Report – Pike River Mine Drift Re-entry and Recovery

Document Control

Document Ref.	PRRA 31.10.18	Issue No.	1.0
Date of Issue	31/10/18	Author(s)	See schedule in Appendix A

Revision History

Issue No	Authorised for Release By	Date Effective	Summary of Changes
0.1	Dave Gawn	30/10/18	PRRA team, author & editorial comment
1.0	Dave Gawn	31/10/18	For issue to Minister

The recommended plan in this report is certified, to be:

- Technically feasible
- Achievable safely; and
- Consistent with the general requirements set out in the Health and Safety at Work Act 2015, the specific requirements set out in the Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016, and other relevant legislation

31/10/18

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Chief Executive
Pike River Recovery Agency

31/10/2018.

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Contents

Glossary

Term	Meaning
Airflow	movement of air through underground roadways
Auxiliary fan	An electrically powered wheel mounted 1000volt fan used to ventilate dead-end roadways. Used in conjunction with ducting (vent cans) to force or extract air to the end of the roadway.
Bore hole/drill hole	Hole created by drilling to gather geology information and to drain or inject gas into the drift or mine workings. Can be done from the surface or underground.
Brattice	Impervious, fire resistant plastic/fabric cloth used in the construction of ventilation control devices eg stoppings curtains, tubes etc to direct the course of airflow.
Change-over station	Short duration refuge, in which miners may exchange self-rescue units (breathing apparatus) during evacuation of a mine.
Contraband	Items prohibited underground because they could either produce or provide a spark that could act as an ignition source, provide additional fuel after ignition in an explosive atmosphere or create additional hazards to the work place. For example, cigarettes, lighters, aluminium drink cans, cell phones battery powered watches.
Conveyor	Located in the drift to transport rock out of the mine. It consists of an endless belt being driven by a motor drum system over a structure roller assembly.
Drift	An inclined access from the surface to the coal seam that passes through rock strata.
Flameproof	Steel enclosures that house electrical equipment within which an explosive mixture of gas can ignite without igniting explosive gases surrounding the equipment, due to the highly engineered tolerances and inherent strength.
Fresh air base (FAB)	Location underground where a known fresh air source is available. This may have an air source that is independent of the main ventilation air for safe refuge of personnel in the event of mine evacuation of escape.
FRG	Stand With Pike – Family Reference Group
Frictional ignition	Ignition of methane gas from sparks created by metal striking or rubbing against rock, or by rock striking rock, or by metal striking metal, or general mechanical components rubbing against each other or coal and generating heat.
Gas detector / gas monitor / gas sensor gas meter	An electronic instrument, either portable (handheld), fixed on a rib or mounted on a piece of mining equipment, that detects and measures a range of gas contents in mine air.
Grizzly	Feed hopper and sizer for the conveyor.
Hazardous zone	(see restricted zone)
Inbye	The direction towards the coal face from any reference point.

Intake	Underground roadways that have uncontaminated/fresh air moving through them that has not yet passed a working place.
Intrinsically safe	Equipment and wiring which is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of methane gas, due to specific design of electrical components.
JHA	Job Hazard Assessment
Main drift	Primary roadway from the portal used to provide long-term access for people and equipment access to and from the mining areas.
Main fan/primary fan	Largest fan that draws or pushes all air through the mine
Mega bolt	Extra long high capacity – up to 50t cable-type roof bolt
Monitor	Gas monitor, used to detect and measure levels of gas in the air.
Non-certified equipment	Equipment that has not been certified as flameproof or intrinsically safe
Non-restricted zone	Areas within a mine not classified as restricted
Outbye	The direction away from the coalface from any point of reference
Permit to mine (PMT)	Weekly detailed plan of the forecast underground mining activities (mine operations, mechanical and electrical services and technical services). Production and health and safety risks of the planned activities are assessed and identified and mitigation measures are adopted as part of the weekly mine plan.
Pit bottom in Stone	An area where the mine drift used to access the coal seam intersects with the mine workings. At Pike River mine, the lowest part of the mine workings at the top of the drift.
Portal	Entrance to the tunnel; surface end of the drift.
PRDH	Pike River Drill Hole
Real time monitoring	Recording data from sensors on the SCADA and safe gas system
Refuge chamber/ refuge station	Safe haven where miners can wait either until the danger has passed or they are rescued. It has guaranteed air supply and sustenance; it also has high integrity seals so it can be self-contained and not prone to explosion damage.
Restricted zone	Parts of the mine where only flame proof or intrinsically safe equipment may be used; defined in the Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016.
Return	Any underground roadways that have 'used contaminated' air moving through them towards the surface after it has passed a mining area.
Roof bolt	A long bolt inserted into the roof, preventing and limiting the extent of roof falls – used to bind rock strata in a beam arrangement so that it is self supporting.
Roof fall	Process where the roof is undermined and fails to the extent that the roof collapses.
SCADA	(Supervisory Control and Data Acquisition) Computer system used to monitor and control underground infrastructure, including gas monitors, pumps, fans etc.

Self-rescuer	A temporary breathing apparatus for use when mine atmosphere becomes unbreathable with a self-contained oxygen source – in this case chemically derived.
SOP	Safe Operating Procedure
Spontaneous combustion	Coal reacts with atmospheric oxygen even at ambient temperatures and this reaction creates heat. If the heat liberated during the process is allowed to accumulate, the rate of the above reaction increases exponentially and there is a further rise in temperature. When this temperature reaches the ignition temperature of coal, the coal starts to burn and the phenomena is described as spontaneous combustion.
Stone dust	Limestone dust sprayed over the roof, ribs and face, and throughout the mine to render coal dust inert.
Stopping	A structure (temporary or permanent) built across a roadway to direct air flow.
Stub	A small dead end extension roadway (2-5 metres) off the main roadway. Stubs may be used for locating plant and equipment or to allow one vehicle to be parked and another vehicle to pass.
Tag board	System for identifying who is underground. Tags are placed on the board when miners enter the mine and are removed when they leave.
TARP	Trigger Action Response Procedures. Step by step processes of what to do, who to call and actions to take in cases where urgent action is required.
Tube bundle	Bundle of tubes spread throughout the underground workings used to draw gas to the surface for analysis. At Pike River mine a tube bundle is also surface laid and enters the mine through various bore holes.
Venturi	A compressed air powered ventilation device used to increase airflow.
WRAC	Workplace Risk Assessment and Control. WRAC is a proactive or pre-event approach to examining any or all parts of the work site to ensure that risks are understood and controlled to a reasonable level.

Executive Summary

This report presents the findings from seven planning and risk workshops conducted in Rapahoe over the period 30 April to 25 October 2018. The objective was to develop and risk assess viable courses of action for the safe manned re-entry to the Pike River Drift in order to make a recommendation of the preferred option to the Minister Responsible for Pike River Re-Entry.

Recommendation:

Preferred option - Single Entry. The Executive group of Dave Gawn (Chief Executive PRRA), Dinghy Pattinson (Chief Operating Officer and Site Senior Executive and Mine Manager PRRA), Tony Forster (Chief Mines Inspector NSW, Australia and technical advisor to FRG) and Richard Tacon (Chief Executive Bathurst Mining); agreed that all options were technically feasible and could be executed safely. However based on the balance of risk and wider considerations we recommend going forward with the Single Entry option.

- The Single Entry is the least complex; has the most certainty with respect to time, cost and ground conditions; has the lowest number of risks to manage; is the least costly; the lowest exposure and is the least affected by weather and flying conditions.
- Whilst it does not have a second means of egress we believe that progressive and thorough inspection of strata conditions, a cautious approach and good mining practice including strata support will mitigate the improbable event of strata failure.
- Whilst the primary forcing ventilation system is not as robust as the through ventilation provided in the other two options it is common practice in mining throughout the world.

The Small Tunnel is the next preferred option.

The Single Entry LDBH is the least preferred option.

Plan Development

An initial concept plan (with variants) was developed from the First Technical Expert Workshop (30th April to 3rd May 2018), with a preferred option that comprised a Large Diameter (LD) Borehole for ventilation and personnel access.

Subsequent to the first workshop, additional work conducted by the Agency identified a short tunnel to the Pit Bottom in Stone (PBIS) as a further option worthy of consideration.

The detailed task analysis identified three options for re-entering the drift. Subsequent risk analysis concluded that all options can be conducted safely and are technically feasible.

The second workshop was tasked with refining and testing three options:

Option A - Short Tunnel to PBIS: This option proposes that a small (2mx2m) tunnel be driven from a suitable site adjacent to Pike Stream, breaking into the drift at Pit-Bottom-in-Stone (PBIS).

Option B - Single-Entry: This option proposes that re-entry will be conducted in stages from the portal by advancing the ventilation system in predetermined increments. Forcing ventilation will be used for this option.

Option C - Single Entry with Large Diameter Borehole. (LDBH): This option proposes that re-entry will be conducted in stages from the portal. A large diameter borehole (600mm finished) would be drilled from a suitable surface location to intersect the drift outbye of PBIS, to be used as an escapeway.

All options require injecting nitrogen (N_2) into the drift and the mine workings - initially, to minimise the methane (CH_4) and create a N_2 inert atmosphere, then when ready for manned entry, to replace the N_2 in the Drift with air.

Also common to all options, is the breaching of the 30m seal near the portal, re-establishing the 170m barrier inbye of the portal and drilling an additional borehole either side of the fall area. A third new borehole will be drilled into the drift at approximately 1400m to help monitor the atmosphere.

When the ventilation, geotechnical and operational practicalities were scrutinised in the second workshop it became clear that the LD Borehole option was fraught with difficulties, including: The impracticability of using one large diameter hole for ventilation and as an alternative escapeway; the legislative restrictions relating to escapeways; finding a suitable drill rig site; the inherent risks in sinking a large diameter drill hole; supporting the hole to ensure it stayed open; and the difficulty in managing spoil and helicopter operations supporting this course of action.

There are three significant advantages to why the Short Tunnel option was initially preferred over the other options: It provides a trafficable on foot second means of egress from the Drift; it allows for greater airflow through the Drift between the portal and the breakthrough point; it establishes a controlled ventilation circuit in the Drift for access and ongoing maintenance.

There are however some significant issues around the Short Tunnel option, including: Finding a suitable site; establishing and maintaining services; worker accommodation; disposal of waste material; the remoteness and accessibility of the site; environmental constraints; breaking through into an irrespirable atmosphere; underslung helicopter operations in restrictive terrain; and the impact of adverse weather.

The Single-Entry option involves entering the Drift from the 170m seal, purging and removing the N_2 and systematically ventilating with air, progressing up the Drift using the main mine fan, and advancing as far as the ground conditions and debris will allow. The Single-Entry option does not include a second means of egress.

Progressing beyond PBIS has the same significant challenges for all three options in relation to ventilation, ground support and forensic examination of the 'debris field'.

Risk

The risk analysis process is the start point to inform this recommendation - it is not the end state. Our risk management process is one of ongoing assessing, controlling, monitoring and reviewing. It is a dynamic iterative system, which will be part of an overall Agency management process. PRRA recognises the substantial amount of work that is still required before safe manned re-entry and recovery of the drift can begin, including but not limited to: detailed planning (design) for each phase of the operation; further BT, FTA and ETA review and assessment of high level events; review and development of specific management plans, Standing Operating Procedures (SOP), Job Hazard Assessments (JHA), Tactical Action Response Plans (TARP), checklists, and change management procedures. These will be developed in the coming weeks/months for the approved Course of Action.

Further, a culture of safety first, deliberate and meticulous planning, well developed SOPs, training and rehearsals, and 'conditions based operations' is fundamental to the successful prosecution of these recovery operations. There is a lot that we do not know and will not know until we are confronted with the situation as we find it underground. This will require agile thinking, the courage of all to say NO if we are uncomfortable, the preparedness to reassess, reset and re-plan when necessary; and knowing when to call it 'quits'.

COA Risk Assessment. All three COA were subjected to a risk assessment attended by internal and external subject matter experts and independently facilitated by the Jim Knowles Group from Australia. The first risk workshop identified and raw ranked key risks using the Workplace Risk Assessment and Control (WRAC) process and then determined 'hard and soft' controls to mitigate the identified risks. This was followed by a second workshop attended by a different group of technical experts and independent advisors to peer review the work of the first workshop, assess the adequacy and effectiveness of the controls, close any gaps identified, and rank the residual risk for all high level risks. A final executive level review of the work was conducted to ascertain the preferred option for recommendation to the Minister Responsible or whether further work was required. The executive level review included the consideration of wider elements and influences impacting on each course of action; for example cost, duration, consent processes, public perception, complexity and environmental impact.

The Risk Analysis process identified:

Small Tunnel - 351 safety risks of which 135 were raw ranked Very High to High

Single Entry - 308 safety risks of which 118 were raw ranked Very High to High

LD bore hole - 342 safety risks of which 134 were raw ranked Very High to High

Following the critique and re-ranking of residual risk by the peer review group the options were ranked as follows:

Small Tunnel - 351 safety risks of which 24 were residual ranked low end High

Single Entry - 308 safety risks of which 22 were residual ranked low end High

LD bore hole - 342 safety risks of which 31 were residual ranked low end High

Following this process the PRRA conducted a compare and contrast workshop between the risk analysis work undertaken by the Agency and that undertaken by Solid Energy New Zealand (SENZ) in order to determine the similarities, differences and where appropriate close any gaps in controls that might have been missed.

Further work was then undertaken to review and assess for adequacy the Bow Tie (BT), Fault Tree Analysis (FTA), Event Tree Analysis (ETA) and associated control measures and checklists undertaken by SENZ and facilitated by Chris Allanson. This comparative study resulted on one extra BT being developed (with the assistance of Mines Rescue Services) for work under breathing apparatus. The remaining BTs, FTAs, ETAs require updating of nomenclature, and branding but are materially sound. This is not surprising because the high level hazards and hazard management has not substantially changed in the four years since SENZ undertook this work.

