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Mine Safety

Investigation report

Report into the death of Lee Peters at the Ridgeway Mine, Cadia, NSW on 6 September 2015

Published by NSW Department of Industry, Skills and Regional Development, NSW Resources Regulator

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First published: March 2017

Authorised by: Manager Regulatory Audit and Investigation Unit

1. Executive summary

Overview

Between 9.17 pm and 10 pm on 6 September 2015, Mr Lee Peters, 28, was fatally injured when he was crushed in a pinch point between a piece of mining plant, known as a Jacon Maxijet water cannon (water cannon), and a mine wall at the Ridgeway Mine, Cadia Valley Operations, Cadia, NSW.

The incident occurred about 1 km underground in an extraction drive (roadway used to extract ore).

The pinch point was created when fragmented rock flowed out of a blocked draw point and contacted the front of the water cannon, which pushed it backwards causing its left hand rear corner to impact with the western sidewall of the extraction drive.

Mr Peters was found by another worker trapped in the pinch point on the northern side of the water cannon. This position was on the downwind (mine ventilation system) side of the machine. Mr Peters was found to be facing a southerly direction in a vertical stance, leading investigators to believe that he was travelling from the north side of the water cannon to the south side when the incident occurred.

At the time of the incident, Mr Peters was undertaking work as a water cannon operator engaged in secondary break operations at East 6 draw point in extraction drive 10 (10E6).

A draw point is used in the block cave mining technique to extract ore for processing. Mr Peter's task as a secondary break operator was to attempt to unblock draw points by undercutting the broken rock and material using the water cannon. A blocked draw point is known as a hang up. Mr Peters was working alone when the incident occurred.

The investigation did not establish how Mr Peters came to be positioned between the water cannon and the sidewall at the time the water cannon was pushed backwards by the fragmented rock. Three possible explanations are:

1. Mr Peters was in the process of taking shelter behind the machine to avoid the rock and material inflow when the hang up released.
2. Mr Peters chose to move to the southern side of the machine when the hang up let go so that he would be upwind in fresh air and out of the dust cloud that accompanied rock and material movement.
3. The task Mr Peters was undertaking failed to release the hang up and Mr Peters was in the process of demobilising (which involves walking past the back of the machine) when the hang up released and pushed the water cannon backwards.

Interviews established that it was not unusual for some operators to move behind the water cannon when a hang up released. A review of previous incident reports also established that rock flows from draw points had extended into extraction drives on previous occasions, and there had been at least two previous incidents where rocks came into contact with the front of the water cannon during the process of water jetting hang ups.

Safety observations

The standard work procedure for operating the water cannon when it was water jetting required the operator to stand on the northern side of the machine but on the opposite side of the extraction drive to where Mr Peters was found, and to retreat downwind when a hang up let go and shelter behind the pillar separating the adjacent draw point.

However, investigators identified that some workers would instead go the opposite way, behind the water cannon, to the fresh air side (upwind) of the draw point. Enquiries revealed that this was in order to get out of the dust that was released when a hang up let go. Some supervisors knew this practice occurred.

This practice exposed workers to a pinch point behind the water cannon which was identified during a safety behaviour observation with senior management.

Investigators also identified that a number of critical policies and procedures that workers were required to comply with contained inconsistent, ambiguous and/or outdated advice. Importantly, this applied to the location and size of bunds constructed in front of draw points to protect workers from the inflow of rock and material from the draw point.

Bunds were classed as a critical control at the Ridgeway Mine. A critical control is defined as '*a control that is crucial to preventing the event or mitigating the consequence of the event. The absence or failure of a critical control would significantly increase the risk despite the existence of other controls*'.

The investigation identified four different directives concerning the location and size of bunds. Further, safe work procedures were not updated to reflect changing risks within the mine.

On more than one occasion workers told investigators that water jetting a hang up was an 'adrenalin rush'. Workers attributed this 'rush' to the sudden release of rock and material during the water jetting process. Such statements provide insight into the operational environment faced by workers involved in secondary break activities using the water cannon.

The investigation also identified that the risk profile of a block cave mine changes over time. When working in such a dynamic environment, continuous assessment of risks must be undertaken to ensure controls remain relevant and effective.

The water cannon procedure in effect at the time of the incident was last updated in May 2012. Subsequently, a significant number of uncontrolled inflows of dry and wet material from draw points occurred, particularly in late 2014. These incidents were attributed to a change in the nature of the cave material.

Legislation requires that procedures are reviewed when incidents occur and proper incident analysis is performed to identify both positive and negative trends. These previous incidents were investigated by the mine operator but there were no revisions to the safe work procedures issued.

The use of the water cannon was considered by the mine to be an effective technique to unblock draw point hang ups. The water cannon was constructed at the request of the mine operator by modifying a purpose built machine for applying shotcrete (sprayed concrete). In order to operate effectively as a water cannon, the operator was required to stand outside the cab and use a remote control, exposing the operator to potential inflows of rock and material.

Remedial measures

Following the incident, the mine operator identified two pieces of plant that could be substituted for the water cannon. Neither machine required the operator to leave the enclosed cabin during operation.

The mine operator also trialled remote control technology that could operate the water cannon from a safe distance and prohibited workers from being on foot in the vicinity of draw points. Inspections of draw points were also required to be undertaken from mining plant such as an underground loader.

A trial was also conducted whereby a ladder and walkway was constructed across the back of the water cannon for access and egress to eliminate workers being exposed to the pinch point between the rear of the water cannon and mine wall.

Industry recommendations

This incident reinforces the risks associated with working in the vicinity of block cave draw points.

When considering the recommendations below, mine operators are reminded of their obligation to take a combination of measures to minimise the risk, if no single measure is sufficient for that purpose.

Operators of metalliferous underground mines that contain draw points but are not block cave operations should consider the following recommendations as far as reasonably practicable.

When undertaking block cave mining and draw point production activities, mine operators should:

1. Use the hierarchy of controls when developing critical controls, with a focus on hard controls (e.g. elimination, substitution or engineering).
2. Consider remote technology, taking workers out of the line of fire from draw points.
3. Prohibit mine workers from undertaking work on foot in the vicinity of underground draw points. without appropriate controls in place.
4. Eliminate or minimise worker exposure to pinch points between mobile plant and mine workings.
5. Construct bunds to consistent standards in appropriate areas such as open draw points and maximise bund size taking into consideration rock fragmentation and material type.
6. Consider the potential for rock material (whether dry or wet) to flow into extraction drives and place workers at risk.
7. Ensure inrush control plans identify and control rock flows from draw points.
8. Undertake regular reviews of the inrush principal hazard management plan and map against the codes of practices and guidelines, including the NSW code of practice for inundation and inrush hazard management.
9. Ensure appropriately trained personnel inspect active draw points to identify hazards and eliminate or minimise risks to health and safety.
10. Ensure human factors and working environment are considered during the development of critical control measures.
11. Ensure monitoring arrangements are developed and implemented to minimise dust exposure.

Contents

2. Purpose of the report

This report has been prepared for the Secretary of the NSW Department of Industry, Skills and Regional Development (the department). It is based on the mining workplace incident investigation conducted by mine safety investigators of the department's Regulatory Audit and Investigation Unit (RAIU). The report details the cause and circumstances of the incident and contains recommendations based on the detailed analysis of information gathered during the investigation.

The purpose of the report is to assist the Secretary of the department, as the regulator of work health and safety at mines, to understand the incident and to share information with industry and the community so that proactive steps can be taken to improve industry safety and prevent similar events from occurring.

3. Investigation parameters

3.1. The department's Regulatory Audit and Investigation Unit

The mine safety investigators of the RAIU investigate the nature, circumstances and cause of major incidents in the NSW mining, petroleum and extractives industry. The unit's role is to carry out a detailed analysis of incidents and report its findings to enhance industry safety and to give effect to the department's Enforcement Policy.

The RAIU operates separately from the department's Mine Safety inspectorate and is not involved in the activities of the inspectors, or the day-to-day inspection of mines.

3.2. Investigation scope

The RAIU had authority to conduct an investigation into this matter because the incident occurred at a mining workplace regulated by the department. In accordance with departmental policy, the incident automatically triggered an investigation by the RAIU because it resulted in the death of a worker at a mining workplace. The investigation was conducted under the *Work Health and Safety Act 2011* (WHSA) and the *Work Health and Safety (Mines and Petroleum Sites) Act 2013 (WHSMA)*.

The investigation focused on:

- identifying the circumstances and causes of the incident
- identifying whether individuals and companies complied with WHSA, WHSMA and associated Regulations
- identifying control measures to prevent future similar incidents.

3.3. Legislative authority to investigate

RAIU mine safety investigators are appointed as government officials under the WHSMA and, therefore, are deemed to also be appointed as inspectors for the purposes of the WHSA and to have the powers of an inspector under that Act in relation to mining workplaces. The regulator has also delegated some additional functions to inspectors, including exercising the power to obtain information for the purposes of monitoring compliance with the WHSA.

3.4. The department's response to the incident

Department officials, including the local Inspector of Mines and Inspector of Mechanical Engineering, attended the incident scene in the late hours of 6 September 2015. The department's Emergency Management Coordination Team (EMCT) provided onsite assistance to the department's mining inspectors and investigators during the emergency response stages of the investigation.

The department's RAIU mine safety investigators attended the mine on the morning of 7 September 2015 and began a formal investigation into the incident.

The investigation was conducted in consultation with NSW Police and other major stakeholders. Investigation activities included:

- incident scene analysis and photography
- conducting interviews with workers
- issuing statutory notices to the mine operator, Mr Peters' employer, plant and equipment suppliers and other individuals to produce information and documents
- obtaining plans of the incident site
- obtaining records from the police, Coroner, emergency services and hospital
- inspecting departmental files relating to the mine
- analysing large volumes of information and records obtained during the investigation
- identifying the causal chain of events that led to the incident
- identifying what risk control measures were in place at the time of the incident
- identifying controls that may have prevented this incident from occurring.

3.5. The department's information release

The RAIU published an information release on 21 September 2015. This document drew attention to the importance of managing the risk to health and safety arising from inundation of mine workings by flowing rock and material. The release noted that control measures should include sufficient bunds to prevent movement of material, safe standing and operating zones for mobile machine operators, and safe means of egress. The release also noted that systems should also be implemented to ensure that people working alone are regularly monitored.

3.6. Investigation status

At the time of writing this report, investigations were ongoing. Investigation activities will continue until all relevant information has been obtained.

4. Cadia Valley Operations complex

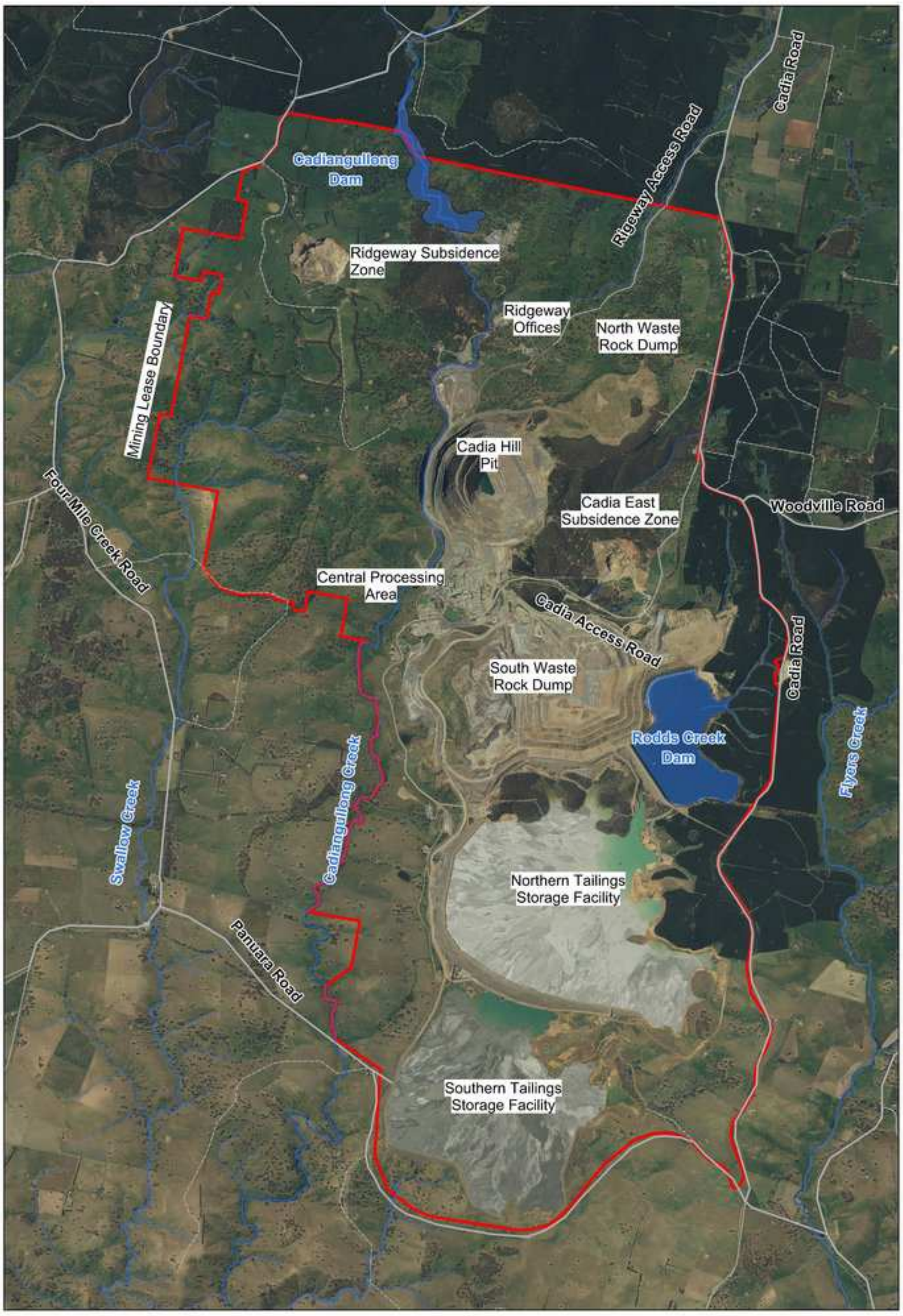
Cadia Valley is situated about 20 km south west of Orange and 25 km north east of Blayney in central NSW.

