conditions were present during several previous daily examinations. The March 13, 2002 MSHA acknowledgement letter placed the operator on notice of the highwall instability hazards associated with surface operations intersecting old underground mining works. It is clear from the language of this letter and statements during interviews that the operator and his agents were aware of the old underground mining works and the hazards that they were creating. Despite having this knowledge, the operator failed to report, record, and take corrective action to eliminate these hazards. During the same period of examinations there existed numerous portions of the spoil bank sloping into the working areas of miners that was experiencing various degrees of failure. In addition, the operators examination program failed to report, record, and take corrective action to eliminate these hazards related to the spoil bank. Therefore, examinations were rendered ineffective in prompting changes in operations including; the engineering design of the ground control plan and the maintenance of up to date mine maps meeting the requirements of 30 CFR 77.1000, 77.1200 and 77.1201.

Equipment

The Komatsu PC750-6 Hydraulic Excavator (SN 10219) being operated by Dale Jones (victim), at the time of the accident, was a crawler unit equipped with a backhoe configuration arm-and-bucket combination. The operator cab was located on the left side of the boom and was not equipped with a falling object protection structure (FOPS) or a roll over protection structure (ROPS). Neither ROPS nor FOPS is required on this excavator by MSHA standards. The maximum digging depth is approximately 28 feet, the maximum digging height is approximately 39 feet, and the maximum digging reach is approximately 45 feet measured from the center of the swing mechanism. The excavator was equipped with a 5.25 cubic yard bucket. The tracks (crawler) were 14 feet wide and 19 feet long. The operator's compartment was five feet off the ground.

The Fiatallis FD50 Crawler Tractor Bulldozer (S/N 3554) being operated by Michael Wilt (victim), at the time of the accident, had a fully enclosed cab with an integrated roll over protection structure (ROPS). The bulldozer track length is approximately 19 feet and the track width is approximately 11 feet. The bulldozer is equipped with a ripper attachment and a semi-U blade that measures approximately 17 feet wide. From the ground to the top of the ROPS is approximately 14 feet.

The impact force of the rocks sliding onto the Fiatallis bulldozer ROPS could not be determined. However, the impact force would likely be much greater than the equivalent gross vehicle weight, and of the ROPS certification load.

Training

An inspection of the training records indicated that Jones and Wilt received training in accordance with 30 CFR, Part 48. During interviews many miners and managers stated that the annual refresher training included highwall hazard recognition. The hazards identified in the training included; loose and falling rocks, cracks, and instability caused by freezing, thawing or rain. The hazard recognition training did not include a discussion of the specific hazards related to subsidence and underground mine workings within a highwall, or the effects of joint sets on highwall stability.

ROOT CAUSE ANALYSIS

An analysis was conducted to identify the most basic causes of the accident. During the analysis, root causes were identified that, if eliminated, would have either prevented the accident or mitigated its consequences.

Listed below are root causes identified during the analysis and their corresponding corrective actions implemented to prevent a re-occurrence of the accident:

1. *Root Cause:* The ground control plan developed by the mine operator did not utilize prudent engineering design in that it failed to address the heavily deep mined Sewickley and Pittsburgh coal seams. The plan also failed to address the effect of mining with the highwall oriented parallel to the well defined dominant joint set. The current mining method did not provide a safe and stable highwall and spoil bank to protect the miners. The associated mine map did not show old underground mine workings.

   Corrective Action: The mine operator revised the ground control plan for the mine on June 12, 2007. This change modified the plan using prudent engineering analysis in the design of the highwall. All employees were trained in the provisions of the new plan. Accurate and complete mine maps were developed.

2. *Root Cause:* The daily examination program of the operator was inadequate. On the day of the accident, the examiner did not examine the entire work site or travel into the pit to examine the highwall face. An adequate examination would assure the miners of safe working conditions or removal from a hazardous area. Additionally, several previous examinations did not result in obvious hazards being reported, recorded, or eliminated.

   Corrective Action: The operator must develop an examination program to conform to the regulatory requirements. Examinations must properly identify hazards, and ensure that hazards are recorded and corrected. Root causes of deficiencies in examinations should be considered when developing the program.

3. *Root Cause*: The training plans and safety program did not provide specific training to the miners or examiners in recognizing hazards related to subsidence and underground mine workings within a highwall, the effects of joint sets on highwall stability, or the combination of both.