A Comparison of some high level considerations. A synopsis of key high level considerations beyond safety and risk follows:

Small Tunnel

Advantages. There are two key advantages to the small tunnel:

Second means of egress. The small tunnel provides the only viable option for a second means of egress. Whilst not required by law a second means of egress is highly desirable if it can be achieved without undue additional risk and it would appease potential adverse public perception. Notwithstanding, any entrapment early in the operation will still require those trapped to negotiate an unknown and unrecovered tunnel up to PBIS and the small tunnel will not provide a second means of egress for any entrapment in-bye Pit Bottom in Stone (PBIS) – an area of significant forensic interest.

Primary ventilation circuit. The small tunnel provides a primary 'through' ventilation circuit up to PBIS. This is generally considered a more robust option than a primary forcing ventilation circuit. Beyond PBIS an auxiliary return ventilation system is still required.

Disadvantages. The advantages outlined above are heavily outweighed (to our mind) by the following considerations:

Time. It will take a minimum of 9 – 10 months from the day approval is given to proceed, for the small tunnel driveage to break through into PBIS. This must be done in Nitrogen and assumes that there are no delays for weather or other unexpected events. This is highly improbable. The time taken to prepare and drive the tunnel will delay breakthrough of the 170m barrier until October 2019, at the earliest.

Consents. The site location for a small tunnel will be inside the National Park boundaries but outside the current authorised/consented area for PRRA activities. This will require DOC and Ministerial level approval which in turn will require the detailed portal site design including water treatment and spoil management.

Portal location. The potential locations of the portal for the small tunnel are in a very difficult gorged area of the Pike River. Factors such as flooding and slips will contribute to the complexity and hazards of this option particularly as much of the activity is likely to take place during the winter months of high rainfall and inclement weather. The portal location will also heavily impact on helicopter operations.

Environmental factors. Water management, tree removal, spoil management, and 'footprint' are significant environmental factors that will require detailed planning in association with DOC and consenting authorities, and careful management to ensure continued public support. Ministerial approval will be required.

Winter weather/ Helicopter Operations – West Coast weather patterns during winter have the potential to significantly impact operations, particularly flying operations, which is a mission critical activity. It is estimated that the small tunnel has a requirement for +/-2100 x underslung helicopter loads to remove spoil from the portal site. Additional flights will also be required to establish and disestablish the site. SENZ Steering Committee report identified that flying is possible only 30% of the time. In order to ensure minimum delay due to weather, sufficient storage for spoil and manoeuvre space will need to be developed, potentially requiring heavily engineered platforms.

Cost – estimated cost (assuming no time delays) is $49M (approx.) based on the shortest tunnel option.

Exposure. Length of exposure to risk/hazards for the small tunnel is an additional 22 weeks over a single entry option (11 weeks for each crew) These 'calculations' have been based on two crews, 12hr shifts, 6 days blasting/1 day services and seven days on, seven off. Detailed design work with contractor involvement will determine the optimum work schedule. (22 weeks assumes an optimistic scenario of no delays).

Uncertainty and complexity. The small tunnel is the most complex and uncertain of the options considered. A combination of factors including the consenting process, weather, strata conditions, and environmental factors, all of which are outside the control of the Agency to one degree or another, contribute to a plan that has additional layers of complexity and risk (over the single entry option) that must be managed. The impact of 'loss of time' through weather delays or unexpected strata conditions has the potential to add significant cost and time to this option.

Single Entry

Advantages. Recovery of the drift from the 30m seal is common to all options. The key advantages of the Single Entry option is its relative simplicity, time to complete, cost, low environmental footprint and its all weather characteristics relative to the other options.

Time. Work on the Single entry option can begin immediately following the decision to proceed. It will take 12 weeks (late March 2019) before breakthrough of the 170m barrier. Poor weather will cause minimal delay.

Consents. All work for this option are within the authorised/consented areas for PRRA activities or in areas of previous mining activity. Work variations would be required for new boreholes with approval being given at DOC regional level.

Environmental factors. Water management, tree removal, and spoil management are already consented and managed within existing processes, procedures, and approvals.

Winter weather – West Coast weather patterns during winter have the potential to significantly impact operations, particularly flying operations which is a mission critical activity. However there is no additional flying required that is unique to this option.

Cost – The estimated cost is approx. $36M. This option is the least costly.

Exposure – There is no added exposure in this single entry option. Exposure within the main drift recovery will be the same for all options

Uncertainty and complexity – The single entry is the simplest plan of those considered and has the most certainty. The large majority of risks and uncertainty in 'single entry' are common to all options. It is not affected to the same degree as the other options by the consenting process, weather, uncertainty of strata conditions (beyond the drift itself), and environmental factors. However the ventilation plan and its execution is more involved/complex and less robust than the primary 'through' ventilation circuit of the small tunnel.

Disadvantages: There are two primary areas where the Single Entry option is less robust than the small tunnel:

Second means of egress – The single entry option has no second means of egress. Whilst not required by law a second means of egress is highly desirable if it can be achieved without undue additional risk and it would appease potential adverse public perception. The NZ public will need assurance of the PRRA culture of: safety first, dynamic and iterative risk analysis, review and management processes; robust control measures and 'best mining practice'.

Primary ventilation circuit – the single entry option relies on a primary forcing ventilation circuit returning via the existing tunnel. This ventilation solution is common in mining and tunnelling around the world. However it is generally accepted that it is not as robust as a primary 'through' ventilation circuit. An auxiliary ventilation system may also be required beyond PBIS (this will be confirmed in the Ventilation plan).

Single Entry with Large Diameter Borehole

Advantages: There are two areas where the LDBH option provides advantage over the Single Entry:

Primary ventilation circuit. This option provides the potential for a primary 'through' ventilation circuit up to the LDBH. This is generally considered a more robust option than a primary forcing ventilation circuit. An auxiliary ventilation system may also be required beyond the LDBH. Note however that if used for the primary ventilation circuit it cannot be simultaneously used for an escape way).

Second means of egress. The single entry LDBH option does not provide a second means of egress. The LDBH can provide an 'in extremis' escape way in the event of entrapment. Whilst not required by law a second means of egress is highly desirable if it can be achieved without undue additional risk and it would appease potential adverse public perception. The NZ public will need assurance of the PRRA culture of: safety first, dynamic and iterative risk analysis, review and management processes; robust control measures and 'best mining practice'. The escape way may be perceived as the same failed option that Pike River Mine selected.

Time: It will take a minimum of 7 – 8 months from the day approval is given to proceed, for the LDBH to break through into the drift. This must be done in Nitrogen and assumes there that there are no delays for weather or other unexpected events. This is highly improbable. The time taken to prepare, drill and finish the LDBH will delay breakthrough of the 170m barrier until mid-July 2019, at the earliest.

Consents. Site location for the LD Bore Hole (BH) will be inside the National Park boundaries but outside the current authorised area for PRRA activities. This may require DOC and Ministerial level approval which in turn will require the detailed drill site design including spoil management plan before submitting consent for approval.

Environmental factors. The environmental footprint and spoil management will be key issues to plan and manage in this option.

Winter weather. West Coast weather patterns during winter have the potential to significantly impact operations, particularly flying operations which is a mission critical activity. This option relies heavily on helicopter operations to support the drilling crews and remove the spoil. It is estimated that 500 x underslung loads will be required to remove spoil and a further 200 x underslung loads to plug the LDBH on completion. SENZ Steering Committee report identified only that flying is possible only 30% of the time. In order to ensure minimum delay due to weather, sufficient storage for spoil and manoeuvre space will need to be developed potentially requiring heavily engineered platforms.

Cost. The estimated cost is $41M (approx.)

Exposure. The length of exposure on the hill for the LDBH is + 28 weeks including establishment and disestablishment. These calculations have been based on two crews, 12hr shifts, and seven days on seven off. Detailed design work with contractor involvement will determine the optimum work schedule.

Uncertainty and complexity. The LDBH option is more complex and uncertain than the single entry option. There are no drill rigs of sufficient size in NZ to undertake the LDBH drilling. The plan requires an 800mm (600mm finished), borehole to be 'blind drilled' into an underground roadway – this process does not have the surety of raise bore drilling. A combination of factors including the consenting process, weather, drilling conditions, and environmental factors, all of which are outside the control of the Agency to one degree or another, contribute to a plan that has additional layers of complexity and risk that must be managed. Notwithstanding, the advantages of an escape way may help appease public perception around safety and there are some benefits (albeit minimal) to a primary ventilation circuit that could be achieved through this option.

[redacted]

26 October 2018

Since Minister Little signed off the Concept Plan the Agency has been completing detailed planning and risk assessment processes for a safe re-entry to Pike River Mine Drift. The Families Reference Group (FRG) has been involved in the planning and risk process, with a representative attending all the workshops along with agency staff, technical experts and other agencies. The FRG has had the ability to join in the conversations giving a voice to what is important to the wider families.

Our own Technical Experts have been involved in the workshops and feedback from them has been positive. The agency staff and technical experts have acknowledged how important hearing the views of the families have been throughout the process. It has had a positive impact on discussions which focuses around the work we are jointly trying to achieve. The Technical Experts have been proactive in their engagement with the FRG and have willingly answered any questions or provided further information.

During the Risk Assessment phases I was impressed with the thorough and detailed way hazards were identified, classified and controls were extensively discussed at multiple levels. I was pleased with the way the technical experts (including our own) challenged each other and I believe the process has been strong, transparent and open. It has been very important to the families that re-entry should not disturb forensic evidence, the experts listened to our concerns and developed practical steps within the process to protect evidence.

The way the process has evolved over the last couple of months has been eye opening, we appreciate the transparency the agency has continued to deliver which is now starting to be seen in our engagement with other agencies including WorkSafe and NZ Police.

We are looking forward to the next phase of the project.

Kind regards

Anna Osborne

Chair, Family Reference Group (FRG)

Stand With Pike

Introduction

Background

The Pike River Recovery Agency *Te Kāhui Whakamana Rua Tekau mā Iwa* (PRRA) was established as a stand-alone government department by Order in Council on 31 January 2018.

The Agency's objectives are to conduct a manned recovery of the mine drift by March 2019 in order to:

- Gather evidence to assist in ascertaining what occurred at Pike River Coal Mine leading up to and on 19 November 2010 and subsequently, in order to assist in preventing future mining tragedies and in promoting accountability for this mining tragedy;
- To give victims loved one's overdue closure and peace of mind; and
- If possible recover any human remains.

Between 30th April and 16th October 2018 PRRA brought together a number of technical advisors from the UK, Australia and New Zealand to develop and risk assess various options to re-enter and recover the Pike River Mine drift. This report documents the results of that body of work.

Orientation - Ground. Pike River mine is located on the eastern side of the Paparoa Range, about 45km NE of Greymouth. It lies between Mt Hawera to the north and Mt Anderson to the south. Access is from the Taylorville-Blackball Road, up Big River Valley via Logburn Road and then 12km of private road to the mine site.

Pike River Mine lies within the boundaries of Paparoa National Park. The portal (entrance) is on the true right bank of White Knight Stream 120m upstream from its confluence with Pike Stream.

The access tunnel (drift) runs in a straight line SE-NW through approximately 2000m of gneiss rock before intersecting the Hawera fault which marks the eastern boundary of the Brunner coal seam. A roof fall is known to have occurred at 2300m. Beyond this is the mine workings and approximately 4km of driven roadway. The drift rises from the portal at 1:9 incline *(Figure 1).* It is intersected by a small fault at 1020m – this area may require ground support.

1800m from the portal is Pit Bottom in Stone (PBIS). This area consists of 460m of roadway and cross cuts and provided space for large underground infrastructure including water pumps, gland pumps, a reservoir dam to hold water for the slurry system, variable speed drives also for the slurry pumps, a crusher and a fuel pod for refuelling diesel vehicles. It is an area of significant forensic interest and also the location of 'Daniel's loader'. At 2100m is the Grizzly – a feeder and sizer for the conveyor.

Inbye PBIS the drift runs through the less stable ground of the Hawera fault to the roof fall – this area may require ground support. The area beyond PBIS has not been explored previously but is known to contain a major debris field and is also of significant forensic interest. 'Russell's loader' is located at 1400m and there are four robots outbye of that. There are currently five boreholes driven into the drift and mine workings. These will be supplemented with a further three boreholes to assist in management of the atmosphere *(Figure 2).*

The mine has a water make of 6l/sec and a methane make of 10l/sec in the current 30m of tunnel. The sealed tunnel and mine workings can't be measured until they are re-ventilated but based on historical data have a methane make of approximately 50-60l/sec. It is currently held at a stable environment of 96% methane (CH_4).

There is a reversible, rated seal at 30m and a further barrier (door open) at 170m. Between these two points there are a number of structures designed to help manage the water within the mine.

The administration buildings are located 1.3km from the portal.

Figure 1. Plan view overlay of Pike River Mine Drift and mine workings

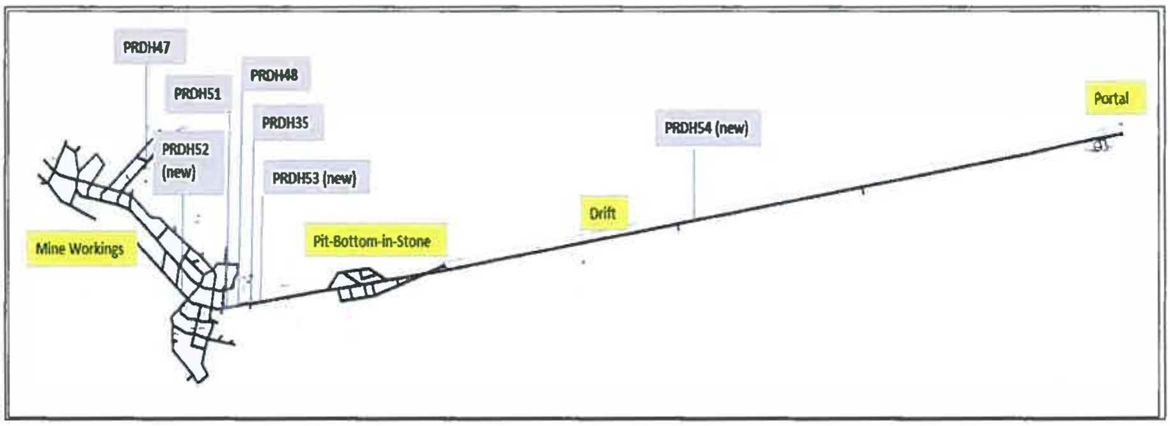


Figure 2. Mine Plan with referenced locations and boreholes

Situation. PRRA was established to develop and execute a plan to re-enter and recover the Pike River mine drift and if possible recover any human remains. There were five key principles of that guided the re-entry and recovery plans developed by the technical advisors and PRRA:

- recovery operations would be conducted in fresh air if at all possible;
- a second egress whilst not legally required was highly desirable;
- the forensic examination of the drift was the main effort and would drive the pace of recovery;
- safety would always take precedence; and
- operations would be conditions based and event driven, not time driven.