Active prospecting and small-scale mining came to the Cadia Valley in the 1850s and 1860s. Low scale mining and exploration was largely unsuccessful until 1992, when Newcrest Mining Limited (NML - which had recently been created through a merger between BHP Gold Mines Limited and Newmont Limited) discovered the Cadia Hill deposit. The Cadia Hill deposit was a large low grade gold and copper deposit that was successfully mined by Cadia Hill Mine using the open cut mining method.

Newcrest continued exploration in the area and, in 1996, discovered the Cadia Far East deposit followed by the relatively high grade Ridgeway deposit. This latter deposit was completely overlain by over burden, being about 500 m below surface, and was the first to be exploited through the establishment of Ridgeway Mine. Sub level caving was initially employed in the upper 300 m of the orebody, followed by block caving extending to almost 1000 m below ground. The Cadia Far East deposit was subsequently developed by the Cadia East Mine using panel caving (or multiple block cave panels).

At the time of the incident, Cadia Hill Mine, Ridgeway Mine, Cadia East Mine and an onsite ore treatment facility formed the Cadia Valley Operations (CVO) complex. Cadia Holdings Pty Limited (CHPL) (a wholly owned subsidiary of NML) was the mining lease holder for all mining leases that form CVO. An aerial photograph of the complex is depicted in Figure 1.

Figure 1 Aerial photograph of Cadia Valley Operations showing the location of Cadia Hill open cut, surface subsidence above Ridgeway Mine and surface subsidence above the Cadia East Panel Cave 1.



4.1. The mine holder and the operator of the mine

On 30 May 2008, the department received an application from Cadia Holdings Pty Limited (CHPL) to nominate NML as operator of the Cadia Hill Gold Mine, Cadia East Project and the Ridgeway Gold Mine (CVO). On 4 July 2008, the department accepted the nomination of NML to be the operator of CVO.

Savings and transitional powers within legislation ensured the continuation of these arrangements through to the date of the incident, which means that the department recognised NML as the nominated operator of the mine at the time of the incident. The department expects that all health and safety information relevant to the safe operation of the mine will be exchanged between the mine holder and the mine operator.

NML owns and operates gold and copper mines in Australia, Asia and Africa (refer to Figure 2). The company is one of the largest gold producers in the world and operates both above ground and underground mines.

NML is listed on the Australian Stock Exchange and the Port Moresby Stock Exchange.

NML's commitment to health and safety is affirmed in the following statement on their website:

> 'Newcrest is committed to the safety, health and well-being of all people involved in our business and recognises that we will only achieve our vision of zero injury when:
>
> - we believe that all injuries are preventable
> - we continually strive to improve our health and safety management systems and practices
> - we value consultation and engagement with all personnel in improving our performance
> - safe behaviour is a condition of employment
> - we accept responsibility for the occupational health and safety of our people, and we all accept responsibility for our personal safety and health and that of others
> - we provide effective training and the right equipment for people to work safely
> - controlling risk and ensuring health and safety is a key part of every decision
> - we promote off the job safety and support the wellness of our people
>
> Our health and safety strategy is built on three key pillars – NewSafe, Critical Control Management, and Process Safety Management. The strategy builds on a strong foundation of group-wide systems and standards which have been implemented in recent years.
>
> NewSafe is Newcrest's next step in building our safety culture. There are three components to NewSafe – NewSafe Leadership which focusses on building safety leadership at all levels; NewSafe Coaching which specifically supports our frontline supervisors; and NewSafe Behaviours which takes our employees and contractors through a process to identify the most important safety behaviours in their area, and uses a behavioural influencing model to formulate their own plan to enable and motivate these behaviours.
>
> Building on a solid foundation of major hazard risk assessments which Newcrest has undertaken for many years, our critical control management approach focusses on verifying the operation of the controls we have identified as being critical to preventing fatalities and life-altering injuries.
>
> Completing our strategic approach is a continual improvement focus on Process Safety Management, an area of safety management which is primarily concerned with preventing high-consequence catastrophic events.
>
> Keeping our people healthy and safe is a core value for Newcrest.'

Figure 2 Locations of operations and advanced projects for NML (source. www.newcrest .com.au)

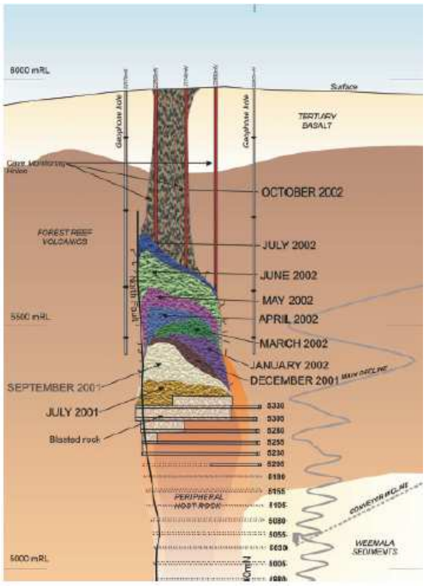
4.2. Ridgeway mine design

Ridgeway Mine ceased production in March 2016. When it was in operation, the mine extracted a copper/gold orebody, the top of which was more than 500 m below surface. The deposit had a maximum dimension of approximately 400 m east-west and 250 m north-south. Construction commenced in 1999 by employing the sub level mining method to extract the upper 300 m of the orebody. This method involves driving horizontal tunnels through the orebody at fixed vertical and horizontal intervals and then progressively blasting the ore around these tunnels on retreat.

After each blast, rubber tyre load-haul-dump machines, which resemble low profile front-end loaders, load the blasted ore from the tunnel face and transport it to tipping points, from where it gravitates to crushers before being conveyed to the surface. The amount of ore recovered or ‘drawn’ from each tunnel face is determined on the basis of tonnes or mineral grade. The face of the tunnel from which the ore is recovered is referred to as a ‘draw point’.

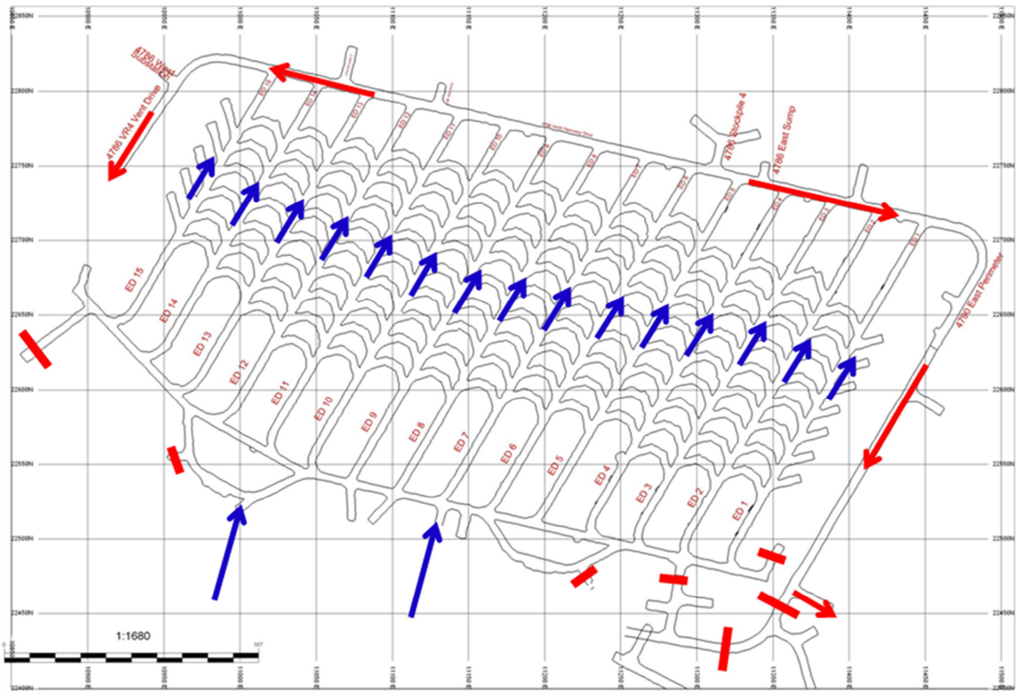
As the ore is recovered, the overburden collapses and caves into the excavation. If the area of extraction is sufficiently large, the overburden will eventually subside through to the surface. Figure 3 shows how caving propagated through to the surface at Ridgeway Mine in 2002.

Figure 3 A vertical section through Ridgeway mine showing the propagation of caving through to the surface (after Dunstan, 2016).



In 2010, the block caving method of mining was introduced to extract about 210 m of orebody below the base of the sublevel cave and to one side of it. This method involves undercutting the base of the targeted section of the orebody with the intention of causing the orebody to then cave under its own weight. In the case of Ridgeway Mine, the undercut section of the orebody was connected by blasted slots to a series of tunnels, referred to as extraction drives, located 18 m below the undercut level. The connections were made by blasting a series of vertical 'funnels', known as drawbells, with the base of each drawbell being accessed from two diametrically opposed draw points on the extraction level. The block caving design at Ridgeway Mine resulted in the development of 248 draw points in an offset herringbone pattern and accessed from one of 15 extraction drives, as shown in Figure 4. Each drawbell was accessed via a draw point on its eastern side and a draw point on its western side, except in the perimeter extraction drives.

Figure 4 Layout of the extraction drives, draw points and ventilation system on 4786 extraction level at Ridgeway Mine. Note blue lines indicate intake air and red lines indicate return air



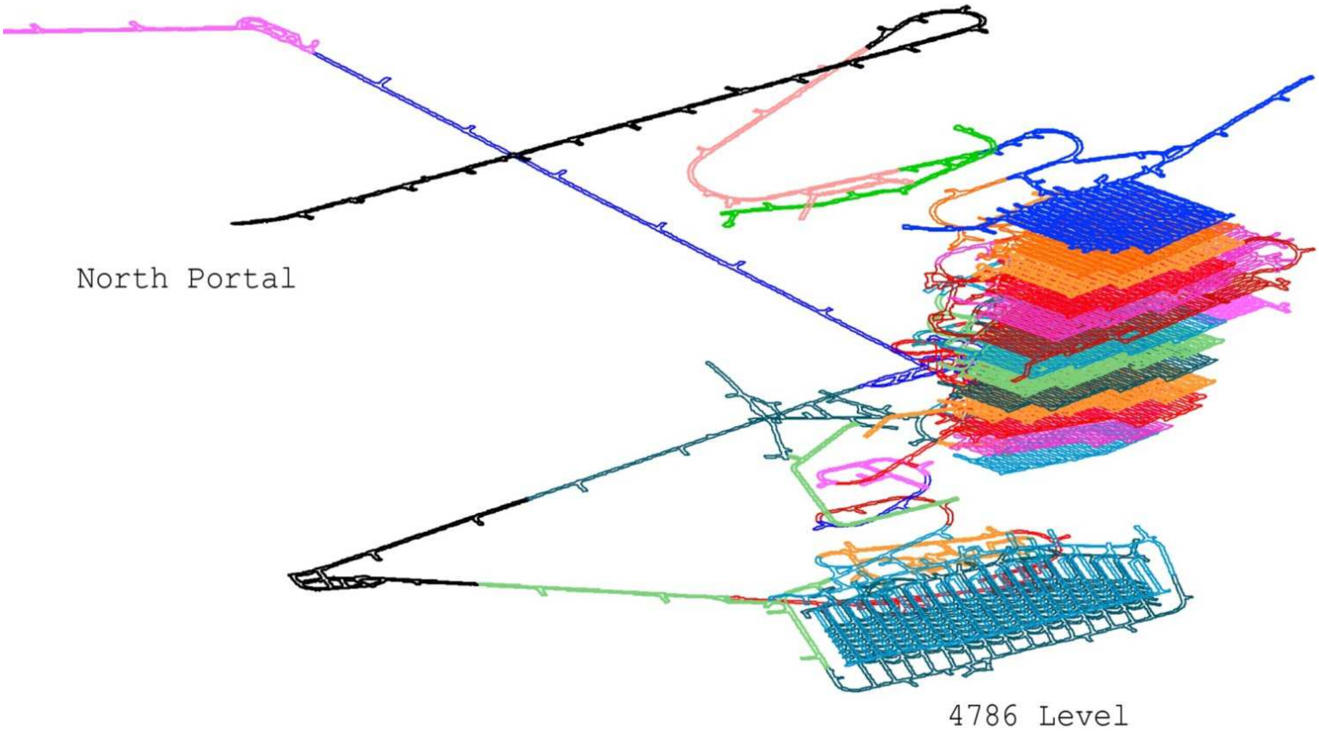
At Ridgeway Mine, hydrofracturing was used to help decrease fragment size in the block cave. This also assured that the cave collapsed at a predictable rate. With the subsequent drawing of ore from draw points on the 4876 extraction level, the cave propagated vertically until it connected with the caved zone of the sublevel caving workings.

An important difference between sublevel caving and block caving is that in the former method, the draw point position is continually changing while in the latter method, the draw point is fixed and has to function for an extended time. One important consequence of this is that draw points in block cave mining can become damaged and worn over time. In order to mitigate these effects, the mouth of a block caving draw point is reinforced and protected with large steel beams and shotcrete (sprayed concrete). The large steel beam that spans the roof at the entrance to a draw point is referred to as a 'brow beam'.

Another important consequence is that preferential flow paths for broken rock can develop over time in a block cave. This has implications for the size, nature and behaviour of the material at a draw point.

Figure 5 shows the overall layout of Ridgeway Mine.