   Corrective Action: The mine operator must revise the training plan and retrain the miners and examiners on highwall hazard recognition specific to the mine and the new ground control plan.

CONCLUSION

The fatalities occurred because the ground control plan did not adequately address highwall conditions, obvious hazards were allowed to exist, and an examination was inadequate. In addition, training did not make miners aware of the hazards introduced by previous underground mining. Severe subsidence above both the Sewickley and Pittsburgh coal seams, resulting from extensive underground mining, caused the highwall to be extremely fractured. Pillar remnants in the Pittsburgh seam represented a severely weakened layer near the base of the highwall. The segment of the highwall that failed was oriented nearly parallel to a well developed joint set. The combination of these factors resulted in a very unstable highwall and resulted in the highwall failure.

Approved by:

__________________________ __________________________

Kevin Stricklin Date
Administrator for Coal Mine Safety
And Health

ENFORCEMENT ACTIONS

1. A **§103(k) order, No. 6604143** was issued to Tri Star Mining, Inc. to ensure the safety of the miners until the investigation could be completed.

2. A **§104(d)(1) citation, No. 6604621**, was issued to Tri-Star Mining, Inc. citing 30 CFR, section 77.1000

   Condition or Practice:
   The mine operator failed to establish and follow a ground control plan for safe control of highwalls, pits and spoil banks for the 001 Pit (Caledonia/419 Pit). The ground control plan was not consistent with prudent engineering design and did not insure safe working conditions due to the following: 1) Severe subsidence above both the Sewickley and Pittsburgh coal seams, resulting from extensive underground mining, caused the highwall to be extremely fractured, unstable, and were obvious. 2) Remnant pillar stubs in the Pittsburgh seam represented a severely weakened layer near the base of the highwall. 3) The segment of the highwall that failed was oriented nearly parallel to a well developed joint set. The combination of these three factors resulted in a very unstable highwall, causing failure. The mining methods employed and selected by the operator failed to insure highwall stability at the accident site.

   Two surface miners were fatally injured when a massive surface coal mine highwall failure occurred on April 17, 2007, at the 001 Pit (Caledonia Pit/419 Pit). (see attached map) In addition to this d(1) citation, the operator did not exercise prudent engineering practices in providing an accurate mine map, Citation No. 6604619, and the mine map was not made or certified by an engineer or surveyor registered by the state of Maryland where the surface mine is located, Citation No. 6604620.

   The mine operator was put on notice from a March 2002 ground control acknowledgement, that when surface operations intersect old underground works, extra care must be taken to assure the safety of miners working near the highwall. The mine operator failed to establish and follow a ground control plan for safe control of highwalls, pits and spoil banks for the 001 Pit (Caledonia/419 Pit in response to the underground workings.

3. A **§104(d)(1) order, No. 7146873**, was issued to Tri-Star Mining, Inc. citing 30 CFR, section 77.1713 (a)

On April 17, 2007, an inadequate examination of the highwall and spoil bank above the active working areas was conducted in the 001 pit (Caledonia Pit/419 pit). Based upon information obtained in the fatal accident investigation, the highwall and spoil bank was not examined in its entirety. The foreman stated the highwall and spoil bank was only examined from the top of the highwall and not from the pit floor where the entire face of the highwall and spoil bank could be observed. The condition of the Pittsburgh seam pillar remnants, which are located in the highwall, is an important component of the highwall stability. The observation of the movement of these pillar remnants is an essential part of the highwall examination in areas where the Pittsburgh seam is exposed. The movement of these pillar remnants could not be adequately observed from the top of the highwall. Also tension cracks were observed above the highwall and were present within 150 feet of the highwall failure and represented a hazard to miners near the highwall.

The victims were working below an unstable spoil pile and the certified examiner did not travel to the pit floor active work area. Tension cracks were present above the victims on the spoil bank crest. This and other hazardous conditions were not reported to the operator or recorded on the examination record. A separate citation number 6604148 was issued for the failure to record hazards of an unstable highwall and unstable spoil bank, including tension cracks above the highwall and on the crest and slope of the spoil pile.

The spoil bank had failed the night before into the working area of the pit leaving a steep spoil slope of up to 60 degrees. In addition to the steepness of the slope there were scarps and cracking in the spoil bank above the active work areas creating hazardous working conditions below the spoil bank.

Two surface miners were fatally injured when a massive surface coal mine highwall failure occurred on April 17, 2007, at the 001 Pit (Caledonia Pit/419 Pit) (See Attached Map).