It was quickly identified that the challenges in recovery of the drift related primarily to ventilation and strata stability. Notwithstanding, three technically feasible, safe courses of action were developed, risk assessed and ranked in order of preference for recommendation to the Minister Responsible for Pike River, the Honourable Andrew Little.

Re-entry and Recovery Planning

Representatives of the Technical Panel, along with members of the Families Reference Group, New Zealand Mines Rescue, WorkSafe, New Zealand Police, other independent advisors and Agency staff, were brought together in a number of separate planning and risk workshops to consider how to re-enter and recover the main drift, with a view to achieving the Agency's objectives:

30 Apr - 03 May	Develop baseline concept plan
13 - 14 Jun	Develop and refine 3 x options for re-entry and recovery of the drift
8 - 9 Aug	Job step analysis of 3 x options
10 - 20 Sep	Risk Analysis Phase 1 – Work Step Risk Assessment and Control (WRAC) process of 3 options
1 - 2 Oct	Risk Analysis Phase 2 - Peer review of WRAC process conducted in Risk Analysis Phase 1
16 Oct	Brief back for PRRA Executive review and decision on preferred option to be forwarded to Minister
23 - 25 Oct	Develop and refine ventilation plan for 3 x options

Separate reports for each of these workshops are available on request.

Following the development of the 'baseline concept plan' in May, and subsequent ministerial level approval for further planning, two more options were developed. All three were then subjected to an independently facilitated risk assessment process. At each stage independent peer review was built into the process and an inquisitorial/challenge environment encouraged in order to mitigate any 'group think' and provide robustness to the end product.

Option Development. Three options were developed and risk assessed in the workshops:

Option A; Small tunnel

Option B: Single Entry

Option C: Single Entry with Large Diameter Bore Hole

Only the preferred option (Single Entry) is developed in this report in order to provide the reader with a narrative of intent and an understanding of how the recovery using a Single Entry forcing fan ventilation concept will be undertaken. The Small Tunnel and Single Entry with LDBH are included in outline for completeness but the detail can be explored further in the Annexes and attachments. All three options were assessed as being technically feasible and able to be executed safely.

Preferred Option: Single Entry

Intent Statement: It is our intent to safely re-enter and recover the Pike River Mine drift in fresh air. We will progressively recover the drift undertaking a deliberate staged forensic examination with support of the NZ Police in order to help determine what caused the Pike River Mine tragedy and recover any human remains if possible. **Main effort:** Forensic examination. On completion of the recovery and forensics phase the mine will be re-sealed, the site remediated and handed over the Department of Conservation.

Safety will take precedence over everything else and a high level of self-discipline, training and adherence to procedure is expected by all involved in the operation. Extensive use will be made of rehearsals particularly for composite teams underground (UG), and the recovery of specific pieces of equipment. Execution of each phase will be 'conditions based' and event driven, not bound by artificial time constraints. We will operate with a minimum safe footprint and the principle that only those required UG will go UG. The operation will be conducted in seven phases with preliminary operations to set the conditions for a successful start state:

Concept of Operations. It will be a seven phase operation, each phase setting the conditions for the next. The sequence of phases/key tasks is shown at *Flow Diagram 1.* A detailed task analysis is at Attachment 1.

Preliminary Operations. This phase will include key tasks to commission the Nitrogen plant, purge the mine of methane with Nitrogen and drill three new boreholes to help manage the UG atmosphere. There are also numerous tasks required to ensure that the mine site remains compliant. The tasks for the preliminary phase are detailed in the work programme at Annex A. End State: drift purged to BH48 and workings via BH47; BH52, 53 and 54 drilling complete; nitrogen lines laid to BH47 and 52; fresh air introduced to 180m.

Phase 1. Breach the 30m seal and re-establish the 170m barrier.

Phase 2. 30m - 170m: Conduct forensic search 30m – 170m then remove 30m seal and deconstruct the water management infrastructure.

Phase 3. Remove the 170m barrier and progressively search and recover the drift to inbye PBIS

Phase 4. Establish rated seal (20psi) inbye PBIS and conduct detailed forensic examination of PBIS

Phase 5. Recovery and examination inbye PBIS to rockfall

Phase 6. Reseal the mine: re-establish water management infrastructure and rated seal at portal; refurbish site for handover to DOC

Phase 7. Handover to DOC and disestablish the Agency

Supporting Operations:

Ventilation Nitrogen injection, methane decanting to atmosphere and subsequent nitrogen decanting to atmosphere will occur during the preliminary phase. The drift will be purged with nitrogen from the 30m seal. Methane will be decanted through PRDH48 (in the drift) and PDH47 (in the mine workings) during this initial purging. Fresh air will be introduced into the drift inbye the 180m point via one of the spare 250mm drainage pipes through the 30m seal. Nitrogen-inertisation of the mine workings will continue throughout the re-entry phase to maintain a positive static pressure inbye the roof fall, relative to the drift. Re-ventilation will be incremental using force ventilation. The duty of the 4-stage fan will be increased commensurate with advance. For a detailed summary of the ventilation plan see Annex B.

Forensics. The draft forensics plan is at Annex C. The forensics operation is the Main Effort. It will be deliberate and cyclical. The routine will see a reconnaissance team of experienced underground (UG) miners clear and mark off an area (the made safe zone), mapping hazards and ensuring the strata integrity, and safety of the cleared zone. NZ Police will provide two teams: a digital imaging team to survey and record each marked zone, and a forensic search team to conduct the deliberate search of the same. These teams will have a minimal footprint and be accompanied by experienced underground miners. On completion of the forensic search, the team will hand over to the UG support team who will progress the UG services forward. The cycle will then start over. All personnel will undergo training and conduct rehearsals to ensure that they are qualified, competent, and current.

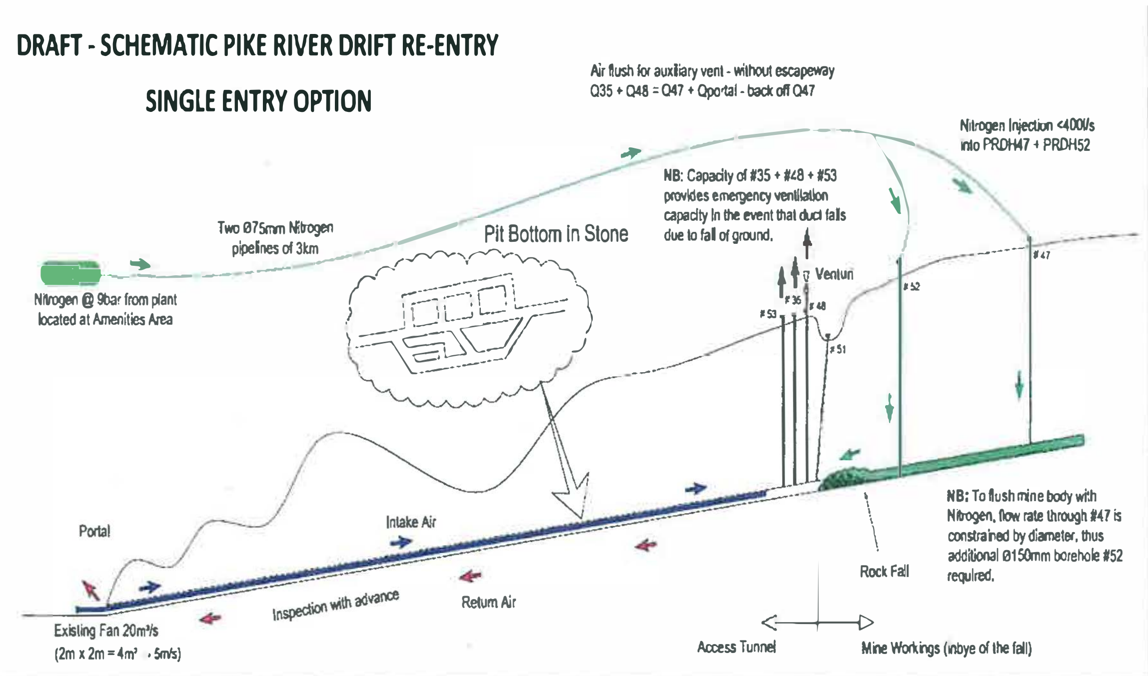


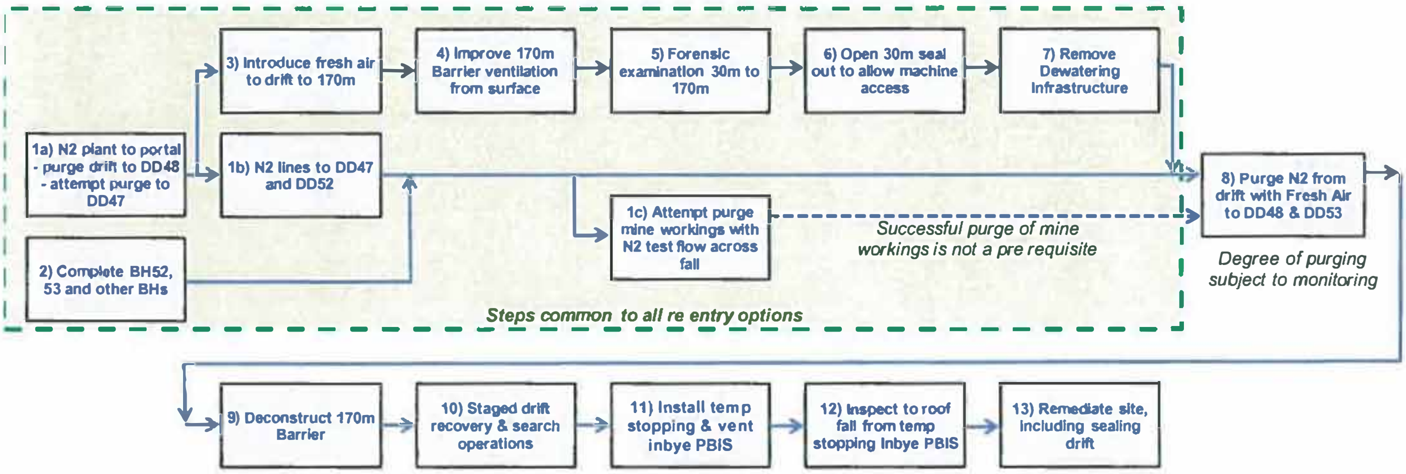
Figure 3. Single Entry schematic

Indicative Timings

Feb 2019	Breach 30m seal
Apr 2019	Breach 170m seal
Jun 2019	Examination of PBIS complete
Aug 2019	Full drift recovered and forensic examination
Dec 2019	Complete drift resealed, site remediated and
Jun 2020	Handover to DOC Agency disestablished and closed

The major tasks for Single Entry are described in the flow diagram below.

Option B Single Entry



Flow diagram 1. Single Entry step by step process

Groupings:

Command – this group will lead operations and includes all statutory appointment holders.

FRG and families – The FRG and families are a key component of this operation. The FRG will provide point of contact to the wider families group. The Agency will support this group with a liaison officer. The FRG participate in the command group as desired as active listeners.

Operations – responsible for day to day operational control of activity both above and underground.

Above Ground support. Above ground support provided by the Agency includes security and ground services support to ensure the mine is maintained in a legally compliant, safe, state throughout.

UG reconnaissance – Made up of underground staff, the primary purpose of this reconnaissance group is to ensure that the drift is safe, and carry out hazard mapping. The teams will also carry out a 'forensic scan' in order to assist the forensic search team to plan the next phase.

Forensics/DVI. NZ Police will provide the support for forensics and DVI (if required). Two teams will work underground: digital imaging team to survey and record items of interest, and a forensic search team to conduct the deliberate search of the drift. An above ground support team will manage exhibits, evidence and co-ordinate the police effort.

UG support. This team will conduct underground operations in support of the search teams. Key tasks include removal and erection of seals/barriers/stoppings; progressive introduction of UG services; removal/re-establishment of water management infrastructure.

Contractor support. Various contractor support will be required to support the operation including helicopter operations, drilling operations and other support not able to be met within the resources of the Agency.

Media support. There is intense national interest in this recovery operation. The Agency will provide media support to co-ordinate and manage the attendant media interest.

NZ Mines Rescue Services. Mines Rescue Services will provide their core role in support of UG operations. Brigadesmen may also be used to supplement the Agency's UG manpower for specific activities.

Agency support. The Agency will continue to run its 'corporate' functions from its Greymouth office.