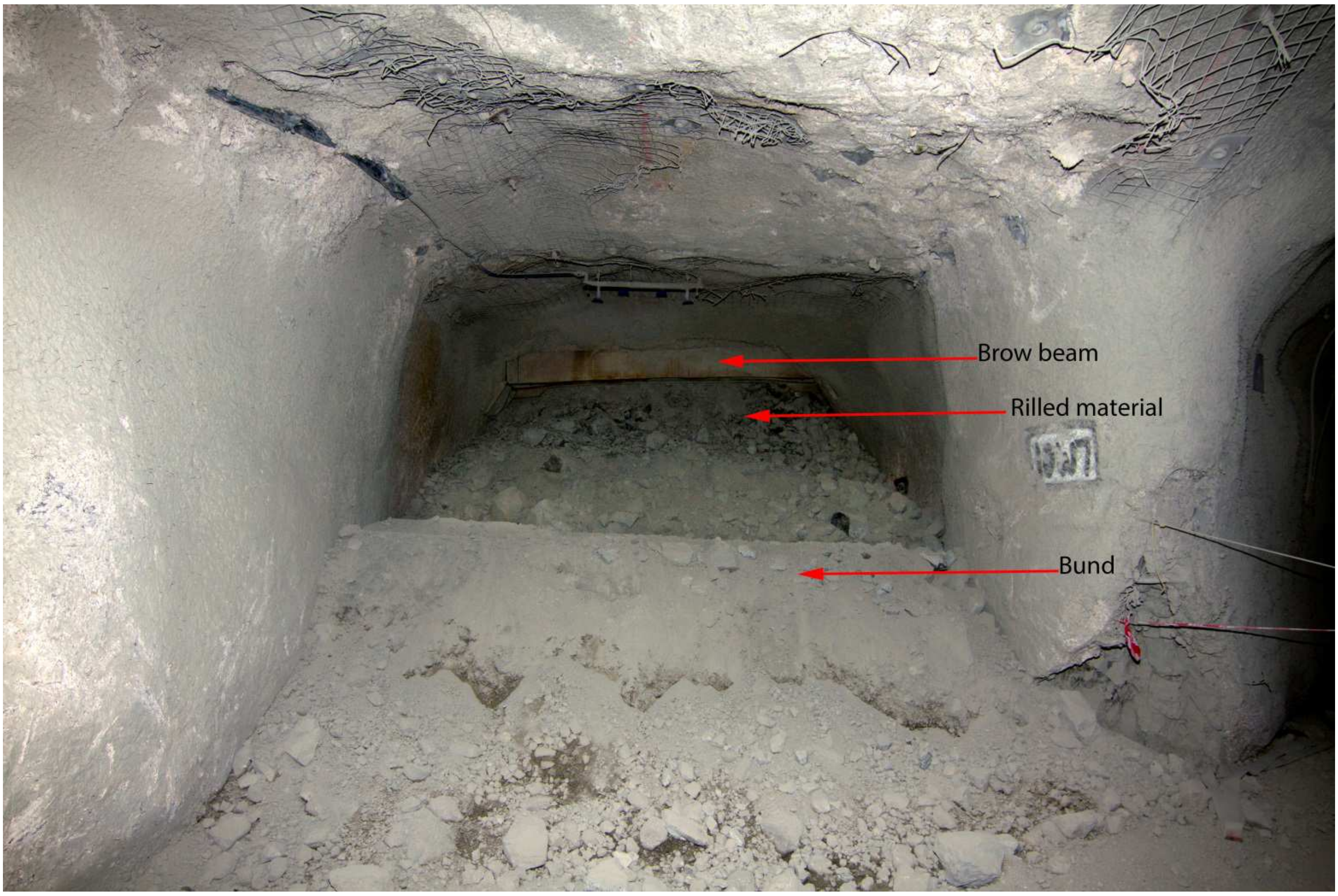
Figure 5 Ridgeway Mine (including sub level cave and block cave operations)



4.3. Caving requirements and draw point behaviour

The objective in block caving is for the orebody to fracture and flow under gravity to the draw points at the base of the cave and to rill out of the draw points at its natural angle of repose. The angle of repose is the steepest angle, measured from the horizontal, at which a material will remain stable. It varies with the physical and mechanical properties of the material. Ideally, as a bucket of material is recovered from a draw point, more material rills in to replace it. This situation results in an equilibrium that is termed a 'closed' draw point.

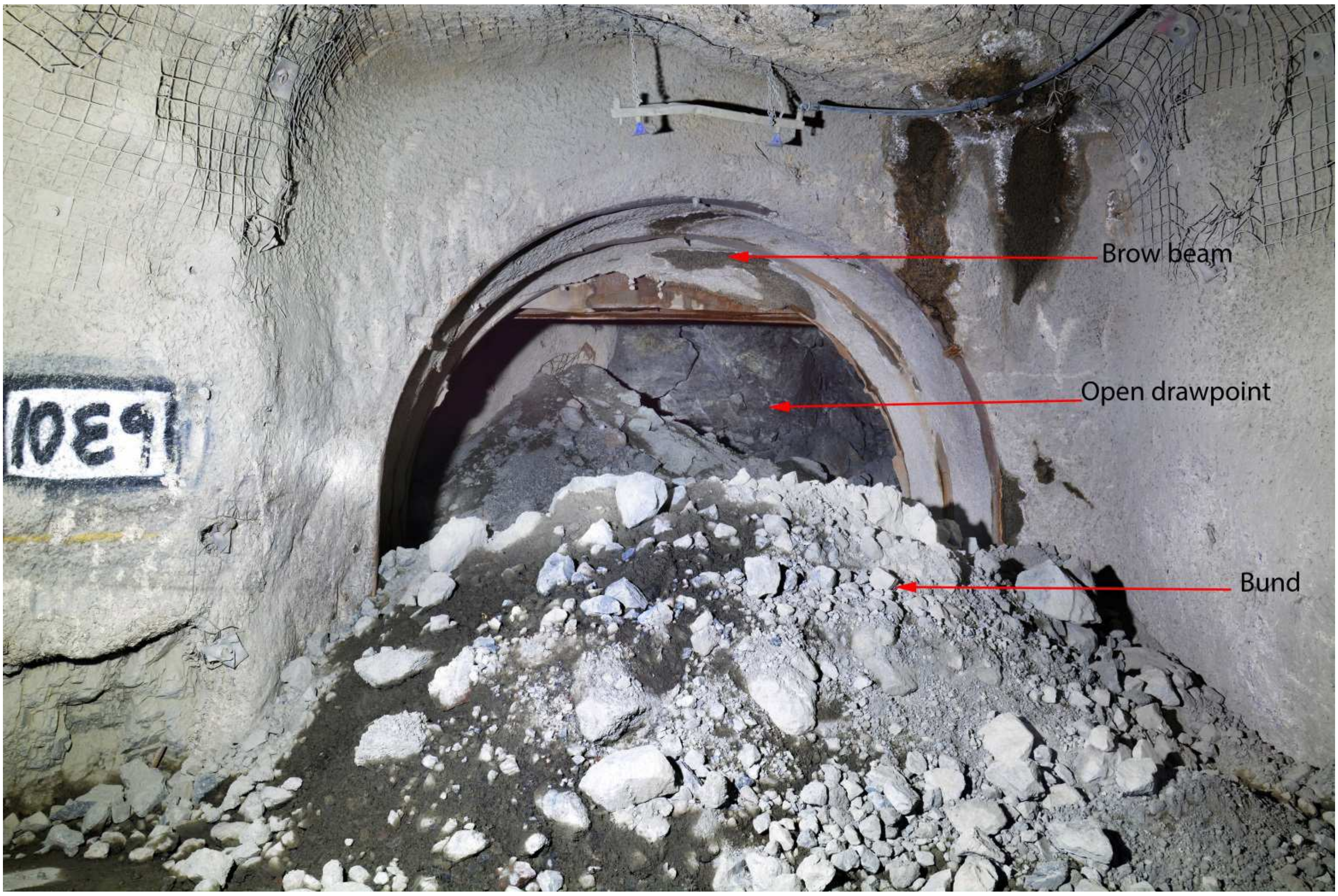
Figure 6 Photograph of 10W7 closed draw point and bund.



Fracturing and grinding occur within the broken rock mass as it collapses in sublevel caving and block caving operations. This process, referred to as ‘comminution’, results in a reduction in particle size, the particles taking on a more rounded shape, and the production of fines. Naturally occurring fine material can also enter the cave from the overburden, especially near the surface. The fine material can percolate through the cave zone and become concentrated at its base. It can also form ‘chimneys’ or preferential flow paths to draw points. Among other things, this can result in a change in the angle of repose and in how material flows out of a draw point. This is a well-known phenomenon in a mature block cave mine.

From time to time, draw points can become ‘choked off’, or ‘hung up’ and cease to flow. This can be due to the mouth (or throat) of the draw point being obstructed by one or more very large rocks or to the formation of arches of broken rock within the drawbell. The process for clearing these obstructions is referred to as ‘secondary break’.

Figure 7 Photograph of 10E9 open, hung up draw point and bund.



Moderately large size rocks may be removed by a loader and broken into smaller pieces using a hydraulic hammer. Otherwise, large rocks have to be drilled and blasted within the mouth of the draw point.

Methods for attempting to release a rock arch include drawing ore from neighbouring draw points, undermining the arch using a water jet (or water cannon), and setting off explosives (bombing) inside the draw point.

One consequence of a hang up at a draw point is that the mouth of the draw point is not choked off with rill but is open to the cave. This situation is referred to as an ‘open’ or ‘cracked’ draw point. It presents a serious risk as the working area around the draw point is no longer protected from falling material and any associated localised air blasts and mud rushes within the draw bell.

The void space beneath a hang up gives rise to the potential for a localised air blast when the hang up releases and the falling material rapidly displaces air from the void. The potential energy of the material being held back by a hang up gives rise to the potential for this material to flow into the work area when the hang up is released. A combination of fine material, especially clay, and water (that enters from the surrounding rock mass and the surface) above the hang up gives rise to the potential for a mud inrush into the work area when the hang up lets go. The risk of this occurring increase as the cave matures.

These are all well-established risks in caving mining systems. Usually, it is not feasible to quantify the nature of these risks at a specific draw point. This is because the area is inaccessible and there are many different combinations of how material can behave within a draw bell and the main body of a cave. Therefore, one fundamental or critical (essential) control to mitigate the risk of working in front of an open draw point is the construction of a ‘bund’. A bund is a barrier of broken rock constructed in front of a draw point to a stipulated height across the full width of the drive (roadway, tunnel).

4.4. The health and safety management system

At the time of the incident on 6 September 2015, the *Work Health and Safety Mines Regulation 2014* (WHSMR) stipulated that the operator of a mine must establish a health and safety management system that included the identification of principal mining hazards and the risk assessment of those hazards. The legislation also defined the contents of a principal hazard management plan. Due to the complexity of many operational health and safety management systems, savings and transitional arrangements have been added to the legislation to provide a two-year grace period for existing operators that had already complied with either the *Mine Health and Safety Act 2004* or the *Coal Mine Health and Safety Act 2002* (both repealed).

NML and Ridgeway Mine both existed before the implementation of the new WHSMR and had developed and implemented a health and management system as required under the *Mine Health and Safety Act 2004*.

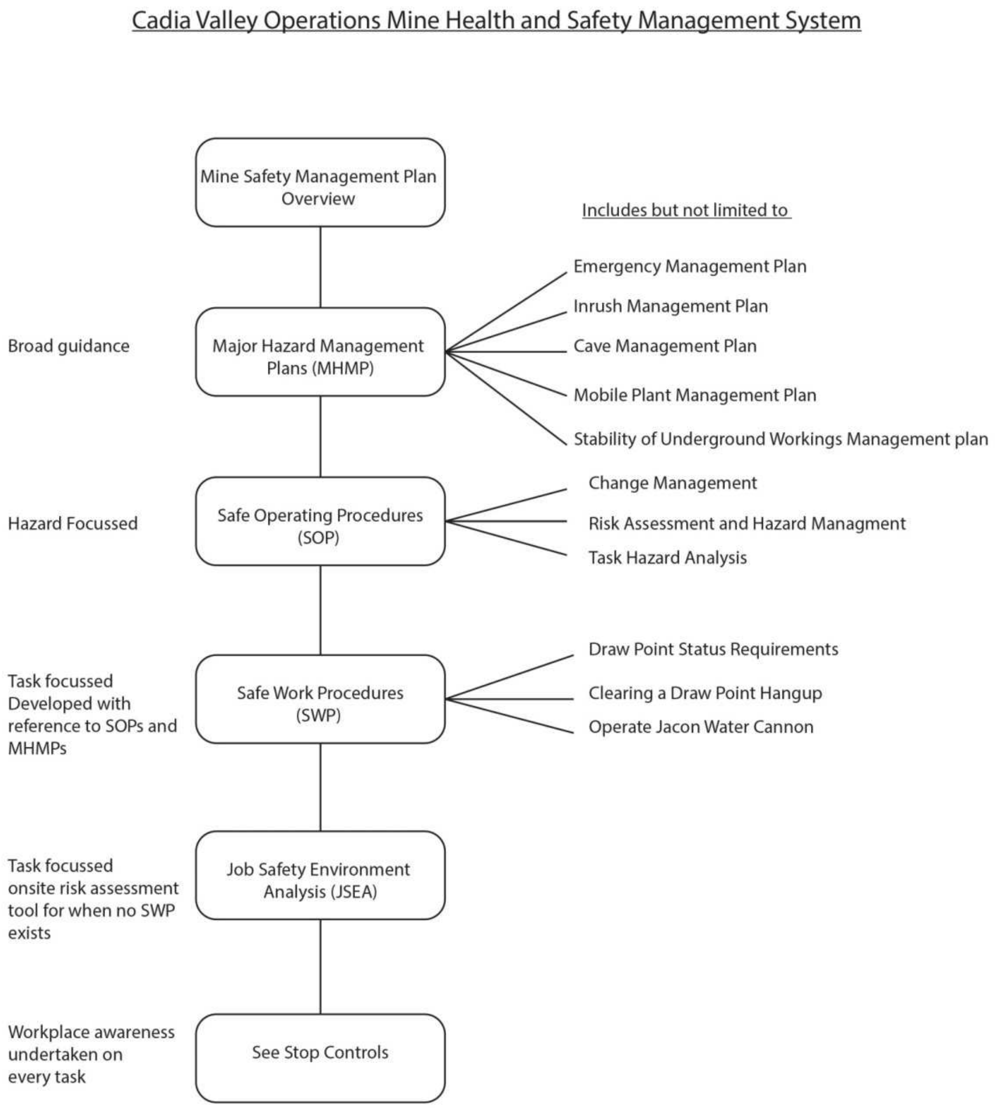
The NML health and safety management system master document is known as the mine safety management plan (MSMP). The MSMP identified elements of the CVO safety and health management system required for compliance with both NML corporate safety and health objectives and site specific work health and safety statutory obligations.