To abate this citation, an updated training plan and training shall be conducted for all certified foreman and miners at Job #3 to recognize hazards associated with subsidence. The operator's training plans and safety program did not provide specific training to the miners or examiners in recognizing hazards related to subsidence and underground mine workings within a highwall, or the effects of joint sets on highwall stability.

4. A **§104(d) (1) Order, No. 6604622**, was issued to Tri-Star Mining, Inc. citing 30 CFR, 77.1006(a)

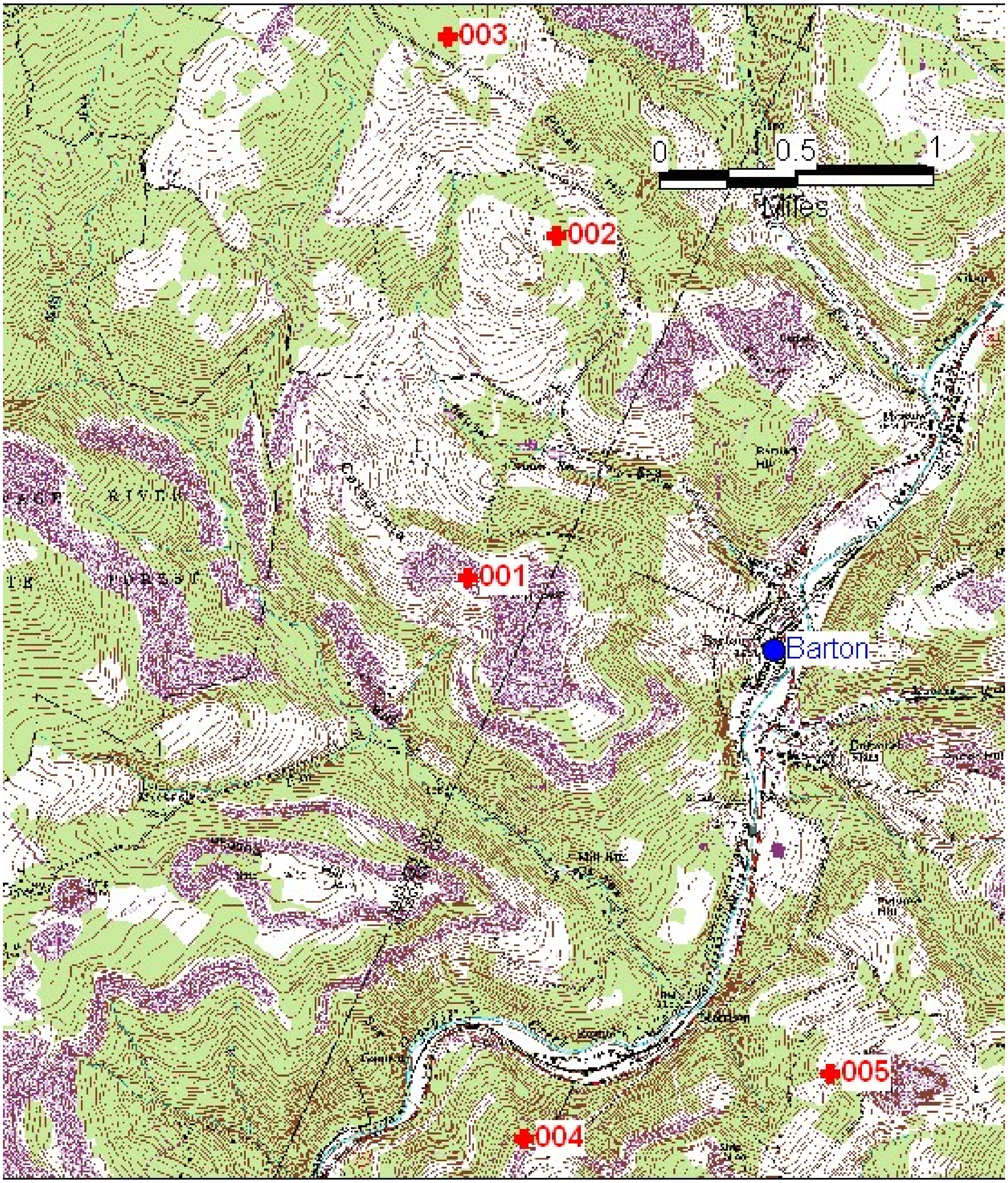
   Condition or Practice:
   On April 17, 2007, the track excavator operator and the dozer operator were assigned and were working near a dangerous highwall and under a dangerous spoil bank in the 001 pit (Caledonia) (see the attached map). The unstable highwall collapsed resulting in fatal injuries to the two equipment operators that were working in the pit below the highwall. The highwall was 275 feet high and the collapsed area was approximately 230 feet high, 240 feet wide, and up to 40 feet deep. A combination of the following factors made the highwall dangerous: loose and fractured rock from subsidence in numerous areas on both sides of the failure, joint set orientation along the highwall at the failure, lack of effective benching, remnant pillars that resulted in weakened strata, and the effects of seeping water.