Tasks. There are key tasks common to all Courses of Action including:

- Re-entry and recovery of the drift will be done in fresh air
- The mine drift and mine workings will first be purged of methane using nitrogen pumped into the drift from the portal (entrance)
- Methane will be vented from boreholes (BH47 at the top of the mine workings and BH48 in the drift outbye the roof fall)
- Two additional 150mm boreholes (BH52, BH53) will be drilled from the top of the mountain entering the drift either side of the roof fall, in order to manage the ventilation circuit and nitrogen/fresh air fringe outbye of the roof fall. A further 50mm borehole (BH54) will be drilled approximately 1600m up the drift to monitor the introduction of fresh air into the drift.
- Nitrogen lines will be laid from the Nitrogen plant to BH47 at the top of the mine workings and BH52.
- Fresh air will be introduced into the drift through the portal using a forcing fan
- Nitrogen will be pumped into the mine workings through BH47 and BH52 over the roof fall at the top of the drift in order to ensure an inert atmosphere is maintained over the roof fall and to create a pressurised nitrogen/fresh air fringe outbye of the roof fall. *(Figure 4)*
- The 30m seal will be breached
- The 170m barrier will be re-established
- The water management infrastructure will be removed *(Figure 5)*

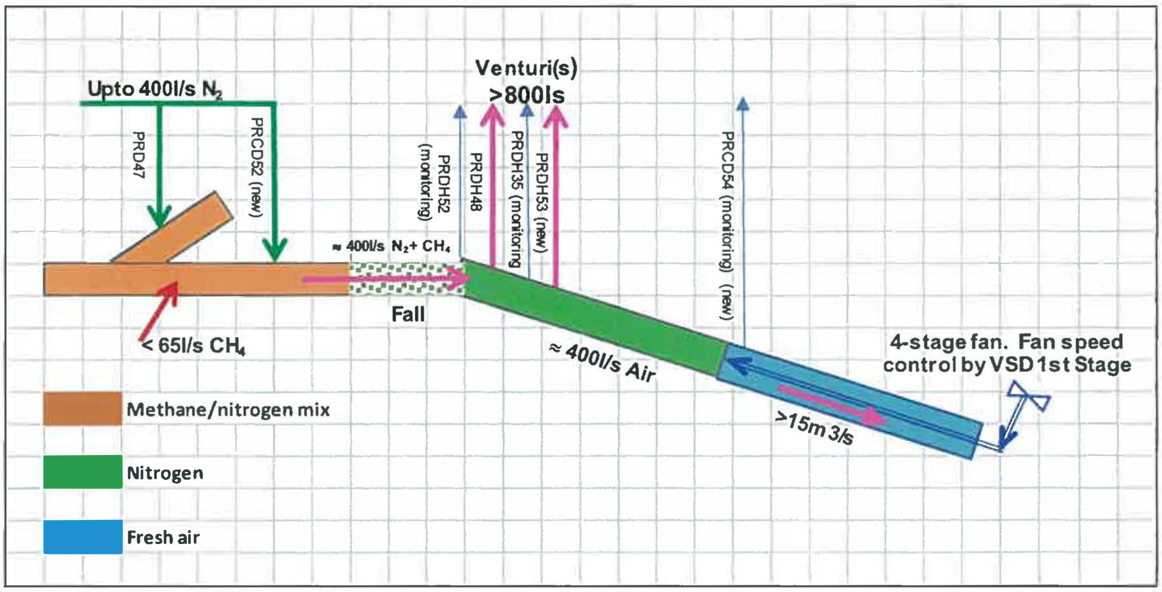


Figure 4. Ventilation

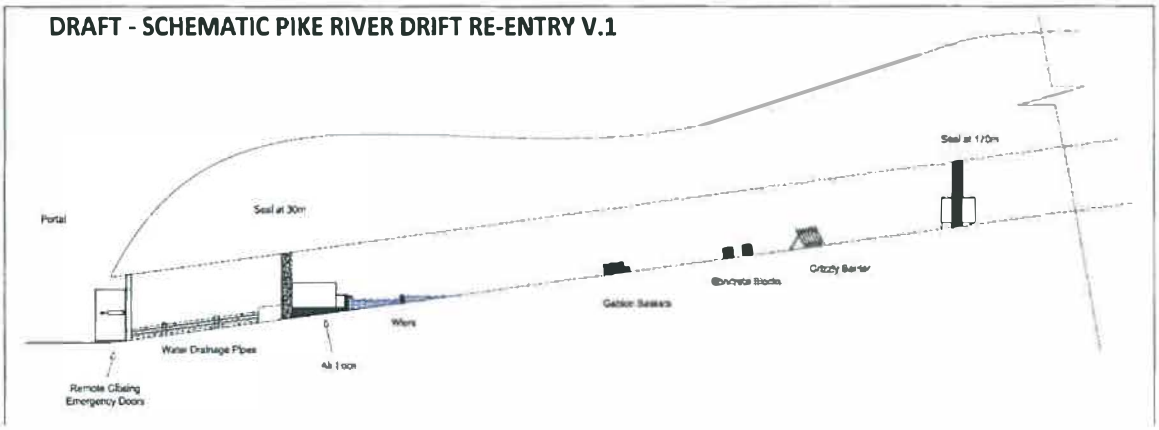


Figure 5. Water infrastructure between 30m and 170m

- The 170m barrier will be breached.
- A staged forensic examination of the drift will be undertaken with support of the NZ Police from 0m to as close to the roof fall as is safe.
- The final 300m between Pit Bottom in Stone (PBIS) and the roof fall may require an auxiliary fan and part of this exploration may need to be undertaken using breathing apparatus. (This can only be fully assessed on sighting the conditions in this critical area).
- On completion the mine and site will be remediated including the re-establishment of the water management infrastructure and a reversible seal at the portal.
- All infrastructure not required by DOC will be removed.
- A post closure management plan will be developed and the site handed over to DOC.
- The Agency will be progressively disestablished and closed.

Option A. Short Tunnel re-entry stages

A schematic of the Short Tunnel option is shown below.

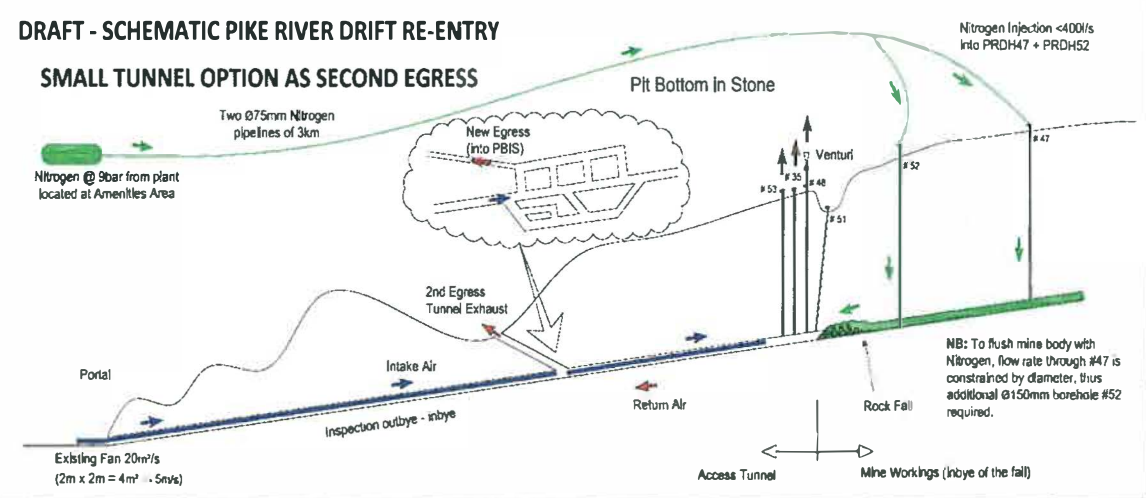
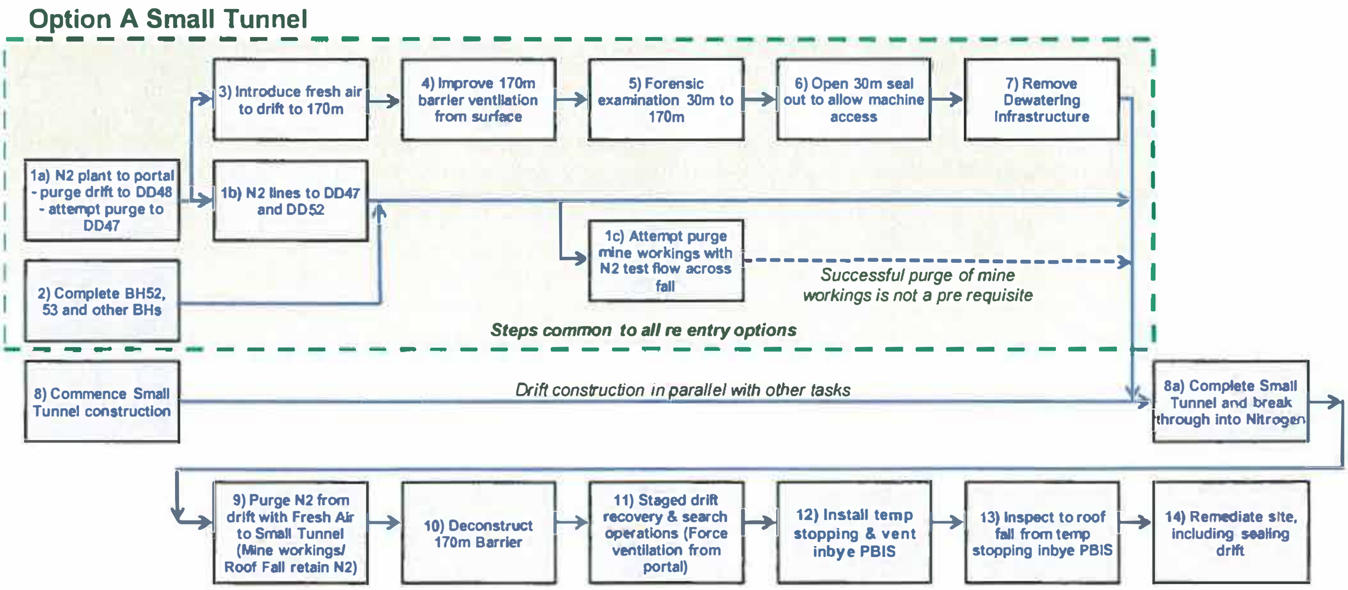


Figure 6. Small Tunnel - schematic

Description. Stages specific to the Small Tunnel option are as follows:



Flow diagram 2. Small Tunnel Step by step process

Small Tunnel The key differences between this option and the Single Entry is the driving of the small tunnel. This will provide a second means of egress and a return air ventilation circuit. Whilst compelling at face value the intrinsic challenges and additional risk in doing so are not insignificant. These are outlined on page 25-26. Further detail on this option can also be found in Attachments 1 and 2.

LD Borehole ventilation and egress option

A schematic of the Single Entry LDBH is shown below.

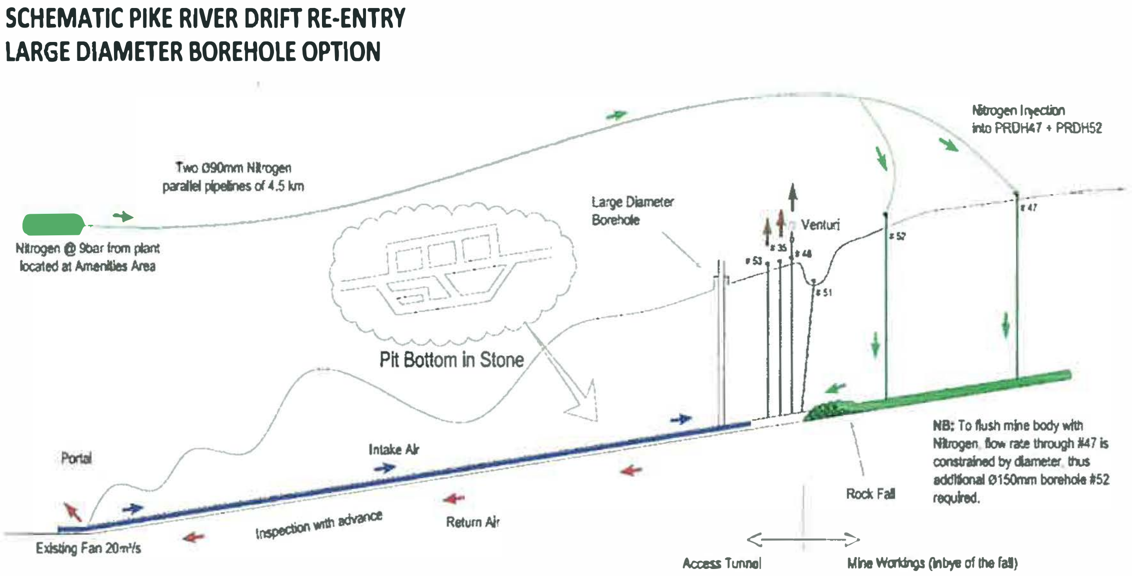
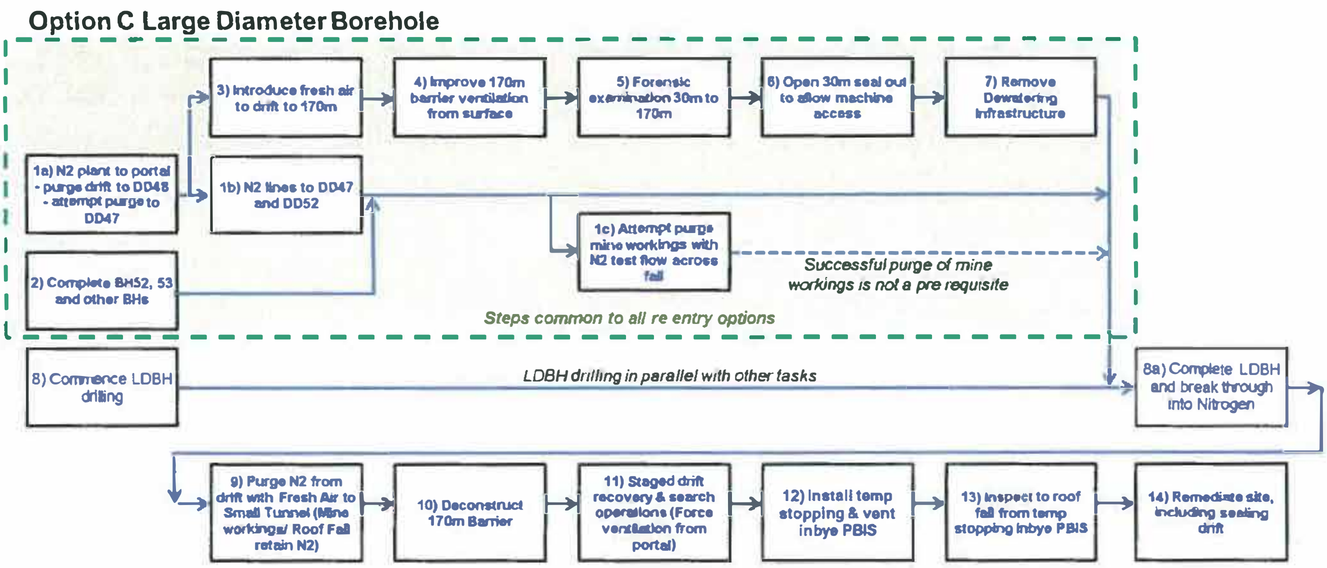


Figure 7. Single Entry with LDBH

Description. Stages specific to the Single Entry LDBH are as follows:



Flow Diagram 3. Step by step process Single Entry with LDBH

The key difference between the Single Entry with LDBH and the Single Entry is the drilling of an 800mm (600mm finished) borehole from the surface into the drift inbye of PBIS. The adds limited ventilation value but does provide the potential for an escape way in the event of entrapment. There are intrinsic challenges and risk with this option as outlined on pages 28-29. Further detail can be found in Attachments 1 and 2.