The MSMP applied to all areas at CVO including Ridgeway Mine.

As depicted in Figure 8 the HSMS was divided into:

- the MSMP overview
- major hazard management plans
- safe operating procedures
- safe work procedures
- workplace risk assessment
- workplace awareness

Figure 8 A graphical representation of the Health and Safety Management System structure for Cadia Valley Operations prepared by the lead investigator.



5. The employer

At the time of the incident, Mr Peters had been employed by Pybar Mining Services Pty Limited (PMS) for about four years. PMS is a wholly owned subsidiary of Pybar Holdings Pty Limited (PHPL).

PMS specialises in underground hard rock mining. PHPL was the third largest underground mining contractor in Australia. PMS projects included the Tritton and Hera mines in NSW, the Osborne and Starra mines in Queensland, the Ballarat mine in Victoria and the Red October mine in Western Australia. PHPL described its underground mining capabilities as:

- Australia-wide project management resources
- rapid mobilisation through dedicated project start-up teams
- a fleet of more than 300 items of machinery and equipment
- integrated, industry leading management systems
- best practice processes and procedures
- strong safety culture backed by robust and ingrained systems
- a collaborative partnership and focus on our clients' bottom line

- a complete service offering to keep projects on budget and on track
- an experienced management team with a single-minded approach to safety, smart thinking and continuous improvement.

6. The labour hire agreement

On 31 August 2011, CHPL and PMS entered into a contract for the provision of labour and equipment hire for general maintenance, shift coverage, shutdown and minor capital works.

The contract outlined PMS's health and safety obligations, in particular the contractor's obligations with regard to the provision of health and safety information and working under the NML health and safety management system.

The relationship between PML and CHPL was a relationship of independent contractor and principal. PMS employees were expected to work under the NML health and safety management system while at work at CVO.

It was a statutory provision of PMS to ensure that their employees were working under a safe system of work. This means that PMS was expected to review the NML health and safety management system at regular periods and ensure its adequacy for supporting their employees. PMS ensured that this occurred by providing a dedicated project manager for CVO whose role included consultation, co-operation and co-ordination of activities with relevant people at the mine site.

7. The deceased worker

7.1. Profile

On 28 March 2011, Lee William Peters was offered project-based full time employment with PMS. He was assigned work at the Ridgeway Mine through a contract with CHPL.

At the time of the incident, Mr Peters was employed as an underground mining technician at Ridgeway Mine. His role included operating underground production mining equipment, operating secondary rock breaking equipment and undertaking general mine maintenance.

Mr Peters was 28 years old at the time of his death.

7.2. Training

NML provided Mr Peters with on the job training. This training included an authorisation to operate the water cannon underground and instruction on its operation in the vicinity of a draw point. Mr Peters was also trained and authorised in the following aspects of work at the mine:

- Access development and production areas
- Operate a bogger
- Operate a bobcat
- Ridgeway underground area induction
- Accessing development and production areas
- Secondary rock breaking and drilling
- Work in and around ore passes and open holes

Mr Peters' training in relation to risk assessment and hazard awareness procedures at Ridgeway Mine included training in the following:

- JSEA – Job safety and environment analysis and risk awareness training as part of general site induction
- Code of conduct
- PEER – People eliminating everybody's risk
- SSC – See stop control
- Target zero

At the time of the incident, Mr Peters was expected to work within the NML health and safety system as stipulated in the PMS and NML contract of works. Mr Peters was required to undertake work assigned to him by his supervisor. Mr Peters was also expected to undertake workplace awareness assessments (SSC), be competent in operating the water cannon, be trained in and understand the specific safe work practices relevant to the tasks assigned to him and be familiar with higher level documents within the NML system.

7.3. Experience

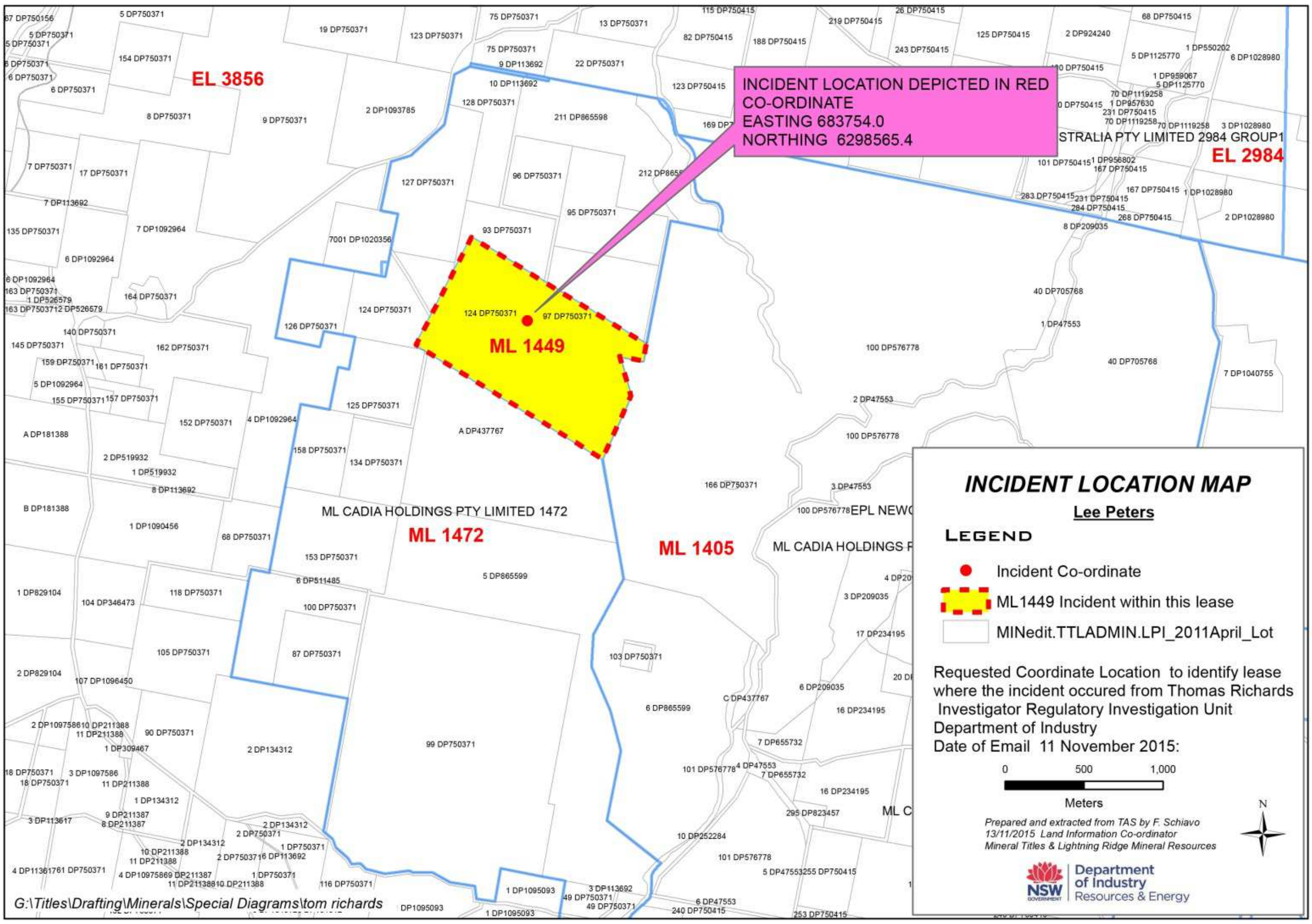
Mr Peters operated a small business outside of his obligations with PMS and NML and is reported to have experience around heavy mobile earth moving equipment.

8. The circumstances of the incident

8.1. The location of the incident

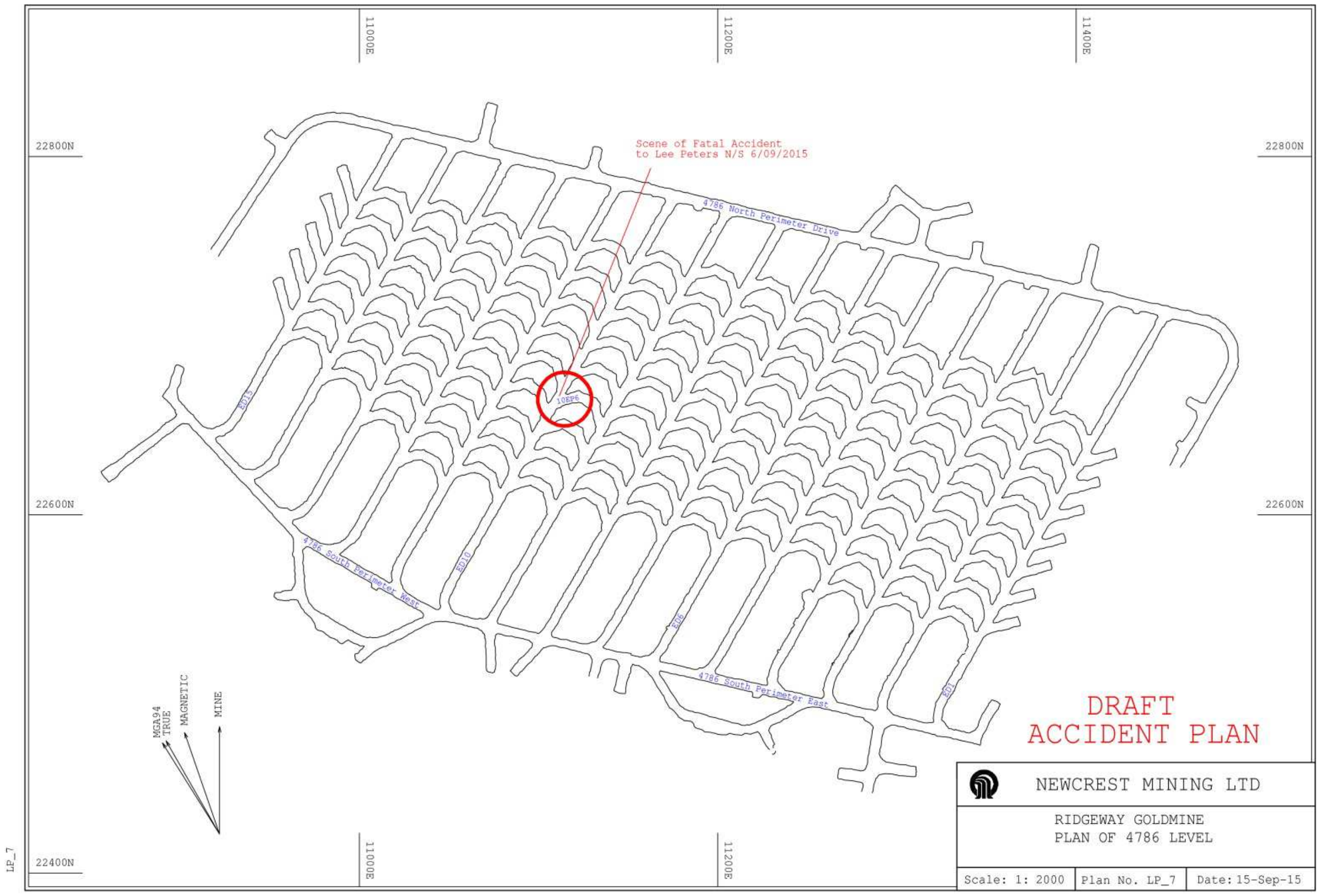
The incident occurred at Ridgeway Mine, which is wholly within mining lease 1449 (ML1449). ML1449 was granted under the Mining Act 1992 on 1 June 1999 and has an expiry date of 4 October 2017. There are no surface exceptions or depth restrictions. Figure 9 provides the exact co-ordinates of the incident, which demonstrates its location in comparison to the mining lease.

Figure 9 Incident location map provided by NSW Department of Industry. (Note incident coordinates were provided by NML).



There are a total of 15 extraction drives on the 4786 level that access a total of 248 draw points. At the time of the incident, production in extraction drive 10 was suspended to permit secondary breaking operations at draw points. The incident occurred at the sixth draw point on the eastern side of extraction drive 10 (10E6) on the 4786 extraction level. The location of extraction drive 10 is marked in Figure 10.

Figure 10 Incident location map which identifies extraction drive 10, draw point East 6, on 4786 production level as the incident site.



The incident scene is depicted in Figures 11 and 12. NML workers found Mr Peters trapped between the western sidewall of extraction drive 10 and the left hand rear corner of the water cannon. The water cannon was pushed out of the access drive to draw point 10E6 and into the sidewall of extraction drive 10 by a considerable volume of dry rock material (note, water present in photos is believed to have come from the water cannon operation). At the front of the water cannon lay a large rock (about 8 tonnes) which had made contact with the front of the water cannon. Broken rock materials had flowed out of the draw point and across the extraction drive (refer to Figures 11 and 12). Particle size distribution analysis revealed that approximately 50% of the material was less than 10 mm in diameter. Some larger rocks (approximately. 500 mm – 1000 mm in diameter) were interspersed with this fine material. The total volume of material that flowed from the draw point was surveyed and calculated to be 95 cubic metres or approximately 260 tonnes. This calculation did not take into account rock material that may have been present in the form of a bund. If a bund was present at the time of the incident then the calculated volume would be less.

Figure 11 Incident location plan showing the locations of the deceased and the water cannon and the floor contours (at 0.25m intervals) after the inflow event. The blue contours indicate the depth of the material that has flowed from 10E6 draw point.