The spoil bank had failed the night before into the working area of the pit leaving a steep spoil slope of up to 60 degrees. In addition to the steepness of the slope there were scarps and cracking in the spoil bank above the active work areas creating hazardous working conditions below the spoil bank.

The mine operator was put on notice from a March 2002 ground control acknowledgement, that when surface operations intersect old underground works, extra care must be taken to assure the safety of miners working near the highwall. The mine operator failed to establish and follow a ground control plan for safe control of highwalls, pits and spoil banks for the 001 Pit (Caledonia/419 Pit in response to the underground workings.

This is being issued in conjunction with D-1 citation 6604621 and D-1 order 7146873 which also contributed to the accident.

Appendix A
Location of the Five Pits Included in Tri-Star Mining, Inc.'s Job No. 3 Mine



Tri-Star Mining, Inc.'s Job No. 3 Mine, I.D. No. 18-00713, includes five separate pits. The fatal highwall failure occurred at Pit 001, also known as Caledonia Hill and the Maryland No. 419 Permit area.

Appendix B

Sketches and Photographs

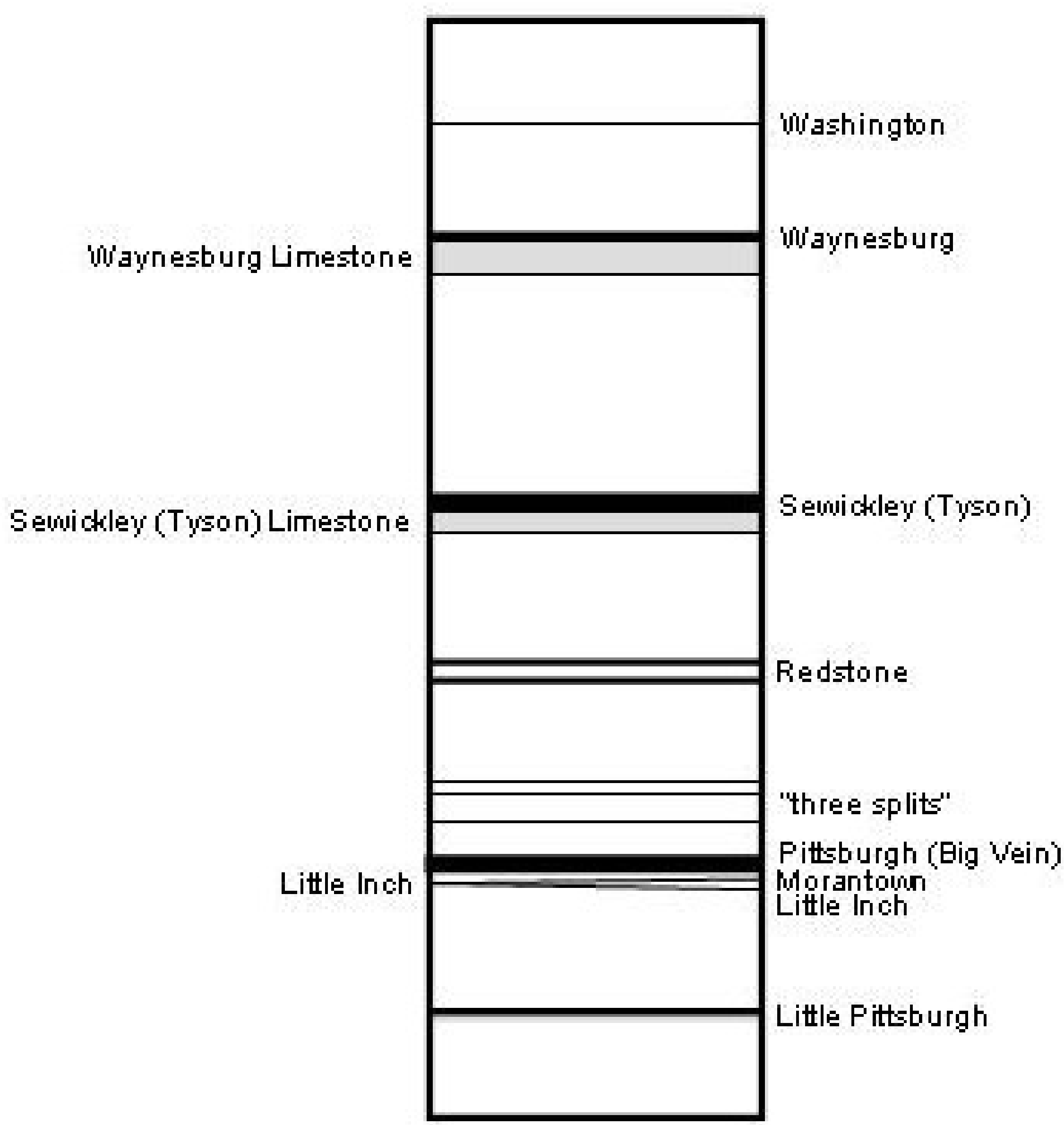


Figure 1. Stratigraphic column for mined coal seams at the 001 Pit. The Little Inch and Morantown merge into a single seam. Extensive underground mine works are present in the Sewickley and Pittsburgh seams.