Ventilation

A detailed ventilation plan is being developed by the Technical Advisor ventilation experts for the Single Entry option and the Small Tunnel option. It will be submitted by 16th November 2018 and will be available on request. A summary report has been prepared and is attached at Annex B.

Basis of Design

Information and data describing the current mine and forming the basis of design for the three options, indicates the following:

The mine is now effectively sealed and contains a non-explosive methane rich atmosphere with a residual gas make less than 50-60l/s CH_4. This indicates that the proposed plan for managing the atmosphere in the coal workings, and across the fall with nitrogen, during re-entry is appropriate for all options.

Test work to date indicates that there is a leakage path through the fall indicating that application of nitrogen to PRDH52 will be successful. In any event, if there is not a leakage path through the fall then the risk of oxygen ingress is not present and the situation remains acceptable.

The ventilation capacity provided during re-entry to the body of the drift will be 15m^3/s but can be reduced to 7m^3/s for the section of drift approaching the fall inbye PBIS. These ventilation capacities can be provided by the proposed ventilation strategy for each option and are appropriate for design requirements.

For the purposes of the ventilation and gas management plan, the drift will be treated as coal mine ERZ1 but, as no coal or stone cutting is taking place, it is not a "working face" and minimum velocities do not necessarily apply. The overall strategy will be to alter ventilation rates as required to comply with prescribed methane concentrations and exposure concentrations for toxic or asphyxiant gases.

The need for 150mm diameter PRDH52 (N_2 injection inbye fall) and PRDH53 (exhaust in parallel with PRDH48 outbye fall) is confirmed by this work.

Nitrogen Injection Strategy

The provision of up to 420l/s nitrogen injection at up to 1 0bar is appropriate for design requirements, the configuration of boreholes and capacity of the proposed reticulation system during initial purging of the drift and during re-entry for all re-entry options.

This nitrogen injection capacity (420l/s) is appropriate for the volume of workings and magnitude of flow rates occurring during changes in barometric pressure.

The nitrogen injection strategy for initial purge of the drift then workings (initially from the portal then also from boreholes via the twin 90mm (76mmID hoses) is appropriate for all options.

The new ≈1,000l/s capacity venturi is not required for nitrogen purge and injection purposes but is required for exhaust capacity from the drift (PRDH48 and 53) for all options during re-entry.

Ventilation Strategy

The nitrogen injection and ventilation strategy and initial recovery of the drift to 170m is common to all options. This will involve ventilation of the drift to 170m using the existing portal fans (up to $15m^3/s$ with a single stage).

The ventilation strategy for access to the fall area is also similar for all options. This will involve an additional auxiliary fan or extension of the force ventilation system. The ventilation capacity will be at least $9m^3/s$ but could be more up to the 130% OC overlap capacity of the circuit (layflat force duct or Small Tunnel).

The main difference between options, in terms of ventilation strategy is that for drift re-entry phase.

Option A Small Tunnel – will be exhaust via the tunnel using existing portal fans for force ventilation

Option B Single Entry – using the portal fans and layflat duct installed in fresh air as they were during drift development.

Option C Large Diameter Borehole – will be essentially the same as Single Entry option. The 600mm borehole cannot provide sufficient ventilation capacity to avoid the need for a force ventilation duct and, in any event, could not be used for egress if it were also employed as an exhaust airway.

As the drift is not a "working face" and, subject to gas concentrations present, lower ventilation rates may be employed. During the re-entry process, the actual ventilation rates to be employed at any point in time will be specified by the appointed Ventilation Officer.

Comparative Analysis of Three Options

A discussion paper was prepared for the PRRA Executive Review Board that met on the 16th of October to consider the three options that had been developed and risk assessed. The discussion paper provides a simple comparison of some high level considerations against the three options for the safe manned recovery of the Pike River Mine Drift, developed by the Technical Expert Working Groups and Risk Analysis workshops. It is not definitive and was provided to inform some of the discussion of the 'Executive Review Board'. It is reproduced here.

Comparison of some high level considerations – a discussion paper

The underlying assumption is that all three options are technically feasible and can be undertaken safely.

There are costs and benefits/strengths and weaknesses with each option and PRRA must weigh all elements including technical (risk), political, economic, social, technological, legal, environmental and informational considerations when making its recommendation to the Minister.

The Risk Analysis facilitated by the Jim Knowles Group is the start point to inform the Board's recommendation - it is not the end state. "The Risk management process is one of on-going assessing, controlling, monitoring and reviewing. It is a dynamic system, which will be part of an overall Agency management process". PRRA recognises the substantial amount of work that is required before safe manned re-entry and recovery of the drift can begin, including but not limited to: detailed planning (design); Bowtie, Fault Tree Analysis and Event Tree Analysis of high level events; review and development of specific management plans, SOPs, TARPs, JHAs checklists, change management procedures… These will be developed in the coming weeks/months. Work previously conducted by SENZ is still relevant and will be reviewed, and updated where appropriate.

Small Tunnel

- **Time**:
    - **Decision Day (D Day)**
    - + 4-6 weeks **Design** work (could be current with consenting but assumes consent will be granted and that design not required for consent)
    - + 6-8 weeks **Consent** time High Risk notification to WorkSafe for a new entry into a mine is 3 months although this would be done concurrent, other notifications to WorkSafe are less time periods so would also be concurrent use of explosives 7 days, entry of mineworkers to a sealed area 7 days
    - 4-6 weeks **RFP** (could be concurrent with Consent process)
    - + 4-6 weeks **Site establishment** (includes Portal prep, tracks, ponds, working area and platforms, explosive storage comms… spec eqpt)
    - + 22 weeks **Driveage** –
        - based 235m (shortest option and no delays for poor weather or strata)
        - 1.8m/day
        - 6 days/week drive, 1 day services
        - 12 hr/day, 2 x crews, 7 days on: 7 off
    - **Total** 36-40 weeks. (before 170m barrier breached)
    - There are three other site options. These add 3, 14 and 26 weeks respectively to the driveage time plus associated costs
    - Assuming consents are not approved before Xmas closedown and that design work and RFP are done currently it is still unlikely that work on the site establishment will begin before March/April. The small tunnel break through is to occur before breaching the 170m barrier in order to ensure that the breakthrough occurs in N2. This will also establish the primary ventilation circuit. Therefore the 170m breach and forensic examination of the main drift is unlikely to begin before September 2019. This assumes that there are zero delays for weather or other unexpected events (eg strata failure).
- **Consents** – site location for a small tunnel will be inside the National Park boundaries but outside the current authorised area for PRRA activities. This will require DOC and Ministerial level approval which in turn will require the detailed portal site design including water treatment and spoil management.
- **Second means of egress** – the small tunnel provides the only viable option for a second means of egress. Whilst not required by law a second means of egress is highly desirable if it can be achieved without undue additional risk and it would appease potential adverse public perception. Notwithstanding the small tunnel will not provide a second means of egress for any entrapment in-bye Pit Bottom in Stone (PBIS) – an area of significant forensic interest. Further, any entrapment before the drift is recovered to PBIS will require those trapped to move through the tunnel in unknown conditions.

- **Primary ventilation circuit** – the small tunnel provides a primary 'through' ventilation circuit up to PBIS. This is generally considered a more robust option than a primary forcing ventilation circuit. Beyond PBIS an auxiliary return ventilation system is still required.
- **Portal location** – the potential locations of the portal for the small tunnel are in a very difficult gorged area of the Pike River. Factors such as flooding and slips will contribute to the complexity and hazards of this option particularly as much of the activity is likely to take place during the winter months of high rainfall and inclement weather.
- **Environmental factors** – water management, tree removal, spoil management, and 'footprint' are significant environmental factors that will require detailed planning in association with DOC and consenting authorities, and careful management to ensure continued public support.
- **Hazards** – there are 135 high level safety risks in this option and 351 safety risks identified overall. (raw ranking)
- **Adverse weather/Helicopter operations** – West Coast weather patterns during winter have the potential to significantly impact operations, particularly flying operations, which is a mission critical activity. It is estimated that the small tunnel has a requirement for +-2000 x underslung helo loads to remove spoil from the portal site. Additional flights will also be required to establish and disestablish the site. SENZ Steering Committee report identified that flying is possible only 30% of the time. In order to ensure minimum delay due to weather, sufficient storage for spoil and manoeuvre space will need to be developed potentially requiring heavily engineered platforms. There are two other potentially significant factors that affect rotary operations in the Pike river gorge/valley: first is the effect of the funnelling of wind down/up the valley, and the second is the flight path requirements for underslung loads – there is only one egress route – down the valley and therefore little room for error. Both of these factors potentially limit flight operations and would need to be fully risk assessed with the contracted helicopter company.
- **Cost** – estimated cost is approximately $49M based on the shortest tunnel option.
- **Rehablitation** – there is additional cost, and risk in disestablishing the infrastructure and re-sealing the tunnel.
- **Post closure management** – No additional monitoring will be required after seal is complete.
- **Security** – there are additional security considerations due to isolation of site, and explosives storage and use.
- **Explosives**. This is the only course of action that uses explosives. Whilst it is assumed that the main drift is sound, any weak or fractured strata could be further stressed by subterranean shockwaves from the blasting. Further study is required to fully understand the implications of blasting on the integrity of ground, particularly in the vicinity of the Hawera fault.
- **Exposure** – exposure (length of time based on number of shifts required to complete work) during the main drift recovery will be the same for all options. It will be mitigated in part by the operational cycle that uses three crews (recon, forensics, and mine services). Whilst one crew is working two are resting. JHAs will provide additional management controls specific to length of exposure for particular tasks. The additional length of exposure for the small tunnel is 22 weeks (11 weeks for each crew). Calculations have been based on two crews, 12hr shifts, 6 days blasting/1 day services and seven days on seven off. Detailed design work with contractor involvement will determine the optimum work schedule.

- **Uncertainty and complexity** – The small tunnel is by far the most complex and uncertain of the options considered. A combination of factors including the consenting process, weather, strata conditions, and environmental factors, all of which are outside the control of the Agency to one degree or another, contribute to a plan that has additional layers of complexity and risk (over the single entry option) that must be managed. The impact of 'loss of time' through weather delays or unexpected strata conditions has the potential to add significant cost and time. Notwithstanding, the advantages of a second egress will appease public perception around safety and there are some benefits to a primary ventilation circuit that would be achieved through this option.

Single Entry

- **Time**:
  - 2 weeks **Consent** time (High Risk notification to WorkSafe for single entry development which would apply is 1 month although this would be done concurrent, other notifications to WorkSafe are less time periods so would also be concurrent use of explosives 7 days, entry of mineworkers to a sealed area 7 days)
  - 0 weeks **Design** work (no unique to this option design work is required)
  - 0 weeks **RFP** (re-entry will be led and undertaken primarily by PRRA)
  - 0 weeks **Site establishment** (no additional work unique to this option is required)
  - **Total** 12 weeks (before 170m barrier breached)
  - Based on the Ministerial decision process that approves this option before the end of November 2018 it is likely that work to re-enter the drift will begin before January. It is expected that the breaching of the 30m seal followed by the forensic examination and deconstruction of the water management infrastructure will take six weeks. Breaching the 170m barrier and subsequent recovery and examination of the drift could begin as early as March/April 2019.
- **Consents**. No new consents are anticipated for this option beyond the BH52, BH53 and BH54 that are common to all options. The level of DOC consent for these boreholes is held at regional level.
- **Second means of egress**. The single entry option has no second means of egress. . Whilst not required by law a second means of egress is highly desirable if it can be achieved without undue additional risk, and it would appease potential adverse public perception. The NZ public will need assurance of the PRRA culture of: safety first; dynamic and iterative risk analysis, review and management processes; robust control measures; and 'best mining practice'.
- **Primary ventilation circuit**. The single entry option relies on a primary forcing ventilation circuit. This ventilation solution is common in mining and tunnelling around the world. However it is generally accepted that it is not as robust as a primary 'through' ventilation circuit. An auxiliary ventilation system may also be required beyond PBIS (this will be confirmed in the Ventilation plan).
- **Portal location**. No additional portals are required.
- **Environmental factors**. Water management, tree removal, and spoil management are already consented and managed within existing processes and procedures, and approvals.

- **Hazards**. There are 118 high level risks identified for this option and 308 hazards overall. (based on raw risk)
- **Adverse weather/Helicopter operations**. West Coast weather patterns during winter have the potential to significantly impact operations, particularly flying operations which is a mission critical activity. However there is no additional flying required that is unique to this course of action. SENZ Steering Committee report identified only that flying is possible only 30% of the time. This may create delay to operations 'on the hill' but it is unlikely to be material to the timeline or budget of this option.
- **Cost**. The estimated cost is approximately $36M. This option is the least costly.
- **Rehabilitation.** There are no additional rehabilitation requirements unique to this option.
- **Post closure management.** Monitoring at the main portal will be required in all three options and will be developed as part of the post closure management plan.
- **Security**. There are no additional security considerations.
- **Exposure.** Exposure within the main drift recovery will be the same for all options. It will be mitigated in part by the operational cycle that uses three crews (recon, forensics, and mine services). Whilst one crew is working two are resting. JHAs will provide additional management controls specific to particular tasks.
- **Uncertainty and complexity** – The single entry is the simplest plan of those considered and has the most certainty. This is not to suggest that it is straightforward, rather that the large majority of risks and uncertainty in 'single entry' are common to all options. It is not affected to the same degree as the other options by the consenting process, weather, uncertainty of strata conditions, and environmental factors. However the ventilation plan and its execution is more involved/complex and less robust than the primary 'through' ventilation circuit of the small tunnel. The NZ public will need assurance of the PRRA culture of: safety first; dynamic and iterative risk analysis, review and management processes; robust control measures; and 'best mining practice'.