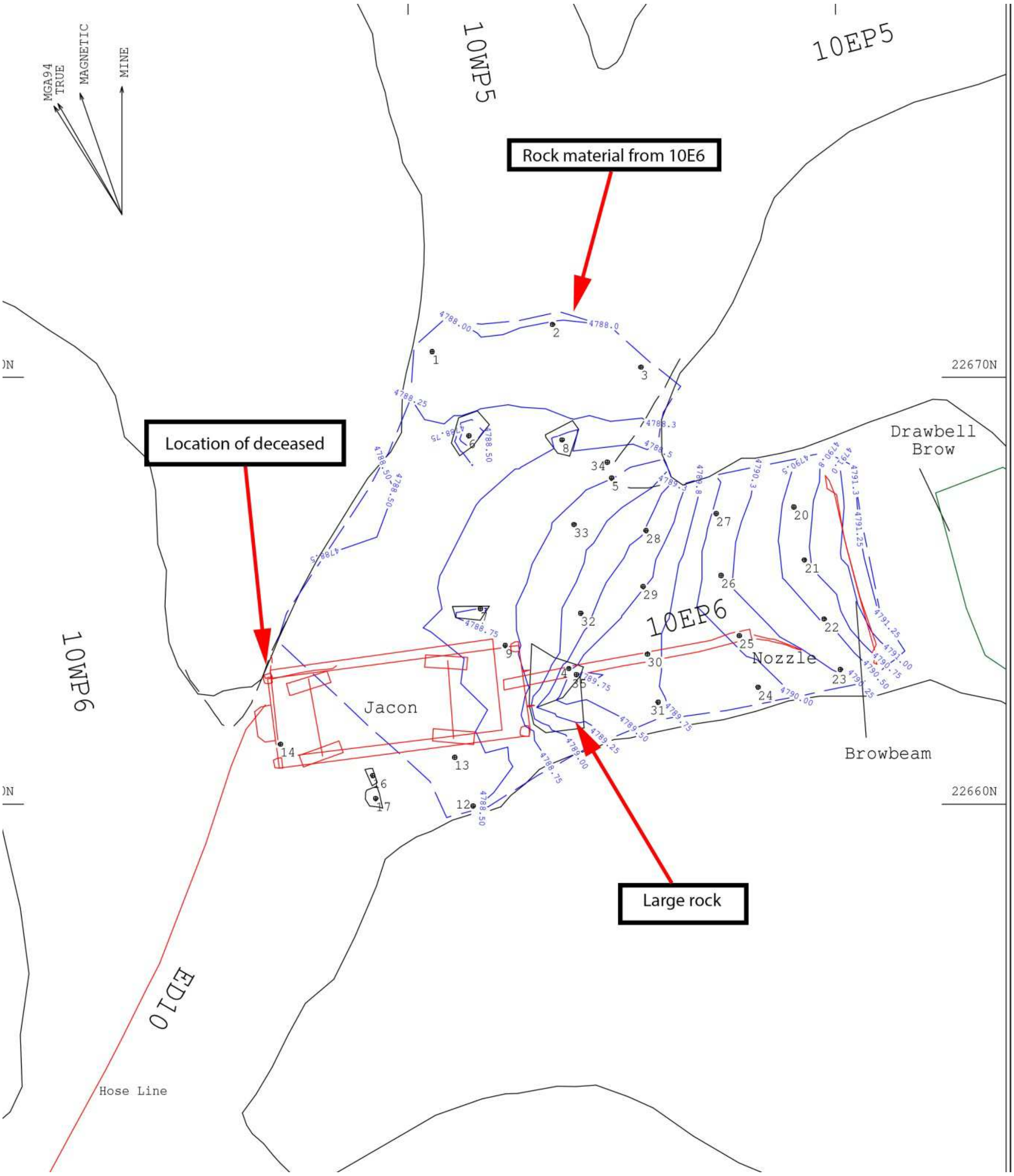


Figure 12 A photograph of the incident scene taken from the north side of draw point 6 in extraction drive 10, looking south (photograph by Department of Industry).

The water cannon will not function in water jetting mode unless the park brake is activated and the doors closed. Investigators noted that skid marks were visible on one rubber tyre and track marks were visible on the mine floor. This has led investigators to believe that the park brake was activated at the time of the incident. Investigators have also established that contrary to the safe working procedure for operating the machine (UGP-233), the front stabiliser jacks on the water cannon were not lowered at the time of the incident. Testing after the incident was unable to establish definitively if the machine would have had more resistance or less resistance to sliding when hit by the broken rock in the given conditions if the stabiliser legs were set. It is worth noting that the theoretical value for the coefficient of friction between metal and concrete is significantly less than between rubber and concrete. Functional testing of the water cannon confirmed that the park brake was operating as designed.

Figures 12, 13 and 14 depict photographs of the incident scene. The significant distance that the material flowed into the extraction drive roadway and down the drive beyond the corner of the pillar is noteworthy. It is also worth noting in figures 13 and 14 the large boulder that has made contact with the front of the water cannon (under place marker 4). This boulder weighed approximately 8 tonnes and was identified as resting on the concrete floor. Interspersed with the fine rill material were larger rocks that encroached on the operators working zone (visible in figure 11) and travelled the entire way to the western (opposite) sidewall.

Figure 13 The water cannon with a large boulder contacting the front of the machine (under place marker 4).

Figure 14 Photograph of a large rock that was contacting the front of the water cannon after excavating around it.

8.2. Requirements for the construction of bunds on 4786 extraction level

Bunding of draw points was designated as a critical control at Ridgeway Mine at the time of the incident.

In 2011, Ridgeway Mine undertook a study using rockfall simulation software with the aim of quantifying the risk presented to personnel and equipment operating in the loading zones of the 4786 extraction level in circumstances where no bunds were present. Three draw point throat widths were modelled, being one quarter open, half open and fully open. Assumptions on which this modelling was based included:

- The open draw points were assumed to be open to 18m high (open to 4808 RL, being the top of the drawbells). This was considered to constitute the worst possible rockfall scenario.
- Five draw points hung up in an extraction drive during a 24 hour period and all five hang-ups coming down during that period.
- A production loader would spend 24 hours workings in this specific extraction drive with all five draw points releasing during that period.
- The total man-hours of specific persons (shift supervisor, secondary breakage leading hand, automation electrician, loader operator) being on foot in this specific extraction drive was two hours per shift (four hours every 24 hours)
- The broken material had a friction angle 37º (corresponding to the angle of rill) and a surface roughness of 5º.
- The rocks involved in a hang up letting go had a mass of 50 kg ± 25 kg.

Conclusions made on the modelling were:

- The most effective bund is a 1.5 m high bund whose inner crest is set back 1 m from the face of the brow beam. This bund is also capable of containing the draw point rill should an open draw point come down suddenly.
- If no bunds are installed in the loading zone extraction drive then the estimated risk of exposure to a loader and to a person working in such an extraction drive is approximately 1 in 12,705 and 1 in 76,235 respectively.

The bunds were also modelled with an angle of rill of 37º. The analysis did not consider the exposure to rock fall of personnel engaged in operating a water cannon to bring down a hang up. The exposure to rock inflow of personnel involved in clearing a hang up is likely to have been considerably higher since they were engaged in the work on a 24 hour per day basis and because Safe Work Procedure UGP-221 stipulated that '*Clearing of a drawbell shall only take place with a minimum of two personnel present*'. The consequence of a rock fall were also significantly greater for the operators of a water cannon since they were required to work on foot in the line of fire of a draw point, as opposed to loader operators who worked off the ground and, effectively, within the protection of a steel cage.

Safe Work Procedure UGP-221 Clearing a drawbell hang up was approved and issued in April 2010 and was updated on 7 May 2012. Investigators were informed that the procedure was current at the time of the incident. The procedure contained two different requirements for constructing a bund, namely:

> *7.0 Safety*
>
> *Step by step actions to bring down a draw point hang up*
>
> 1) *Bog the draw point bucket to brow and bund draw point with a 1 to 1.5 metre bund wall to wall*
> 2) *Wash down hang up with Jacon*
>
> *8.2 Prepare for water canon*
>
> *8.2.1 Bog draw point wide open (bucket to brow)....*

8.2.2 Construct a bund wall 1.5 high placed against the bull nose or placed where the supervisor instructs from the brow. The bund wall is to be the full width of the draw point with a 1m valley.

Safe Work Procedure UGP-233 Operate Jacon Maxijet water cannon was issued and approved on 19 April 2012 and had a scheduled revision date of 7 May 2014. Investigators were informed that the 2012 procedure was current at the time of the incident. This procedure contained the following requirement for constructing a bund:

6.6 Washing down a hang up in an open draw point

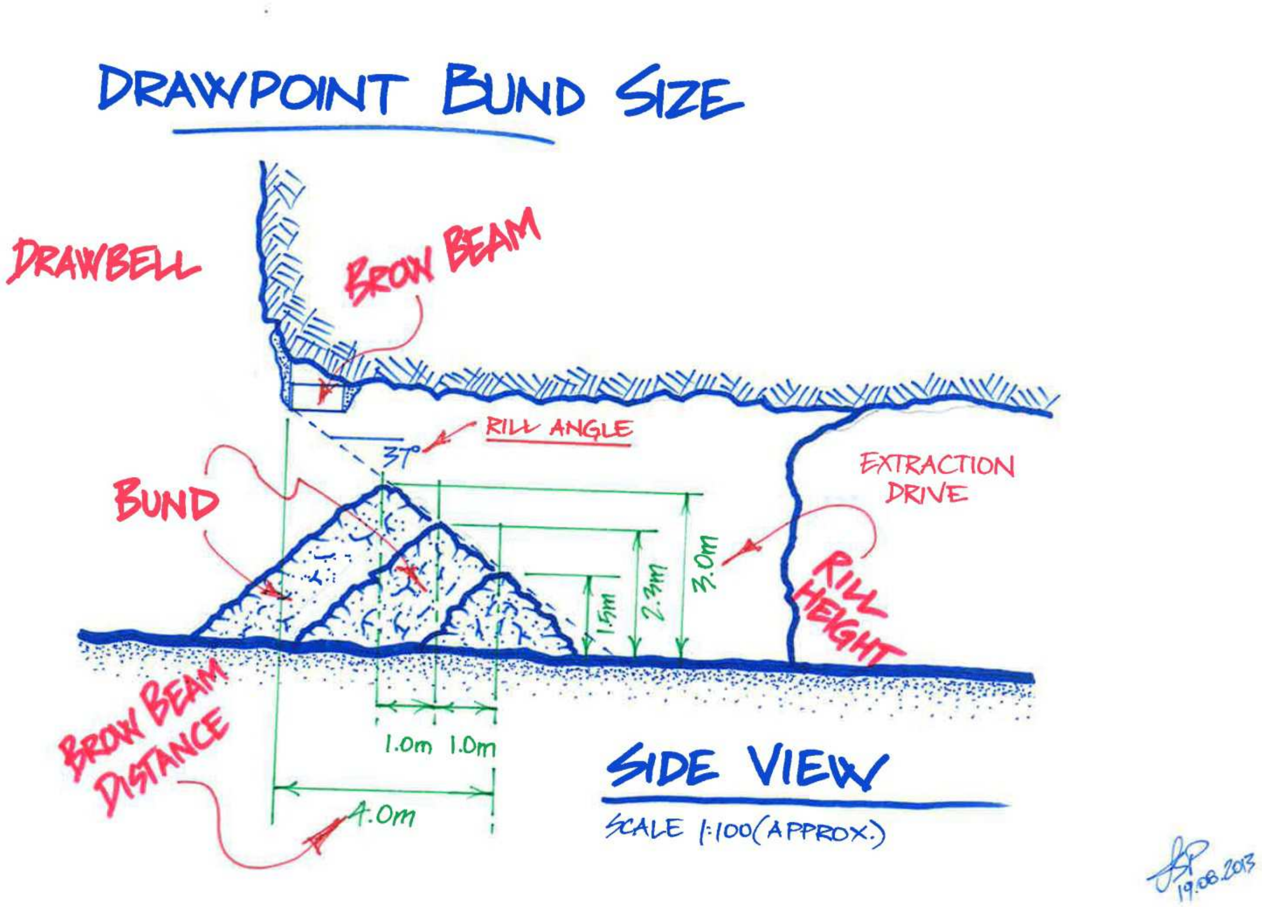
A bund must be constructed that is:

- ***NO LESS THAN 1 METRE IN HEIGHT*** *and*
- ***NO LESS THAT 2 METRES BACK FROM THE OPEN BROW BEAM***

Following a series of uncontrolled inflows at closed draw points, compulsory 1.5 m high bunding (1.5 m back from the brow beam) was implemented at all draw points in 2014. The two procedures mentioned above were not updated to identify this new requirement.

The new bunding requirements were addressed in Ridgeway Mine panel start meetings of 19 March 2015 (for C and D crews) and 26 March 2015 (for A and B crews). Figure 15 shows a picture relating to bunding requirements that were included in the PowerPoint presentations to the panel start meetings.

Figure 15: Picture of Ridgeway Mine bunding requirements shown at Ridgeway Mine panel start meetings of 19 March 2015 and 26 March 2015.



Note the bunding requirements shown in Figure 15 are:

- not to scale
- all bund dimensions are premised on the material used to construct the bund having an angle of repose of 37º.

The sketch and the accompanying panel start documentation did not provide an explanation for the three different bund sizes shown in Figure 15.

The investigation established that the sketch of bunding shown in Figure 15 was reproduced on the shift sheets at the Ridgeway Mine. The shift sheet did not include an explanation of the different types of bunds.

Draw point diagrams were also posted in the crib room on extraction level 4786 at the time of incident. These documented the following requirements:

- *A bund of at least 1.5 m high and 1.5 m back from the flow beam or brow must be installed for the following situations and should be constructed of stable material from an alternative draw point*
  - *Closed draw point – moist, wet, flowing with rill angle <40º*
  - *Closed draw point – moist, wet, flowing with rill angle >70º*
  - *Closed draw point – moist, wet, flowing. Rill angle between 40º and 70º*
- *Closed draw points with large perched rocks must have a bund installed before work can commence at that location.* The accompany diagram does not specify the location of the bund but does show it to be 1.5 m high.
- *The standard for a bund for an open draw point is 1.5 m high and 1.5 m back from the flow beam or brow*
- *If the draw point is "closed-off" and oversize is located at the base of the rill or on the apron and is not able to move, a bund is not required for the purposes of rock breaking, oversize drilling or changing (sic)*

Interviews established that a number of the workforce had the understanding that a bund was required to be constructed in all open draw points. There was some variation in what they thought the size of the bund was required to be, although a number stated that it was to be 1.5 m high, wall to wall.