Appendix B Continued

Figure 3. Open joint exposed at top of highwall, between the haul road and the highwall berm, exhibits aperture of three inches. Joint is parallel to trend of adjacent highwall.

Figure 4. Block located 200 feet west of failure bounded by perpendicular joints has rotated from the highwall toward the pit, separating along a joint plane oriented parallel to the highwall. Block exhibits 12-foot separation with respect to the highwall.

Figure 5. Rounded edges on middle tension crack indicate that it was present for a prolonged period, and most likely pre-dated the highwall failure. Swarm of cracks, present between the berm at the top of the highwall and the haul road, is oriented parallel to N 60-70° W-striking joint set. Area is located approximately 600 feet west of the failure.

Appendix B Continued

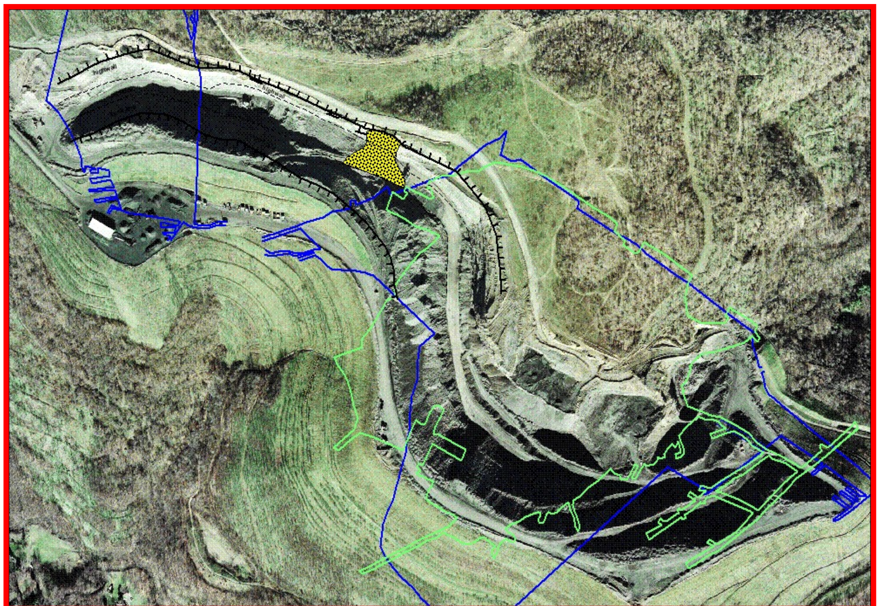


Figure 7. November 2006 aerial photo of the 001 Pit overlain by April 2007 failure area and outlines of underground mine workings. Blue outline represents underground mining in the Pittsburgh seam; green outline represents underground mining in the Sewickley seam. Additional mine workings were observed in the highwall, for which no mine maps were found. Highwall and spoil bank locations documented during investigation are slightly offset from the older pit outline shown in the photo.