Single Entry with Large Diameter Borehole (LDBH)

- **Time**:
  - 4-8 weeks **Design** work (will need to be undertaken prior to consent process)
  - 4-6 weeks **Consent** time (DOC but likely to require Ministerial approval) High Risk notification to WorkSafe for single entry development which would apply is 1 month although this would be done concurrent, other notifications to WorkSafe are shorter time periods so would also be concurrent, entry of mineworkers to a sealed area – 7 days. This option could also fall under new entry into a mine - 3 months)
  - 4 weeks **RFP** (concurrent with consent process)
  - 6 weeks **Site establishment** (includes platform development, establishment of drill rig. Living space will already be developed for BH52 & 53)
  - 8 - 10 weeks **Drilling** May need to wait until after completion of BH52 & 53
  - **Total** 26 - 28 weeks (before 170m barrier breached).
  - Based on the Ministerial decision process that approves this option before the end of November 2018 it is still unlikely that the design work will be completed before end January (Xmas closedown); the consenting process and RFP by mid-March; and site preparation including commissioning of the drill rig, end of April. Breaching the 30m seal and deconstructing the water management infrastructure could be undertaken concurrently with the drilling programme. Therefore breaching the 170m barrier and subsequent recovery and examination of the drift could begin as early as mid-July 2019. This timeline leaves very little contingency for delays.

- **Consents**. The site location for the LDBH will be inside the National Park boundaries but outside the current authorised area for PRRA activities. This will require DOC and possibly ministerial level approval which in turn will require the detailed drill site design including spoil management plan.
- **Second means of egress**. The single entry LDBH option has no second means of egress. Whilst not required by law a second means of egress is highly desirable if it can be achieved without undue additional risk and it would appease potential adverse public perception. The NZ public will need assurance of the PRRA culture of: safety first; dynamic and iterative risk analysis, review and management processes; robust control measures; and 'best mining practice'. The LDBH does provide an 'in extremis' escape way – but this will have a 'look and feel' of the solution used at Pike River Mine that contributed to the tragedy.
- **Primary ventilation circuit**. This option provides the potential for a primary 'through' ventilation circuit up to the LDBH. This will be examined as part of the detailed ventilation plan. This is generally considered a more robust option than a primary forcing ventilation circuit. An auxiliary ventilation system may also be required beyond the LDBH. However the LDBH cannot be used simultaneously for an escapeway and ventilation.
- **Portal location**. No additional portals are required.
- **Environmental factors**. Environmental footprint, spoil removal and water management will be key issues to plan and manage in this option.
- **Hazards**. There are 134 high level safety risks identified for this option and 342 safety hazards overall. (raw risk)
- **Adverse weather/Helicopter operations**. West Coast weather patterns during winter have the potential to significantly impact operations, particularly flying operations which is a mission critical activity. This option relies heavily on helicopter operations to support the drilling crews and remove the spoil. It is estimated that 500 x underslung loads will be required to remove spoil and a further 200 x underslung loads to plug the LDBH on completion. SENZ Steering Committee report identified that flying is possible only 30% of the time. In order to ensure minimum delay due to weather, sufficient storage for spoil and manoeuvre space will need to be developed potentially requiring heavily engineered platforms.
- **Cost**. The estimated cost is $41M (approx.)
- **Rehabilitation.** The LDBH will need to be permanently sealed and all infrastructure removed. Additional monitoring will not be required.
- **Post closure management**. No additional 'unique to this option' monitoring will be required after re-sealing is complete.
- **Security.** There are no additional security considerations.
- **Exposure.** Exposure within the main drift recovery will be the same for all options. It will be mitigated in part by the operational cycle that uses three crews (recon, forensics, and mine services). Whilst one crew is working two are resting. JHAs will provide additional management controls specific to different tasks. The length of exposure on the hill for the LDBH is + 28 weeks including establishment and disestablishment. These calculations have been based on two crews, 12hr shifts, and seven days on seven off. Detailed design work with contractor involvement will determine the optimum work schedule.
- **Uncertainty and complexity –** The LDBH option is more complex and uncertain than the single entry option. It is yet to be determined whether there are the skills or the drilling rig in NZ to undertake the LDBH drilling. The plan requires an 800mm (600mm finished), borehole to be 'blind drilled' into an underground roadway – this process does not have the surety of raise bore drilling. A combination of factors including the

consenting process, weather, drilling conditions, and environmental factors, all of which are outside the control of the Agency to one degree or another, contribute to additional layers of complexity and risk that must be managed. The impact of 'loss of time' through weather delays or unexpected drilling conditions has the potential to add significant cost and time. A winch mechanism will need to be designed and engineered. Notwithstanding, the advantages of an escapeway may help appease public perception around safety and there may be some benefits (albeit minimal) to a primary ventilation circuit that could be achieved through this option.

Risk Assessment

The planning and risk assessment workshops were attended by a combination of internal and external subject matter experts. The list of participants and their record of attendance is at Annex D.

On the 8th and 9th of August, Agency staff along with specialist ventilation and geotechnical advisors from the Technical Panel and representatives from NZ Mines Rescue Services and NZ Police were brought together to carry out an externally facilitated, detailed task analysis for each of the three options. This preliminary work informed the Workplace Risk Assessment and Control (WRAC) process undertaken during the first phase of the risk assessment. The report is attached as Attachment 3.

Phase One of the Risk Analysis was conducted over the period 10 – 21 September. The process was inquisitorial and iterative with scope to examine options in depth. It was externally facilitated by the Jim Knowles Group from Australia.

Agency staff, technical experts and specialist stakeholders including the Family Reference Group, WorkSafe NZ, the Mines Rescue Service, Department of Conservation (DOC) and NZ Police generated input into the Risk Analysis. Phase One Risk Analysis formally analysed the risks in each aspect of the Concept Plan for re-entry and recovery of the drift and its forensic examination; through to handover to the DOC.

Some sessions were also open to members of the public and media who were invited to observe. The purpose was to ensure that the process in addition to being rigorous was also open and transparent.

A subgroup of the team assembled for the Risk Analysis also examined risks associated with the non-underground/non-technical components of the Agency's mission through the conduct of a PEST(I)LE analysis activity on the 18th September.

	VH-25	VH-20	H-16	H-15	H-12	H-10	M-10	M-9	M-8	M-6	M-5	M-4	L-4	L-3	VL-2	VL-1	
Option A (Small tunnel)																	
Safety	0	2	1	19	94	19	0	70	59	27	8	10	35	5	2	0	351
Environment	0	0	0	0	0	1	0	1	10	4	0	1	6	0	1	0	24
Reputation	0	1	1	7	17	19	1	13	16	12	4	2	8	0	2	0	103
Value	0	1	1	1	6	15	9	14	24	37	1	0	62	6	15	0	192
Option B (Single entry)																	
Safety	-	1	0	16	83	18	0	64	48	27	8	27	10	5	1	0	308
Environment	-	0	0	0	2	0	0	1	3	2	0	5	0	0	1	0	14
Reputation	-	1	1	6	12	19	1	10	10	8	4	4	4	0	1	0	81
Value	-	1	1	1	4	17	5	7	21	24	2	45	0	3	12	0	143
																1	
Option C (LD Borehole)																	
Safety	0	1	0	23	94	16	5	68	51	32	8	3	32	7	2	0	342
Environment	0	0	0	0	3	3	0	1	7	5	0	1	8	0	2	0	30
Reputation	0	1	1	11	24	16	9	16	14	14	5	1	6	0	1	0	119
Value	0	1	1	2	8	14	14	14	29	41	3	1	54	3	13	0	198

Table 1. Phase I Risk assessment - Workshop 1 – raw risk

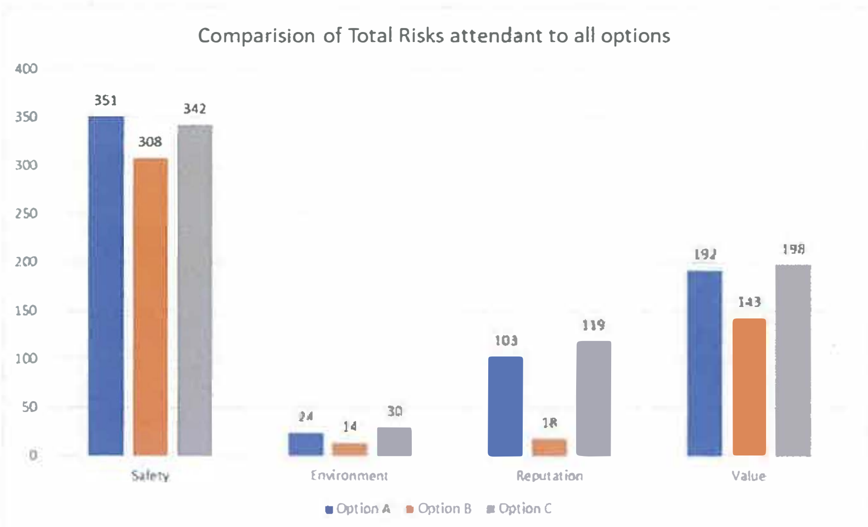


Table 2. Comparison of total risks – all options

Phase Two was the peer review of the risk analysis for all three options. This was held over a two day period and involved a detailed examination of the high risks for each option. The mandate of the review was to fully critique and review each of the proposed options and to assess the adequacy of the proposed control measures identified in the risk assessments, then to re-rank the residual risk. Members of the public and media were also invited to parts of these sessions. The results of the residual risk ranking of high level risks is at Table 3.

Risk Review Analysis (Phase II) of Very High & High Risks from Phase I Risk Assessment

	Total VH & H R (PH 1)	VH-25	VH-20	H-16	H-15	H-12	H-10	Total VH & H R (PH 2)	M-10	M-9	M-8	M-6	M-5	M-4
Option A (Small tunnel)														
Safety	135	0	0	0	0	1	23	24	0	0	68	2	5	8
Environment	01	0	0	0	0	0	1	01	0	0	0	0	0	0
Reputation	45	0	0	0	0	3	18	21	0	0	16	0	4	6
Value	24	0	0	0	0	0	9	09	0	0	1	0	2	2
Option B (Single entry)														
Safety	118	0	0	0	0	1	21	22	0	0	69	0	5	7
Environment	02	0	0	0	0	0	1	01	0	0	0	0	0	0
Reputation	39	0	0	0	0	3	17	20	0	0	8	0	4	4
Value	23	0	0	0	0	0	8	08	0	0	2	0	4	2
Option C (LD Borehole)														
Safety	134	0	0	0	0	1	30	31	0	0	74	0	7	8
Environment	06	0	0	0	0	0	4	04	0	0	0	0	1	0
Reputation	53	0	0	0	0	11	23	34	0	0	11	0	7	5
Value	26	0	0	0	0	0	9	09	0	0	2	0	7	4

Table 3. Review Analysis (Phase II) of Very High and High Risks from Phase I Risk Assessment - residual risk

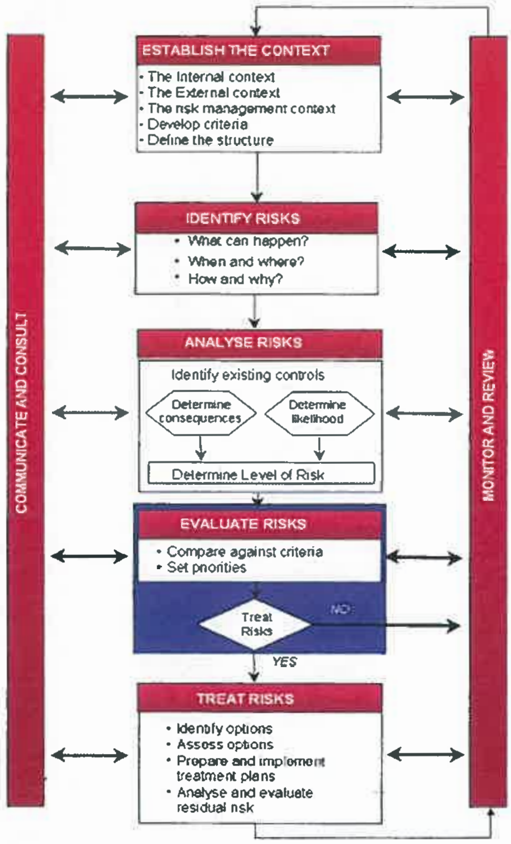


Figure 7. Risk Management Process – in detail (AS/NZ/ISO31000:2009)

Cost

The Single Entry option is estimated to cost +/- $36M

The Small Tunnel option is estimated to cost +/- $49M

The Single Entry LDBH is estimated to cost +/- $41M

Detailed Costings. The detailed cost estimates are at Annex E. These costs are best estimates based on technical knowledge and professional judgement of subject matter mining experts. A factor of between 0% and 15% contingency has been incorporated into areas of lesser of greater uncertainty, for example: erection of a stopping – low uncertainty = 3% contingency; ground support high uncertainty = 15% contingency. An additional contingency of 15% has also been included for delays due to consent process, or adverse weather which are likely to impact the Small Tunnel or Single Entry LDBH options – this may be overly optimistic. *Table 4* below provides high level costs of key activity for the preferred option Single Entry.