8.3. Requirements for the operation of the water cannon

The water cannon involved in the incident was plant No XT008. It was designed by Jacon Technologies to apply shotcrete. The shotcrete application equipment was removed and replaced with an on-board water tank and a water jet nozzle mounted on the end of the shotcreting boom.

This machinery was risk assessed on a number of occasions. The first time risks associated with the use of a water cannon occurred during the capital expenditure request in May 2011. The risks to health and safety were identified as follows:

> *… Increased machinery does increase the congestion within the mine. Changes to the control room and procedures around parking of equipment when not in use have been considered in order to address this issue.*
>
> *Ventilation is always a safety consideration when making changes to an underground mine. A review of ventilation is currently being conducted. They have been advised of the proposal and will take into consideration the additional equipment when making their assessment of ventilation requirements.*

On 17 May 2011 a risk assessment record/risk reduction plan was partially completed for the operation of the water cannon. A specific risk of inrush was identified and the following existing controls were identified:

- *bunds*
- *mandated safety distance for machine of 2 metres from bund*
- *nozzle not to protrude past brow beam*

A risk assessment workshop was undertaken on 10 January 2012. The workshop included the Mine Foreman, OHS advisor, Training Coordinator Secondary Break Coordinator and a Secondary Break Operator/trainer. The following unwanted events were identified during operation of a water cannon and when a hang up comes down:

- *exposure to respirable dust*
- *inrush of rock while inspecting hang up*
- *damage to boom when hang up comes down*
- *slips trips falls*
- *personal injury*
- *equipment damage*
- *process loss*
- *uncontrolled movement*

The following controls were identified:

- *operator positioned upwind to access fresh air when hang up comes down*
- *hang up inspections carried out from behind bull nose*
- *task specific PPE*
- *nozzle only past brow beam procedure*
- *trained/assessed competent operators*
- *SWP's including Jacks down for operations*
- *housekeeping*

Proposed improvement action was to *'adjust procedures and training to suit operating in relation to control dust exposure while being safe from inrush of rocks'* and *'adjust procedures and training to suit operating in relation to retraction of boom when hang up comes down.'* Due to the risk ranking for this task remaining high, final sign off of the task was required by the Manager of Mining, which occurred on 25 January 2012.

Following this risk assessment the *Safe Work Procedure UGP-233 Operate Jacon Maxijet water cannon* was created.

As already noted, *Safe Work Procedure UGP-233 Operate Jacon Maxijet water cannon* was issued and approved on 19 April 2012 and was current at the time of the incident. The procedure contained the following requirements relevant to the operation of the machine at the time of the incident.

6.6.14 Once the operator is in position, and caution tape installed:

- *the operator is to stand on the Northern side, close to the bull nose*

IMPORTANT. If the rill comes down the operator should fit a dust mask, turn off the Jacon (via remote) and wait for the dust to settle and visibility to return to at least 40 metres before moving away.

6.6.16 The operator should position themselves on the Northern side of the Jacon standing in the middle of the drive or close to the bull nose, but not past the front jacks for the draw point being hosed, this gives the operator a chance to move behind the bull nose to avoid any dust or rock that may come over the bund, if the hang up comes down, once the hang-up is down, the operator is to make their way to the Southern end of the drive to fresh air.

6.6.17 The operator must remain upwind of the draw point, if the rill comes down the operator is to

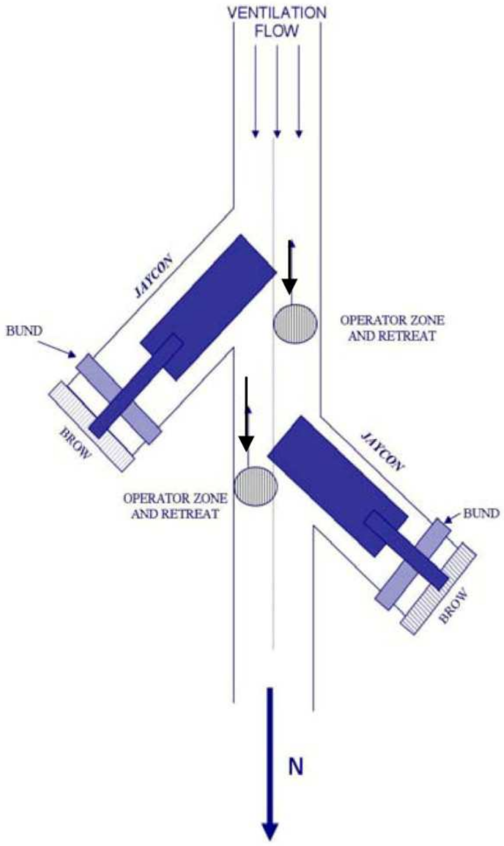
- *Retract the boom while walking away from the machine*
- *Fit a dust mask*
- *Turn off the Jacon engine via remotes*
- *Wait for the dust to settle.*

6.6.23 Complete the following activities at the completion of activities:

- *Look under the machine for rocks that may have rolled under there, remove before lowering the jacks.*

The diagram that accompanied these instructions has been reproduced in Figure 16.

Figure 16: Diagram from *Safe Work Procedure UGP-233 Operate Jacon Maxijet Water Cannon* illustrating where the water cannon operator was to stand and retreat when a hang up was being washed.



Reference to Figure 16 shows that the designated operating position is not consistent with that described in the text of the safe work procedure. Rather, the operating position is shown on the opposite side of the extraction drive, immediately adjacent to the rear end of the water cannon that was closest to the sidewall of the extraction drive. This corresponds to the location in which Mr Peters was crushed.

Safe Work Procedure UGP-221 Clearing a drawbell hang up included the following requirements in relation to the operation of a water cannon.

> *8.3.9 The water cannon operator must remain behind the pillar when the water cannon is in use.*
> *8.3.10 All personnel within the direct vicinity of the water cannon at the open draw point will fit a dust mask to ensure that personnel are not breathing dust should the hang up release suddenly.*
> *8.3.11 If the hang up releases then the water cannon operator is to turn off the water and wait for the dust to clear such that visibility returns to at least 40 m before going back into the drawbell.*

It is apparent that there were inconsistencies between Safe Work Procedure UGP-221 and Safe Work Procedure UGP-233 in respect of the wearing of dust masks and the standing position when operating the water cannon.

8.4. Chronology of events leading to the incident

The incident of 6 September 2015 was associated with the inflow of dry material into the workplace when a hang up let go.

The following chronology confirms the occurrence of inflows of dry finely fragmented rock on the 4786 Extraction level during the 12 months preceding and the first four months after the incident.

19 September 2014

A dry material push was reported in 12E9.

Excerpt: *…report 12E9 having a push of dry material out into the extraction drive.......This would indicate we have started to pull material from the SLC...Any open draw point requires a substantial bund installed to ensure safety of any personnel working in the area, particularly those on foot for inspections or sampling.*

9 November 2014

A power point presentation detailed the following inflow event.

Excerpt: *An uncontrolled flow of material occurred in 11EP1........The loader driver was attempting to take his 3rd bucket for the shift when the material flow occurred. The force of the flow pushed the loader out of the draw point approximately 5m. The loader operator was uninjured.*

20 November 2014

An instruction was issued to mining supervisors regarding the operation of the water cannon and two recent uncontrolled material movements in draw points.

Excerpt: *If operating the Jacon water cannon please ensure the following:-*

- *If the draw point has large rocks with very little fines present then commence watering as normal*
- *If the hung up draw point consists largely of fines, the (sic) reconsider how this is going to be approached. In cases where the draw point is extensively hung up with mostly fines then we may decide not proceed with any watering activity in this place until an alternative can be implemented.*
- *As with normal watering activities you must ensure you have a clear path of retreat out of any dust and potential "line of fire" if the material starts to come down.*

23 November 2014

A geotechnical memo was created that attempted to address the uncontrolled movements that were occurring at Ridgeway Mine.

Excerpt: *Moving forward, whilst knowledge & data is collected, bunding all draw points (regardless of closed/open/wet/fines) is the isolation control, CVO management will be required to establish if this risk is acceptable.*

Excerpt: *The maturity of cave has introduced an increased amount of fine material that is reporting at the draw points, and this fine material has a potential of violently pushing its way out of the drawbells either in a dry or wet stage when mixed with water.*

26 November 2014

Excerpt: *Draw point 5E1 uncontrollably rilled again during the loading cycle. This time a geotechnical engineer viewed the scene and reported that the rill angle measured 30 degrees.*

11 December 2014

Excerpt: *It was reported that material rilled 2 m past the bull nose of draw point 5E1. This occurred during the loading cycle and contained very dry fines (30-70%).*

23 July 2015

Excerpt: *An uncontrolled movement of rock material occurred in draw point 11E7… If you view photo 0964 there is a large rock present which I believe to be part of the bund that was in place, to the right of the bund is still present and contained the flow, on the left if had rilled over bund and past bull nose 1.5 MTRS [metres].”*

Further information provided by the supervisor to the geotechnical engineers included:

- *“Moisture content of rill (dry, damp, wet, saturated) DRY*
  Distance travelled past bull nose
  1.5 MTRS”
- *Drawbell was bunded wall to wall 1.5 MTRS high. Rilled over bund on L/H side approximately 1.5MTRS past bullnose*
  No brow beam present and good fragmentation. 80% 300mm+ 20% other. No water present, dry movement.

2 September 2015

Draw point 11W8 had a dry uncontrolled material movement.

Excerpt: *Tonight we had 11W8 reel (sic) out into the drive. The draw point had a brow beam in it. The operator had taken around 40 tonnes out and was coming back for another bucket when he found the material across the drive. The material was very dry with lots of fines and some coarse material there was no sign of water the dampness you see in the photos is the sprays. The material was around 2 m high at the western side bullnose and then dropped off to about 0.5 m on the eastern wall*

27 January 2016

Draw point 11E9 experienced an uncontrolled movement of rock material.

Excerpt: *The material was very fine and dry and it looked like it had flowed, as indicated by the rounding of the edges at the bottom of the rill pile. The fine material likely came from the existing sub level cave above.*

Figure 17 and 18 show examples of uncontrolled inflows of material from draw points at Ridgeway Mine. Dry material was associated with the inflow shown in Figure 17 and wet material with that shown in Figure 18.

Figure 17 An uncontrolled inflow of dry material at draw point in extraction drive 11 (note water visible in rill pile is from dust suppression sprays).

Figure 18 An uncontrolled inflow of wet material at a draw point in extraction drive 15 in August 2015.

8.5. History of rocks impacting water cannon XT008

An examination of the service history for the specific water cannon involved in the incident was undertaken during the investigation. It was identified that on numerous occasions the water cannon required service work or repair due to contact with material coming from a draw point.

A review of past incident reports identified two previous occasions when the water cannon involved in the incident was hit by rock as a result of a hang up letting go.

1 June 2013

Incident at draw point 9E1

Description*...was operating XT008 on the 4786 extraction level in ED9, in draw point 9E1. This was an open draw point when the hang-up he was washing down came with a big rock, it clipped the end of the boom and hitting the front of the XT008. All procedures were followed and bund was in place to standards.....*

Action *... spoke to crews about awareness of hang ups when watering down with the Jacon. This was a high hang up which came down with a lot of force. All procedures and bund were in place and proved to be efficient for this task.*

Completion comments*… showed how following proper procedures that the boom can still be damaged as this is the most exposed machine in the mine.*

Sign off comments*… unfortunately the nature of work that the water cannon Jaycon's conduct (sic) also involve an element of exposure for the machine. All systems and processes were followed, meaning no personnel were at risk.*

22 August 2015

Incident at 4W3

Description*...male contractor…mine technician, was operating XT008 Jaycon washing down hang up in ED4W3. When the hang up dropped, a large over size rock caught the end of the boom dragging it down and buried boom in rill.*

Sign off comments… *The task of releasing a hung up draw point with the aid of high pressure water is a common one. Controls in and around the protection of people while performing this task is to have a 1.5m bund installed. (minimum height). This process was followed and the bund contained the material movement. To have the boom of the water cannon over the bund is necessary for effective results. This positioning of the boom puts it in direct line of fire of the material move and on rare occasions contact is made causing damage. In this circumstance there are no actions to prevent a recurrence.*

Figure 19 A photograph of another incident involving the water cannon XT008 on 22 August 2015. Note the large rock making contact with the front of the water cannon

The investigation established that mine management had considered the potential for the water cannon to be pushed back if a draw point hang up let go:

> *After our discussion today at the Jacon water cannon in ED5 myself and three Jacon operators have reviewed the Jacon maxi jet water cannon procedure UPG-233 and have found the procedure to be correct and follows the safest practice for operating this machine. The procedure states that the operator is to stand downwind (Northern side) to the draw point closest to the bullnose with best visibility being in this position and that if a draw point comes down suddenly apply a dust mask and when visibility allows proceed to the southern side of the draw point to fresh air. We discussed the possibility of the Jacon being pushed back if a draw point slumped or pushed out when watering down and we all agree that if standing on the opposing side of the machine it is actually being pushed towards the operator where operating on the northern side the machine would be pushed away from the operator. Reviewing this procedure lead to some good discussions and learnings.*

8.6. Chronology of incident involving Mr Peters

Production documents obtained from NML suggest that extraction drive 10 was one of the most used extraction drives at Ridgeway Mine.

5 September 2015

During day shift, a bogger operator was assigned to extract ore from 10E6. Records suggest that he was able to extract 140 tonnes before a hang up at the draw point occurred. Just before 4:00 pm on 5 September 2015 the bogger operator changed the status of 10E6 from active to hung up. This was the last time anyone extracted rock from the draw point before the incident on 6 September 2015. The bogger operator continued to extract rock from other draw points in extraction drive 10 for the rest of his shift. The bogger operator could not recall with any certainty that he had placed a bund in 10E6 after the hang up. However, he did state that it would be very unusual for him not to have placed a bund in this draw point as it was common practice to do so. He reported that there was nothing unusual about the behaviour of the rill pile in 10E6 prior to the hang up.