Figure 8. Pillars visible in the Sewickley seam retain square pillar corners despite total failure of the immediate roof and complete in-filling of old rooms. Layers of the immediate roof typify sag into the underlying rooms.

Figure 9. Wood post is preserved in crushed, in-filling rubble in a Pittsburgh seam room. Coal pillar is completely failed, characterized by extensive crushing and shearing, and illustrates the extent of damage in the Pittsburgh seam.

Appendix C
Technical Reporting of Geology and Geotechnical Analysis

Geology

Where the thin layer of unconsolidated overburden had been removed to expose the underlying rock, N 60-70° W-striking joints exhibited open apertures of up to three inches (Appendix B Figure 3). Large blocks (30 x 10 x 20 feet) had separated from the top of the highwall, offsetting the berm by 11-40 feet, and were bounded by two perpendicular, intersecting joints (Appendix B Figure 4).

The swarms of tension cracks were observed from directly adjacent to 700 feet west of the failure area, extending along the top of the highwall. The presence of mud, as well as the presence of cat-tail growth, along the top of the highwall between the berm and haul road indicated prolonged periods of standing water that was available to lubricate underlying joints. Rounded edges in some of the tension cracks indicated that they had been open for extended periods of time prior to the highwall failure (Appendix B Figure 5). The sides of some mud cracks were aligned into a continuous, ragged trend that was parallel to the N 60-70° W-striking joint set in the underlying rock.

Previous Mining

A number of digital mine maps were obtained from the Maryland Bureau of Mines and the Office of Surface Mining and Reclamation Enforcement (OSMRE) Mine Map Repository. Available maps indicated that underground mining began in the Pittsburgh seam as early as 1888. Other underground mines were developed in the Pittsburgh and overlying Sewickley seams during the 1920's, with subsequent second mining reportedly performed in the 1930's and 1940's (Appendix B Figure 6). Although numerous mine maps from the Caledonia Coal Co. were obtained, no maps of the Swanton Coal Co. could be found.

The extensive jointing that was present in the highwall provided planes of weakness that increased the severity of the subsidence, allowing joint-bounded blocks of the immediate and main roof to drop into the underlying rooms. The rubble was stained with white, flour-like precipitant from circulating groundwater. Water was observed seeping from old works in the Sewickley and Pittsburgh seams exposed in the highwall. The iron staining and water seepage indicated that the highly fractured and jointed rock mass in the highwall freely transmitted ground water. The joint-bounded blocks are more susceptible to sloughing in the vicinity of underground mining, and defined deep, concave indentations in the highwall above the underlying mine openings.

Highwall Failure Mechanism

The failure area was bounded vertically, in the back, by the N 60-70º W joint set. The perpendicular joint set, oriented N 20-25° E, along with subsidence damage to the strata, created weak boundary areas on the sides of the failure. The failure is believed to have extended laterally from the joint set in the back, through the Pittsburgh coal seam together with its immediately overlying and underlying shale, out to the face of the highwall. Although the bottom of the failure was covered by the rubble pile, two miners and the mine foreman stated that the coal pillar remnants in the Pittsburgh seam, near the base of the highwall, tended to slide outward toward the pit. Remnant Pittsburgh coal seam pillars east and west of the failure were protruding several feet. Additionally, a Pittsburgh coal seam pillar remnant was located in the rubble pile, approximately 30 feet out from the highwall.

The largest 24-hour rainfall amount that occurs on average once per year in this area is approximately 2.4 inches. The highwall was heavily fractured due to mine subsidence. Fractured rock allows water to easily drain, preventing the water from building up and creating high hydrostatic pressures.

Appendix D
Persons Participating in the Investigation

Tri-Star Mining, Inc. Management Officials.

George Beener .... Owner
Ray Tighe .... Mine Foreman
Kerry Beener .... Foreman

Tri-Star Mining, Inc. Employees

Donald F, Baker Jr. .... Rock Truck Driver
Derek S. Broadwater .... Rock Truck / Equipment Operator
John David Cook II .... Shovel Operator
David Dwire .... Rock Truck Driver
Don E. Dwire Jr. .... Truck Driver / Heavy Equipment Operator
Ryan Duckworth .... Mechanic/Mechanic Helper
James Gowans .... Loader Operator
Wesley A. McCutcheon .... Certified Blaster
Charles Thomas Morgan .... Loader Operator – Coal Yard
James D. Paugh .... Dart Coal Truck Driver
Jeffery S. Pyle Jr. .... Bulldozer Operator
Derrick S. Rhodes .... Rock Truck Driver
John Switzer .... Track Drill Operator
Allen K. Wilt .... Coal Loader-Front End Loader Operator