Contingency. Levels of contingency and uncertainty vary with regards to each specific task. For example if a task is normal mining practice with a low level of uncertainty 3% contingency has been allocated to that task, such as building a stopping in a tunnel. If a task has a high level of uncertainty surrounding it, 15% and higher contingency has been allocated. (Contingency is not just accounted for in dollar figures or percentages – it can refer to extra time for a particular activity or in the case of ground support, for example, allowing for a greater proportion of the drift to be supported). Because of the location of the mine site in such a dynamic environment and a huge dependency on helicopter flights, time is largely the unknown factor, best estimates have been calculated based on past experience up at Pike River and this has been incorporated into the contingency. High contingency tasks are outlined below:

- **Underground electrical equipment and power** (Nitrogen plant running 24/7, electrical equipment certified for use in a coal mine, power will only be known once the first electricity bill is received post nitrogen operations)
- **Drilling operations** (unknown geological conditions and inclement weather conditions increase time which directly affects the overall cost)
- **Contracted labour** (drift support labour, drilling operators, ventilation contractors, statutory mine officials, Mines Rescue Personnel)
- **Mine Site Staff costs** (increased amount of staff due to not using a primary contractor to carry out drift re-entry work)
- **Helicopter operations** (flying personnel on and off the hill during 24/7 de-gassing operations as well as drilling operations, flying hours have been based on 60hours per week)
- **Insurance** (unknown at this stage what insurance is needed once underground operations begin, insurance figure estimates have been modelled off current underground operations in NZ ~1.5M)
- **Tunnel re-support activities** (tunnel roof and rib conditions are largely unknown at this stage, for the purposes of the budget re-supporting 25% of the drift was accounted for and the numbers are based on previous mining experience when re-supporting a tunnel. Even though the re-support costs may be accurate, the condition of the drift is unknown hence why a high level of uncertainty was allocated to this task)
- **Agency life cycle** (This is directly affected by time, the longer the project runs the higher the cost to keep the Agency running. Monthly costs to keep the Agency running are reasonably fixed and have a low level uncertainty associated with it.)

- **Rehabilitation** (DOC expectations are unknown at this stage and this will have a bearing on the level the Agency will have to go to, to satisfy expectation. The Agency is working closely with DOC throughout the whole project and full disclosure will be submitted to them prior to re-entry work finishing.

Legal Compliance

All three options are consistent with the general requirements set out in the Health and Safety at Work Act 2015, the specific requirements set out in the Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016, and other relevant legislation. The preferred option, Single Entry, has two characteristics in particular that were fully debated:

- With regard to a second means of egress. The Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016 s170 **Escapeways in underground coal mining operation** states that (1) "The mine operator of an underground coal mining operation must ensure that the mining operation has at least 2 exits trafficable on foot (**escapeways**) to the surface that are separated in a way that prevents any reasonably foreseeable event happening in 1 of the escapeways that may stop a person from being able to escape through the other escapeway" It further states in Schedule 1 **Transitional, savings, and related provisions** under Existing mining operations "**2 Transitional provision for escapeways in underground coal mining operation** "Until 16 December 2024, nothing in regulation 170(1) applies to an existing mining operation that is an underground coal mining operation" Pike River mine is classified as a working underground coalmine.

- With regard to force ventilation. The Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016 s143 **Quantity and velocity of air** (1) states that "The mine operator must ensure that (a) the volume of air passing through an active working face, other than a longwall working face, is not less than 0.3 cubic metres per second for each square metre of normal development cross-sectional area and (b) the volume of air passing through an active longwall working face is not less than 4 cubic metres per second for each metre of extracted height in the face. (2) The mine operator must ensure, in respect of any underground part of a mining operation where a mine worker is doing work or may travel, that the air in that part is provided at an adequate quantity and velocity to ensure that the mine worker will not be exposed to a concentration of dust that is likely to cause injury or illness to the mine worker". For the purposes of the PRRA Single Entry ventilation and gas management plan, the drift will be treated as coal mine ERZ1 but, as no coal or stone cutting is taking place, it is not a "working face" and minimum velocities do not necessarily apply. The overall strategy will be to alter ventilation rates as required to comply with prescribed methane concentrations and exposure concentrations for toxic or asphyxiant gases and dust as per (2) above.

Both issues were raised and debated at the various workshops. WorkSafe NZ was attendant at each workshop and we were guided by their advice. PRRA recognise that there is still work to be done in the detailed design of the ventilation and gas management plan (complete 16th Nov 2018) and the detailed gas monitoring plan however there is nothing to suggest that the Single Entry option will not be compliant with the pertinent regulations. PRRA is commissioning a further independent review of this important piece of the plan and we will continue to engage with and be guided by WorkSafe NZ.

Assurance

Assurance through peer review, challenge syndicates, active listeners and independent observers has been a foundation stone for the development, planning process and the risk analysis of the three courses of action presented here. At all times an environment of challenge and robust discussion was encouraged to ensure that the plans that were developed were as sound as possible and the risk assessment robust. External facilitators ensured that the debate stayed on point and that all had their opportunity to contribute. The risk analysis process included daily sessions open to the public and media to provide a higher degree of transparency to the discussion. Assurance throughout the process included the following:

- Embedded independent observers/advisors from external agencies (WorkSafe NZ, NZ Mines Rescue, Department of Conservation, NZ Police);
- Internal peer review by the Technical Advisors, PRRA staff, Worksafe NZ representatives, NZ Mines Rescue representative;
- External peer review by Independent Reviewers involving questions, comments and recommendations relating to the workshop notes, the appendices and the draft revised plan reports;
- Review by FRG advisors and representatives;
- Review and approval by CE and COO;
- Overarching governance level assurance by advisor to the Minister.

A table of attendance at the various workshops and peer reviews is at Annex D. Following the submission of this report it will be subjected to further reviews by NZ Police; the Minister Responsible for Pike River Re–entry, and WorkSafe NZ. We welcome each of these reviews as well as the scrutiny of the NZ public once this body of work is published on the Pike River Recovery Agency website. Our intent is to ensure that we commit to, and execute, the safest and most robust plan possible for recovery of the drift. Review and assurance will be an ongoing process as we progress with the detailed design work for each phase.

Conclusion

This report reflects the work of the Agency and it partners over the past six months. Through a process of 8 workshops, three technically feasible courses of action for a safe manned re-entry and recovery of the Pike River Mine drift were developed and subsequently risk assessed. The executive review board taking into consideration the risk analysis and the wider considerations of a non-technical nature, concluded that whilst all options were technically feasible, the Single Entry posed the least risk, was the simplest plan to execute and provided the most certainty with respect to factors outside the control of the Agency. The Single Entry option is estimated to cost approximately $36M and completion time for recovery estimated to be circa August 2019 with handover to DOC by the end of December 2019.

This body of work is the start point for the detailed design of each task and phase of the operation that must now take place to ensure successful execution of the plan. Risk assessment is not a static process rather it is dynamic and iterative and will require a disciplined approach to planning, training, rehearsals, and the daily operational routine at the mine site. A culture of safety first must be embedded into the Agency and all those involved in the operations. There is a lot that is unknown underground and we must ensure that our mindset, and management processes and procedures are sufficiently agile to pause, reassess, readjust and reset if necessary when confronted with the unexpected. We are confident that we have the plan, the talent and the capability to prosecute this operation successfully.

Finally, I note here that our partnership with the FRG has been fully productive and the Agency appreciates the support and commitment they have provided throughout this process.

Certification

The recommended preferred Single Entry Option referred to in this report is certified to be:

- Technically feasible
- Achievable safely; and
- Consistent with the general requirements set out in the Health and Safety at Work Act 2015, the specific requirements set out in the Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016, and other relevant legislation

Recommendation: It is recommended that the Single Entry option using a force ventilation system be approved for final design work and subsequent execution to re-enter the Pike River mine and recover the drift.

Ma whero ma pango ka oti ai te mahi

Standards

Health & Safety at Work Act 2015

Health and Safety at Work (General Risk and Workplace Management) Regulations 2016

Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016

Health and Safety at Work (Worker Engagement, Participation, and Representation) Regulations 2016

Mines Rescue Act (2013)

Mines Department Guidelines (NSW)

Mines Rescue protocols

Ventilation Approved Code of Practice

Fire or Explosions Approved Code of Practice

Ground or Strata Instability Approved Code of Practice

Air Quality Approved Code of Practice

Emergency Preparedness Approved Code of Practice

AS/NZS ISO 31000:2009, Risk Management – Principles and Guidelines

References:

Steering Committee Report to the Health and Safety Committee of the Solid Energy New Zealand Limited on the Re-entry Options into the Pike River Mine Drift dated 04 Nov 2018 (Privileged/Confidential).pdf

Solid Energy New Zealand Limited Pike River Drift Re-entry Project Fault Tree Analysis of Potential Unwanted Top Level Events (In Confidence).pdf

Solid Energy New Zealand Limited Pike River Drift Re-entry Project Event Tree Analysis Draft Report Re-issued (In Confidence).pdf

Engeo Pike River Portal Geotech Assessment Final.pdf

Pike River Mine Tunnel Portal Inspection_21_06_2018.docx

DOC Pike River Heliport Assessment 2017 – OPUS

DOC Pike River Bridge Inspection Report 2017 – OPUS

DOC Access Arrangement Information MP 41453 Pike River Recovery Agency 24/7/18

Memorandum of Understanding; Parties: Pike River Recovery Agency and Department of Conservation dated 14 February 2018

Pike River As-Built Report completed by URS 15/7/2014.pdf

ANNEX A

Work Programme

Key details, up to the breaching of the 30m seal, include the following:

Scope

Outline and plan the critical job steps/tasks before breach of the 30m seal commences. Resources need to be assigned to each task, a timeline established (start + finish), ascertain the materials required and the overall plan documented. This plan will be a guide to ascertain whether we are under resourced and is also a quality control check that our timeline is accurate/achievable. The purpose is not to identify risks associated with each job as that is covered by JHA's, RA's etc. The estimated timeframe to breach the 30m seal is mid-February 2019.

1. **Nitrogen System Commissioning**

    - **Timeline**- (01/10-5/11/18)
    - **Resources**- Three people being 1x BOC and 1x PRRA, 1x Ventilation Officer
    - **Materials required**- Gaskets and all nitrogen gear is onsite, supplied by BOC
    - **Overall plan**- Memoss (primary plant) commissioning complete, however cryogenic (secondary plant) unit commissioning to be completed 5 November. Two days' work with BOC and Agency staff involved. Flow meter system to be up and running by the time cryogenic unit is running.
    - **Actions**- JHA completed by [redacted] and reviewed by [redacted] Dinghy will send letter to WorkSafe advising what is happening. Ventilation change form to be completed. Check all actions, as per nitrogen plant risk assessment, are completed prior to the commencement of nitrogen injection.
    - **Potential delays to the job**- No delays have been identified due to all gear and materials already onsite.

2. **Nitrogen System Electrical Work**

    - **Timeline**- (01/10-5/11/18)
    - **Resources-** 1x PRRA employee
    - **Materials required-** Pipe section for orifice plate to be connected to spare tube in TBS. Nitrogen valve price to be confirmed for 7x valves (offshore supplier, lead time to be confirmed)
    - **Overall plan-** All electrical work has been completed on both the primary and secondary nitrogen plants
    - **Actions-** Final incident for flash over report to be submitted to PRRA by Electronet (Dinghy)
    - **Potential delays to the job-** No delays to this part of the electrical work.

3. **Installation of steel Nitrogen Line from Amenities to Portal**

- **Timeline**- (22/10-9/11/18)
- **Resources-** 4x contractors, 2x PRRA if required
- **Materials required-** Non-return valve at injection point
- **Overall plan-** Cleaning of the 300mm line to be completed 26/10/18, reduced to 150mm pipe to White Knight bridge 29/10/18, further reduction to 100mm from sub-station to portal 2/11/18
- **Actions-** Add task to JHA placing 100mm pipe to portal. Add 300mm line flushing with water to JHA
- **Potential delays to the job**- Lack of personnel to complete the job.

4. **Installation of the Rapid Remote Sealing Emergency Doors**

- **Timeline**- (23/10-19/11/18)
- **Resources**- 2x engineering contractors, 4x scaffolding contractors, 4x PRRA
- **Materials required-** Scaffold, bolting equipment, drill steel and drill bits, chemicals, emergency doors, vent bags, air fans, chain hoists, Hiab
- **Overall plan**- doors have been fabricated, scaffolders have been onsite to quote for the job, installation of scaffold to be installed. Bolting to be completed prior to doors onsite
- **Actions**- Ventilation trial prior to installation, JHA to complete, inertise the drift and have fresh air at the 140m TBS point. Ventilation change form to be completed. Organise contractors and scaffolders to be onsite. JHA to be reviewed by Ventilation Officer. Introduction to site for all machinery and equipment brought in by contractors
- **Potential delays to the job-** Steel nitrogen lines to be installed at the portal. Nitrogen purge to happen before the commencement of installation of the doors.

5. **Installation of the 90mm nitrogen line**

- **Timeline-** 20/12/18
- **Resources**- 6x PPRA
- **Materials required-** 90mm poly pipe (9km), joiners, manifolds, strops, valving systems, winch, chainsaw, communications (radio, sat phone), and tools
- **Overall plan-** first 3km of pipeline arriving on-site 2/11/18, unloaded at CHPP. Fly 4x PPRA personnel on to the hill and walk out. Discuss the line and plan around helicopter pad upgrades and track upgrades (last part of track down to portal). Spinning jenny lay out the pipes in 100m lengths. Split guys in two teams from CHPP and on the hill. Fly 5x lengths at any one time
- **Actions**- JHA to be completed. Personnel involved are PRRA, [redacted] (facilitator) helicopter pilot. Separate JHA to be completed with Electronet for helipad upgrades and track upgrade

- **Potential delays to the job-** Inclement weather, personnel busy with other tasks i.e. installation of emergency doors. Supplier delay pipe turning up to site.

6. **Electrical work to be completed on the hill**

- **Timeline**- Comms by 1/12/18, electrical work for nitrogen plant 7/1/2019
- **Resources**- 2x PRRA, 1x contractor for splicing
- **Materials required**- Battery packs, solar panels and generators, firefighting equipment
- **Overall plan-** Install generator, install battery back-up system, communication system and control systems
- **Actions**- To be purchased: 6kVa generator, battery back-up system, communication systems, control systems, separate system for PRDH47 (nitrogen). JHA for electrical work on the hill.
- **Potential delays to the job**- problem with the fibre cable. May have to run an additional line.