6 September 2015

At 6.34 pm Mr Peters attended the mine's turnstile entry. Mr Peters changed into his work overalls and tagged on to the Ridgeway Mine surface tag board. He then undertook his usual pre-shift briefing and travelled down to the production level where he was provided a shift sheet that identified his work area for the shift. He received his instruction to undertake secondary break work in extraction drive 10.

At 8.49 pm Mr Peters made radio contact with the surface coordination team (SAOC) to identify that he was working in extraction drive 10. At 9.17 pm Mr Peters and his supervisor had a radio conversation about other work he was required to complete. This was the last contact with Mr Peters.

At approximately 10.00 pm another worker, who was operating the rock drill and had been assigned work in extraction drive 10, traversed the drive to see how long Mr Peters would be.

The other worker found Mr Peters fatally injured and trapped behind the water cannon at extraction drive 10E6 draw point. The incident scene depicted in Figure 12 shows the water cannon still in position; however Mr Peters has been recovered. Figure11 identifies a plan of the scene and locates where Mr Peters was trapped.

8.7. Cause of death

A post mortem was conducted at 8.30 am on 9 September 2015 at the Newcastle Department of Forensic Medicine. It was determined that the direct cause of death was 'multiple injuries' in keeping with blunt force trauma from being crushed between the water cannon and the mine wall. There were no other significant conditions reported as contributing to the death of Mr Peters. It was likely Mr Peters died instantly.

8.8. Toxicology

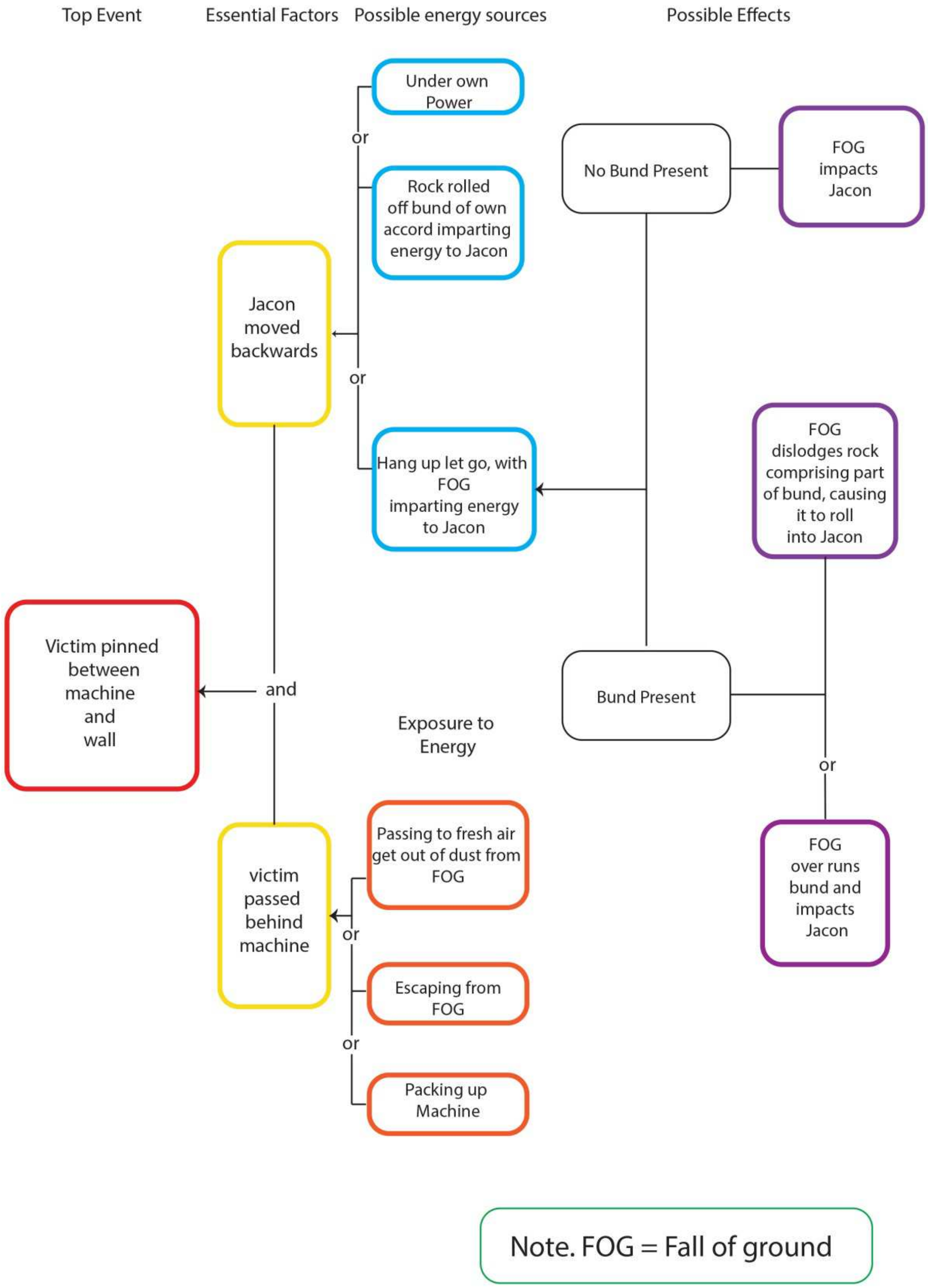
A quantitative analysis of Mr Peter's blood and urine was undertaken by the NSW Forensic and Analytical Science Service. The analysis determined that there were no drugs or toxins detected in the samples received by the service. The service did detect very low levels of blood and urine alcohol. The pathologist advised that these findings are suggestive of alcohol consumption some hours before death and that the body was in the elimination phase of excreting the alcohol. The pathologist goes further to state that it was unlikely that the deceased would have been impaired by the level of alcohol and would not have affected his ability to perform his workplace tasks.

9. Causal factors

9.1. Incident analysis

Figure 20 depicts a causal analysis undertaken by investigators. The causal analysis was one of the tools used by investigators to determine lines of enquiry. It illustrates the salient points that led to the incident involving Mr Peters.

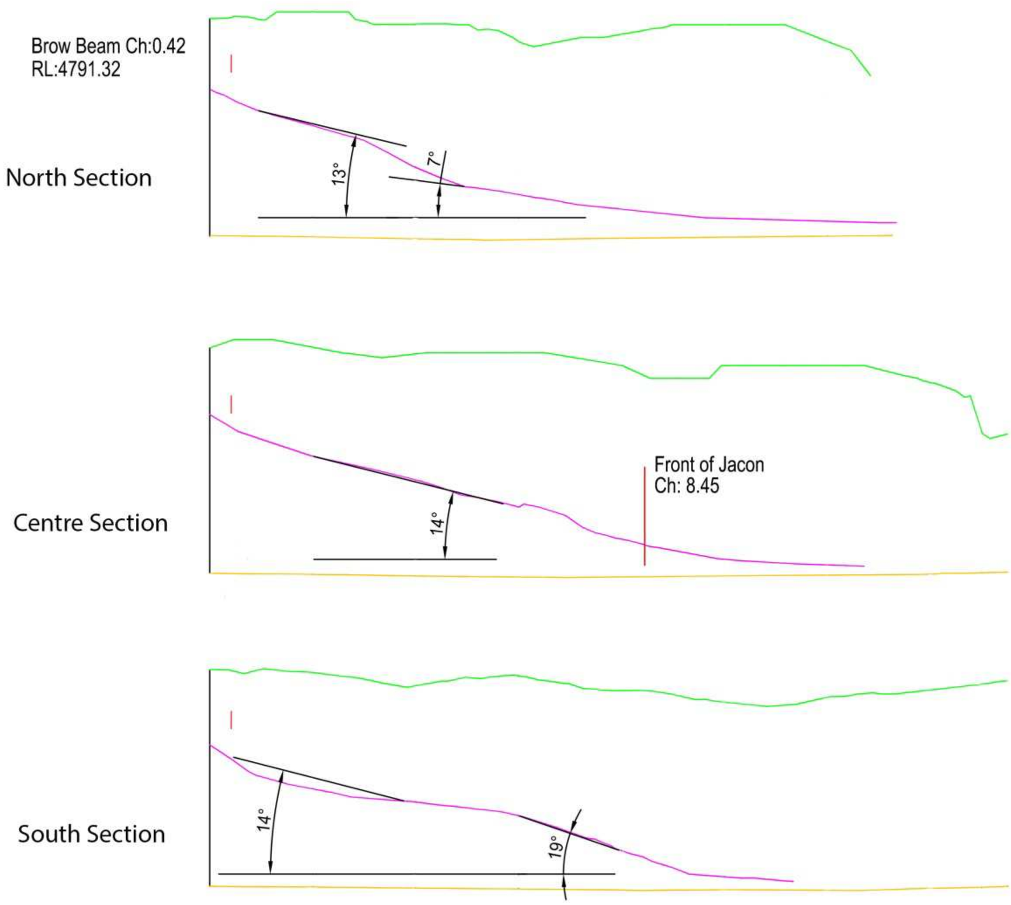
Figure 20 Causal analysis of incident.



9.2. Rill composition and behaviour

Figure 11 shows the floor contours at 10E6 as measured by CVO staff after the incident. This figure forms the basis for Figure 21, which shows vertical profiles through the rill (muck pile), down the centreline and between the mine walls.

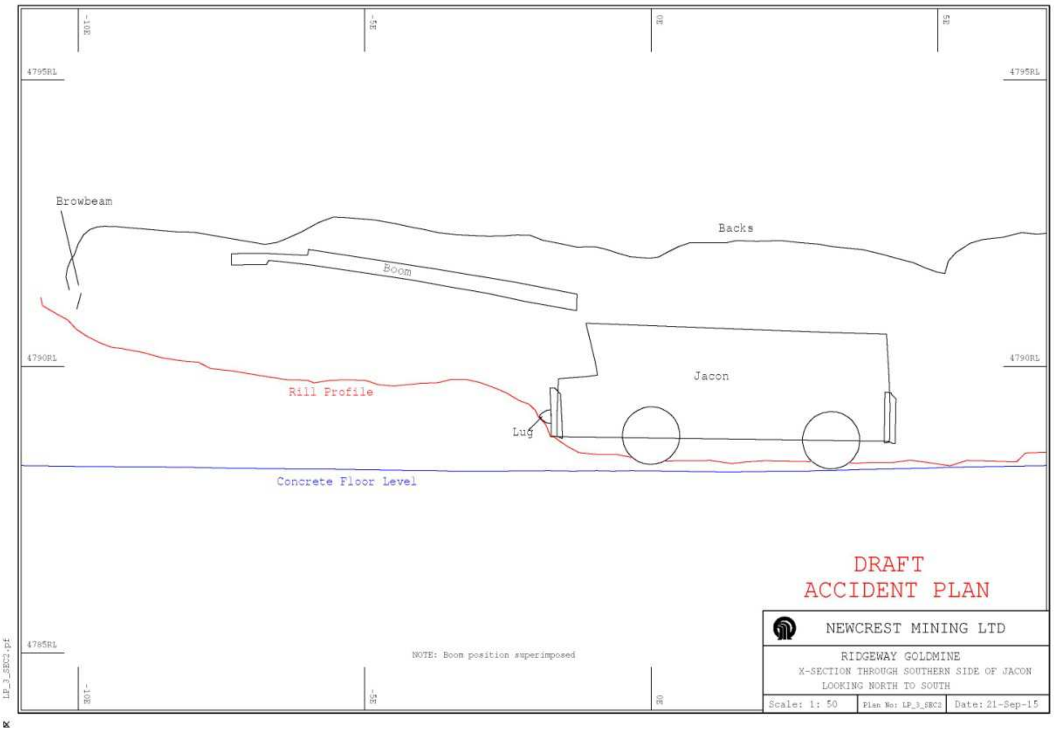
Figure 21: Vertical section showing angle of rill at 10E6 after the incident.



Particle size distribution analysis of material collected from trenches constructed in the zone that would be occupied by a bund constructed to specifications showed that approximately 50% of the material was less than 10 mm in diameter. Larger rocks (about 500 mm – 1000 mm in their long dimension) were interspersed with this fine material. The total volume of material that flowed out into the extraction drive was surveyed and calculated to be 95 cubic metres or approximately 260 tonnes.

Survey data shows that the overall angle of repose of the inflow material ranged from between 7º and 19º. However, the rill towards and along the southern mine wall was characterised by an extended and relatively flat section, as particularly apparent in Figure 22. These angles of repose compare to that of 30º recorded in the pre incident chronology for draw point 5E1 and 37º used in the numerical modelling conducted in 2011 to determine bund size and location.

Figure 22: Cross-section through southern side of Jacon, looking north to south.



9.3. The presence, state and influence of a bund

Bund walls are considered a critical control at the Ridgeway Mine.

Following the incident, CVO undertook an internal audit of all draw points. It was identified that 50 draw points (or some 20%) did not have a bund installed. Table 1 shows the height of bunds in extraction drive 10 as measured about four weeks after the incident and prior to resumption of mining. The bunds that had not been dressed since the incident ranged in height from 0.6 to 1.4 m.