Rish Equipment

Michael A. Sherwood .... Mechanic/Service Technician

Robert L. Dugan Jr. & Associates

Robert L. Dugan Jr. .... Consultant

Highland Engineering & Surveying

Larry Bayles .... Partner/Engineer

Maryland Emergency Management Agency

Roger Bennett .... Western-Regional Administrator

Maryland Department of Environment, Water Management Administration

John Cary .... Director
Ray Karlstrand .... Environmental Compliance Specialist
Ralph Mongold .... Environmental Compliance Specialist

Mine Safety and Health Administration

Charles J. Thomas .... Chief, CMS&H Health Division
Craig S. Aaron .... Mining Engineer
Jason W. Rinehart .... Industrial Hygienist
Gregory B. Meikle .... Mine Safety and Health Specialist, Accident Investigations
Donald T. Kirkwood, P.E. .... Supervisory Civil Engineer, Technical Support
Sandin E. Phillipson, Ph.D. .... Geologist, Technical Support
Ronald E. Gurka .... Senior Trial Attorney, Regional SOL

Appendix E
Victim Information (MSHA Form 7000-50(b)

Accident Investigation Data - Victim Information
Event Number: 4 0 7 7 5 5 8

U.S. Department of Labor
Mine Safety and Health Administration

Victim Information: 1

1. Name of Injured/Ill Employee: Dale F. Jones
2. Sex: M
3. Victim's Age: 51
4. Last Four Digits of SSN:
5. Degree of Injury: 01 Fatal
6. Date(MM/DD/YY) and Time(24 Hr.) Of Death: a. Date: 04/17/2007 b.Time: 10:00
7. Date and Time Started: a. Date: 04/17/2007 b.Time: 6:00
8. Regular Job Title: 173 Backhoe operator
9. Work Activity when Injured: 072 Operate surface equipment, NEC.
10. Was this work activity part of regular job? Yes X No
11. Experience

	Years	Weeks	Days
a. This Work Activity:	7	32	0
b. Regular Job Title:	7	32	0
c: This Mine:	16	44	0
d. Total Mining:	16	44	0

12. What Directly Inflicted Injury or Illness? 089 Broken rock, coal, ore, waste
13. Nature of Injury or Illness: 170 Crushing
14. Training Deficiencies: Hazard: New/Newly-Employed Experienced Miner: Annual: Task:
15. Company of Employment: (if different from production operator) Operator
Independent Contractor ID: (if applicable)
16. On-site Emergency Medical Treatment: Not Applicable: First-Aid: CPR: EMT: Medical Professional: None:
17. Part 50 Document Control Number: (form 7000-1)
18. Union Affiliation of Victim: 9999 None (No Union Affiliation)

Victim Information: 2

1. Name of Injured/Ill Employee: Michael R. Witt
2. Sex: M
3. Victim's Age: 38
4. Last Four Digits of SSN:
5. Degree of Injury: 01 Fatal
6. Date(MM/DD/YY) and Time(24 Hr.) Of Death: a. Date: 04/17/2007 b.Time: 10:00
7. Date and Time Started: a. Date: 04/17/2007 b.Time: 6:00
8. Regular Job Title: 168 Bulldozer/tractor oper.
9. Work Activity when Injured: 047 Operate bulldozer
10. Was this work activity part of regular job? Yes X No
11. Experience:

	Years	Weeks	Days
a. This Work Activity:	0	45	0
b. Regular Job Title:	0	45	0
c: This Mine:	1	9	0
d. Total Mining:	1	9	0

12. What Directly Inflicted Injury or Illness? 089 Broken rock, coal, ore, waste
13. Nature of Injury or Illness: 170 Crushing
14. Training Deficiencies: Hazard: New/Newly-Employed Experienced Miner: Annual: Task:
15. Company of Employment: (if different from production operator) Operator
Independent Contractor ID: (if applicable)
16. On-site Emergency Medical Treatment: Not Applicable: First-Aid: CPR: EMT: Medical Professional: None:
17. Part 50 Document Control Number: (form 7000-1)
18. Union Affiliation of Victim: 9999 None (No Union Affiliation)