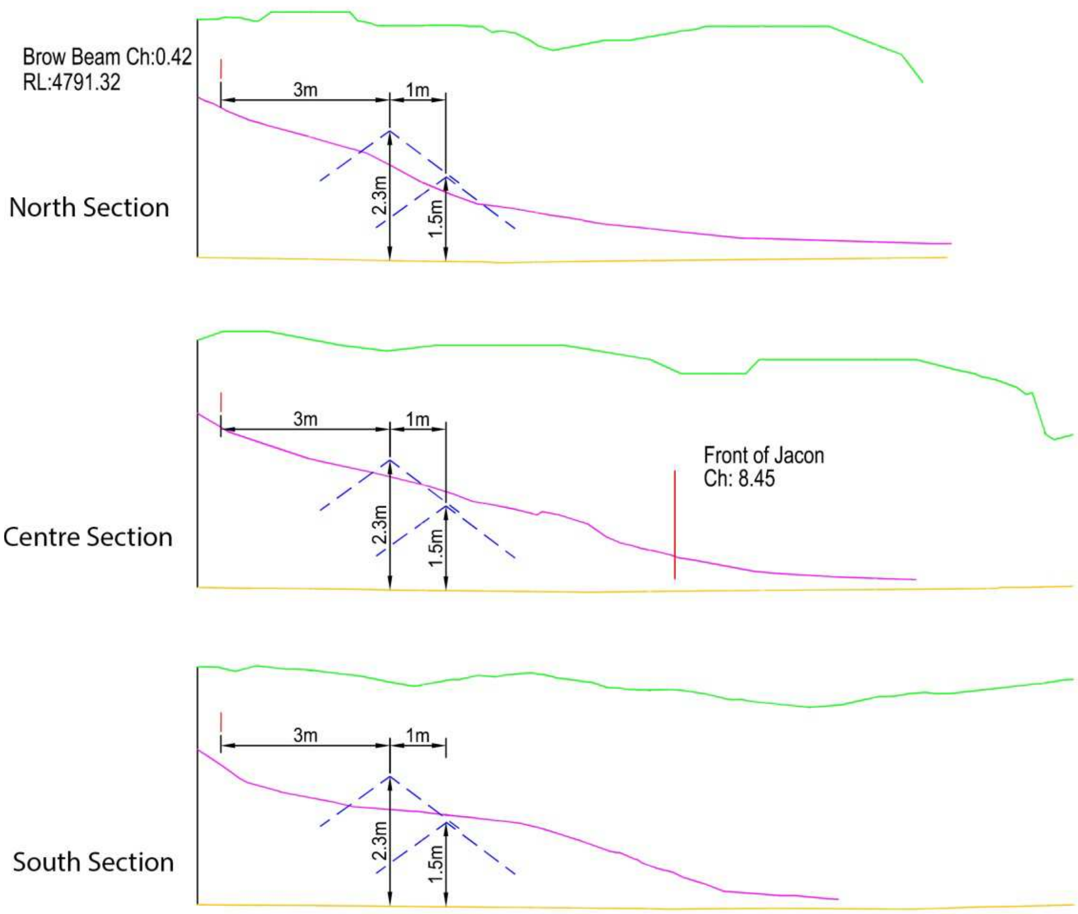
Table 1: Height of bunds in extraction drive 10 as measured approximately 4 weeks after the incident and prior to the resumption of mining, with some bunds having apparently been dressed by that time.

Draw point	Height (m)
10E1	1.2
10W1	1.3
10E2	1.0
10W2	1.4
10E3	1.1
10W3	1.3
10E4	0.6
10W4	1.1
10E5	0.8
10W5	1.4
10E6	-
10W6	1.2
10E7	1.1
10W7	1.5*
10E8	1.5*
10W8	1.5*
10E9	1.5*

10W9	1.4*
* bunds dressed following the incident	

The investigation could not confirm if a bund was in place at 10E6 at the time of the incident and, thus, its position and size. The loader operator that was working in extraction drive 10 prior to 10E6 being classified as hung up told investigators that he believed he had constructed a bund in 10E6 after classifying 10E6 as hung up. Figure 23 shows the location and size of bunds relative to the muck pile if bunds had been constructed to the specification given in figure 15.

Figure 23: Vertical sections showing the locations and sizes of bunds if bunds had been constructed to the specifications given in Figure 15.



9.4. The position of Mr Peters

The investigation did not establish how Mr Peters came to be positioned between the water cannon and the sidewall at the time of the incident. Three possible explanations are:

1. Mr Peters was in the process of taking shelter behind the machine to avoid the rock and material inflow when the hang up let go.
2. Mr Peters chose to move to the southern side of the machine when the hang up let go so that he would be upwind in fresh air and out of the dust cloud that accompanied rock and material movement.

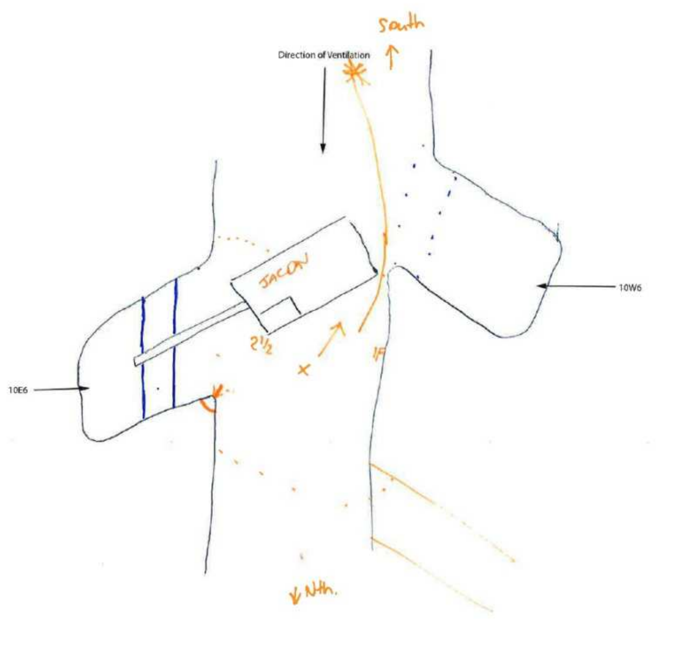
3. The task Mr Peters was undertaking failed to release the hang up and Mr Peters was in the process of demobilising (which involves walking past the back of the machine) when the hang up released and pushed the water cannon backwards.

Interviews with mine workers established that it was not unusual for some operators to move behind the water cannon when a hang up let go, rather than to take shelter behind the bull nose of the pillar on the opposite side of the road. A review of incident reports established both that rock flows from draw points had previously extended into an extraction drive and that there had been at least two previous incidents of rocks coming into contact with the front of the specific machine involved in the incident.

On more than one occasion workers told investigators that water jetting a hang up was an ‘adrenalin rush’. Workers attributed this ‘rush’ to the sudden release of rock and material during the water jetting process. Such statements provide insight into the operational environment faced by workers involved in secondary break activates using the water cannon.

Some operators and supervisors indicated that as soon as a hang up looked likely to come down, they would immediately walk or run around the back of the water cannon to the up wind side of the extraction drive. An example of an operator’s response is shown in Figure 24. Explanations for this non-compliance with the stipulated safe work procedure centred around the fact that when a hang up comes down, it creates a dense cloud of dust. The direction of ventilation meant that if the operator was to move to the North of the draw point they could be exposed to significantly reduced, and sometimes zero, visibility. Not all workers chose to wear a dust mask before a hang up letting go. Some even chose not to wear a dust mask after a hang up had let go.

Figure 24: Drawing completed by a mining technician during interview with an investigator on 25 November 2015.



One plausible explanation already noted for how Mr Peters came to be pinned by the water cannon was that he had completed the washing down procedure without success and was in the process of packing up the water cannon (which requires walking behind the water cannon to disconnect the water supply) when the hang up unexpectedly came down. Evidence from operators suggests that an experienced operator can usually assess when a hang up will come down, however, a number of operators spoken to during the investigation admitted that they have been caught out by a collapsing hang up.

9.5. The modified water cannon XT008

The use of the water cannon was considered by the mine to be an effective technique to unblock draw point hang ups. The water cannon was constructed at the request of the mine operator by modifying a purpose-built machine for applying shotcrete (sprayed concrete). In order to operate effectively as a water cannon, the operator was required to stand outside the cab and use a remote control, exposing the operator to potential inflows of rock and material.

Following the incident, NML identified two types of machines that could be substituted for the water cannon involved in the incident. Neither machine require the operator to leave the enclosed cab of the machine during operation.

10. Foreseeable risk

The risks associated with working in and around open draw points and around mobile mining machinery are well known to the mining industry. Mine operators must effectively manage and control these risks to ensure the health and safety of workers.

There were a number of previous incidents involving the inflow of rock and material at the mine that highlighted the foreseeable nature of the risk.

11. Remedial actions

11.1. Cadia Valley Operations

Following the incident, CVO stood down its secondary break fleet until it was satisfied that an adequate risk assessment had been completed. This risk assessment identified that the risk to health and safety of individuals on foot in the production level was significant, particularly when attempting to bring down a hang up.

After the incident, the mine operator constructed a ladder and walkway across the back of the water cannon for access and egress to eliminate workers from being exposed to the pinch point between the rear of the water cannon and mine wall.

Remote control technology was also trialled that enabled the water cannon to be operated from a safe distance.

Workers were prohibited from being on foot in the vicinity of draw points and inspections of draw points were required to be undertaken from mining plant such as an underground loader.

A full audit of draw point bunds was also undertaken and further emphasis was placed on the need for well-constructed bunds designed to consistent standards.

The mine operator also identified two pieces of plant that could be substituted for the water cannon. Neither machine required the operator to leave the enclosed cabin during operation.

These included an Atlas Copco Scaletec which eliminated the need to leave the cabin within the extraction drives. A drawing of an Atlas Copco Scaletec is depicted in Figure 25 below.

Figure 25 depicts a drawing of an Atlas Copco Scaletec provided by NML.

The mine operator also commissioned MacLeans water cannons for secondary break work at the Cadia East Mine. A picture of a modified MacLeans water cannon is depicted below in Figure 26.

Figure 26 A MacLeans WC3 water cannon.

12. Conclusions

The investigation identified that some relevant documents within the health and safety system had not been updated. The investigation also identified that some of the policies and procedures that workers were expected to comply with contained inconsistent, ambiguous and/or outdated advice. Importantly, this applied to the location and size of bunds constructed in front of draw points to protect employees from inflow of material from the cave and to the procedure for clearing a hang up in a draw point.

Bunds were classed as a critical control at the Ridgeway Mine. Notwithstanding this, there were at least four different directives as to the location and size of bunds. Safe work procedures were not updated to reflect changing requirements. At the time of the incident it was expected that there should be a bund 1.5 m high wall to wall in every draw point regardless of draw point status (i.e. hung up, closed, open). An audit of every draw point in the mine following the incident showed significant non-compliance with this requirement.

The investigation also confirmed that the risk profile of a block cave mine is dynamic. In the case of Ridgeway Mine, the nature of the fragmented rock from the cave and the rill angles were changing and a significant number of dry and wet uncontrolled material movements from draw points had occurred in the 18 months preceding the incident.

The safe work procedure for the water cannon required the operators to move down wind behind the bull nose when a hang up came down, some workers would go the opposite way, behind the water cannon, to the fresh air side of the draw point. This was known by some supervisors. There was also ambiguity about the requirements for operators to wear dust masks. In any event, some operators choose to work without dust masks.

The mine operator had considered the implications of rock inflow coming into contact with the water cannon. The operator identified that there was a risk of the machine being pushed back, however this was dismissed because it was believed that the safe work procedure (an administrative control) accounted for a safe standing zone well away from the machine. Newcrest management demonstrated that they considered the implications of rock inflow impacting the water cannon and that it was known from the following that a bund was not a totally effective control:

- Numerical modelling undertaken in 2011, which showed that rocks could still bounce over a 1.5 m high bund with an inner face 1 m back from the brow beam
- The water cannon safe working procedure required workers to move behind the bull nose to avoid rock that may come over the bund and to also look under the machine for rocks that may have rolled under the machine when working at a draw point
- Two significant incident reports of rock impacting the water cannon at draw points.

Bunding design was based on a design angle of rill of 37º the nature of the rill had changed since the initial numerical modelling. A lower angle of rill was documented for one uncontrolled inflow, bunding design was not revised following this incident. Two significant incidents where rock made contact with the water cannon were classified minor (property damage only). Both incidents and many incidents relating to uncontrolled inflow of material at draw points were classified as a minor risk to health and safety. The incident whereby rock contacted the water cannon only two weeks before Mr Peters was killed was classified as minor.

In the event that the critical control of bunding was ineffective, the next level of control relied on human intervention. Fundamentally, this relied on operators being able to detect the inflow of material in sufficient time to remove themselves from the line of fire, possibly in limited or zero visibility due to dust.

The water cannon was originally a shotcreter modified to perform the task of watering down a hung up draw point. For effective operation the operator was expected to stand outside the cab and use a remote control. Following the incident with Mr Peters, NML identified two pieces of machinery that could be substituted for the water cannon involved in the incident. Neither machine requires the operator to leave the enclosed cab during operation.

Ultimately, the system of work failed for a number of reasons, some of the more important being:

1. The system relied on bunds as a critical control in front of draw points as barriers albeit that there was evidence that broken rock from a cave could overtop a bund in some circumstances.
2. The modified water cannon was not fit-for-purpose. Workers were required to be on foot and in the line of fire of rock inflows when operating the machine as a water cannon.
3. The system had a very high reliance on worker compliance, which was made more critical because of the hazardous and dynamic nature of the environment.

13. Recommendations

13.1. Industry recommendations

This incident reinforces the risks associated with working in the vicinity of block cave draw points.

When considering the recommendations below, mine operators are reminded of their obligation to take a combination of measures to minimise the risk, if no single measure is sufficient for that purpose.

Operators of metalliferous underground mines that contain draw points but are not block cave operations should consider the following recommendations as far as reasonably practicable.

When undertaking block cave mining and draw point production activities, mine operators should:

1. Use the hierarchy of controls when developing critical controls, with a focus on hard controls (e.g. elimination, substitution or engineering).
2. Consider remote technology, taking workers out of the line of fire from draw points.
3. Prohibit mine workers from undertaking work on foot in the vicinity of underground draw points without appropriate controls in place.
4. Eliminate or minimise worker exposure to pinch points between mobile plant and mine workings.
5. Construct bunds to consistent standards in appropriate areas such as open draw points and maximise bund size taking into consideration rock fragmentation and material type.
6. Consider the potential for rock material (whether dry or wet) to flow into extraction drives and place workers at risk.
7. Ensure inrush control plans identify and control rock flows from draw points.
8. Undertake regular reviews of the inrush principal hazard management plan and map against the codes of practices and guidelines, including the NSW code of practice for inundation and inrush hazard management.
9. Ensure appropriately trained personnel inspect active draw points to identify hazards and eliminate or minimise risks to health and safety.
10. Ensure human factors and working environment are considered during the development of critical control measures.
11. Ensure monitoring arrangements are developed and implemented to minimise dust exposure.