7. **Drilling operations**

- **Timeline** (19/11/18- 11/02/19)
- **Resources**- 4x drillers, statutory official, control room operator
- **Materials required**- Drillers, drill rigs, casing, helicopter, drilling fluids. Top of hole arrangement to be confirmed in JHA
- **Overall plan**- Drilling operations to commence early December. Drill PRDH 52, 53 & 54. Plan to drill 52 and 54 in parallel. 12 hour operation for drilling
- **Actions**- Preferred drilling company to be appointed. Risk Assessment to be completed prior to the job. DOC approval for all drill holes (work programme). Inspect 100 lengths of SW 150mm drill casing currently stored at Pike site
- **Potential delays to the job-** Inclement weather, unknown geological conditions, personnel unavailable. 150mm casing delay due to not being in country.

8. **Electrical work required for underground reticulation system**

- **Timeline**- Before March 2019
- **Resources**- Underground qualified electricians (contractors)
- Materials **required**- To be confirmed once preferred re-entry option has been decided. Trailing cables, load centre, portal transformer
- **Overall plan-** 1000volt system for underground to run realtime, re-establish transformer, DAC system, telephone system
- **Actions**- Procurement of 1000volt underground system, flame proof equipment from Australia, JHA to be completed for underground electrical work. Pi system to be purchased.

- **Potential delays to the job**- Materials coming from overseas, lead time.

Below is a summary table and timeline outlining the key project milestone tasks and dates for the Pike River re-entry project.

The milestone dates are a project KPI which are monitored and reported on a weekly basis.

DATE	TASK	STATUS
30 April - 3 May 2018	Initial Technical Expert Alliance workshop	complete
13 – 14 June 2018	Further detailed planning session (ventilation & Geotech)	complete
8 – 9 August 2018	Detailed task analysis	complete
September/October 2018	Determine pressure difference between portal and boreholes	complete
10-21 September 2018	Risk assessment phase 1	complete
28 September 2018	Tender Helicopter work	commenced
01 October 2018	Electricity re-establishment	complete
1-2 October 2018	Risk assessment phase 2	complete
12 October 2018	Rapid remote sealing emergency doors fabrication	complete
16 October 2018	Final risk review phase 3 (decision)	complete
18 October 2018	Tender specialist mining equipment	commenced
19 November 2018	Recruitment of mineworkers	commenced
23 October 2018	Tender Drilling surface boreholes	commenced
26 October 2018	Commissioning of nitrogen plant	complete
31 October 2018	Final report to Minister	
	Post 31 October 2018	
01 November 2018	Additional camera work borehole 47	
03 November 2018	Installation of steel nitrogen pipeline to portal	commenced
31 January 2019	Upgrade the gas sampling system from 10 – 20 points	
16 November 2018	Final detailed ventilation plan delivered	commenced
19 November 2018	Pike River anniversary	
30 November 2018	Purge the drift with nitrogen	
30 November 2018	Purge the drift with fresh air	
20 December 2018	Rapid remote sealing emergency doors installation	
20 December 2018	Installation of twin poly nitrogen lines to boreholes	commenced
31 December 2018	Critical mining equipment on site	
31 January 2019	Upgrade of helipads	
Mid-April 2019	Decant methane from drift and mine workings	
Mid-February 2019	Breach 30m seal	
March 2019	Breach 170m seal	
31 August 2019	Drift recovered and forensic examination complete	
31 December 2019	Drift sealed and handed over to DOC	

ANNEX B

Ventilation Plan Summary

Report on: **RISK ASSESSMENT ACTIVITY FOUR: VENTILATION PLANNING**

Key Tasks 7d and 8a.

Prepared By :

Robin Hughes - PRRA

Roy Moreby - Morvent Mining

Borys Poborowski – Terra Firma Mining

John Rowland - Dallas Mining Services

For : PRRA

Reference : Dinghy Pattinson

Document : Initial written, step-by-step schematics for Options A & B

Revision : Version 3

Date : 28th October 2018

1. **Foreword:** This document has been prepared in compliance with Risk Assessment Activity Four: Ventilation Planning (dated 23-25 October 2018) to satisfy the requirement of Key Tasks 7d and 8a. It is noted that the task refers to 'testing'. The results of roof-fall permeability testing, nitrogen delivery calculations and mine atmospheric behaviour analysis are quite extensive and technically complex. They have been excluded on the basis that, in their current form, are outside the context of what this document is intended to convey and will be included in the final ventilation report, referred to below. Note that the word 'recovery' is used to infer the delivery of fresh air to a previously irrespirable atmosphere in the drift, it has no relevance to geotechnical or forensic recovery of the drift.

2. **Purpose:** The purpose of this report is to offer a brief descriptive summary and set of step-by-step schematics to provide an overview of the ventilation steps for each of these options, pending the delivery of a comprehensive ventilation report by 16th November 2018.

3. **Definitions:** Acronyms and mining terms used in the context of this report are as follows:

   Decant/decanting – The removal of methane or nitrogen from the drift or mine workings.
   Drift – A 2300m stone drive driven in metasedimentary gneiss. (refer Fig. 1)
   HHGD – Hand-held gas detector.
   Mine workings – All roadways and excavations carried out within the coal seam. (refer Fig. 1)
   PBIS – Pit Bottom in Stone. This is a series of roadways that has been developed in stone adjacent to the drift between 1800m and 2000m from the portal. (refer Fig. 1)
   Portal – The entrance to the drift, located adjacent to White Knight Stream (refer Fig. 1)
   PRDH – Pike River Drill Hole.
   RL – Reduced level. Elevation of a given point relative to a common datum (usually sea-level).
   Roof fall – A collapse of roof strata near the point where the stone drift entered the coal seam. Thought to be extensive but known to be permeable.
   TBS – Tube bundle system, a series of small-diameter tubes which deliver air samples to a gas analyser.
   Venturi – A compressed air powered ventilation device used to increase airflow.
   Telemetric system – a system of gas analysis that can be read in real time.
   VCD – Ventilation control device. A stopping, seal, barrier or screen.

4. **Key Assumptions:** The detailed task analysis identified three options for re-entering the drift. Subsequent risk analysis concluded that all options can be conducted safely and are technically feasible.

   Option A – small tunnel. This option proposes that a small (2x2) tunnel be driven from a suitable site adjacent to Pike Stream, breaking into the drift at Pit-Bottom-in-Stone (PBIS).

Option B – single entry. Re-entry will be conducted in stages from the portal by advancing the ventilation system in predetermined increments. Forcing ventilation will be used for this option.

Option C – large diameter bore hole. A ventilation strategy was not requested for Option C and therefore it is not included this report.

A plan of the mine showing referenced locations and boreholes is shown in Fig. 1.

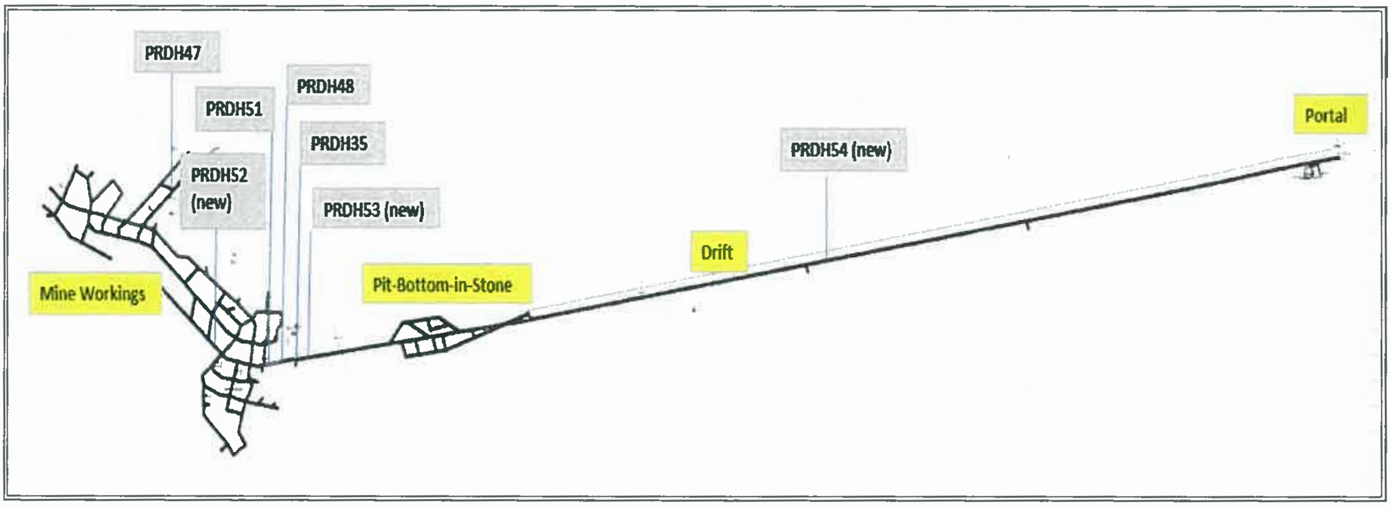


Figure 1: Mine Plan with referenced locations and boreholes

5. Summary of Ventilation Strategies

5.1 Actions common to all options

1. Nitrogen injection, methane decanting to atmosphere and subsequent nitrogen decanting to atmosphere is mandatory for all options.
2. Two additional 150mm diameter boreholes will be drilled to facilitate nitrogen injection in addition to methane decanting (PRDH52 – inbye the drift) and nitrogen decanting (PRDH53 – outbye the roof fall).
3. An additional 50mm diameter borehole will be drilled to establish a mine atmosphere monitoring point between the portal and PRDH35 monitoring point (designated PRDH54 – Approximately 1600m from the portal (drill site to be confirmed)).
4. Venturis will be operated on PRDH48 and PRDH53 at certain stages of the reventilation process. These will require continuous manning when in operation and manually or remotely operated valves.
5. Low-current 1000-volt electricity is required in the drift from the portal to supply a telemetric (real-time) gas monitoring system.
6. TBS tubes will be extended as recovery progresses. Locations as per detailed plan.

7. The drift will be purged with nitrogen from the 30m seal. Methane will be decanted through PRDH48 (in the drift) and PDH47 (in the mine workings) during this initial purging.
8. Emergency doors will be erected ~5m inbye portal (site of existing portal gates).
9. Fresh air will be introduced into the drift inbye the 180m point via one of the spare 250mm drainage pipes through the 30m seal.
10. The 30m seal will be partially opened, the 30-170m section of the drift re-entered with ventilation duct extended and the doors closed in the 170m barrier.
11. 1.4m ducting will replace the smaller ventilation ducting when the 30m seal is opened out for machine access.
12. The dewatering infrastructure will be removed from drift between the 30m seal and 170m barrier.
13. All geotechnical evaluation/remediation and forensic examination work will commence from the portal following re-ventilation.

5.2 Option A – Small tunnel

1. Prior to the small tunnel being broken through into PBIS, the drift will be maintained in a nitrogen-inert state. (Fig. 2)

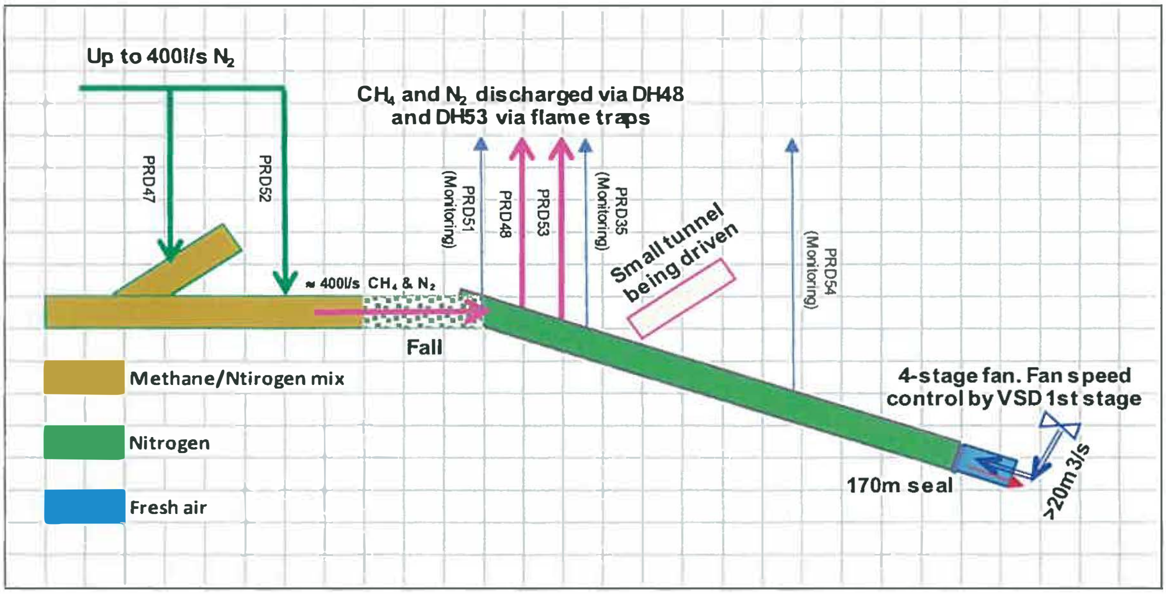


Figure 2: Nitrogen atmosphere in drift prior to break-through

2. The main fan is running to ventilate up to 170m seal.
3. Machine air-lock doors constructed at 30m point, Doors remain open and protected from self-closing prior to break-through.
4. When break-through is imminent, extend the fresh air fringe in the drift to 180m TBS point (and monitoring <3% oxygen at the PRDH54 TBS point) using venturis at PRDH48 and 53 to draw fresh air through the drain in the 170m seal (bend removed).

5. When effective break-through confirmed, partially open the 170m barrier; disconnect 1.4m diameter ducting inbye the machine air-lock; close the machine air-lock doors. (Fig. 3).
6. Increase fan speed to deliver >20m3/sec, nitrogen cleared from drift (2 - 3 hours allowing for several air exchanges).
7. Deconstruct 170m seal.
    a. Geotechnical evaluation/remediation and forensic examination work commences from the portal.
    b. TBS and telemetric monitoring systems and communications extended as recovery of drift progresses.

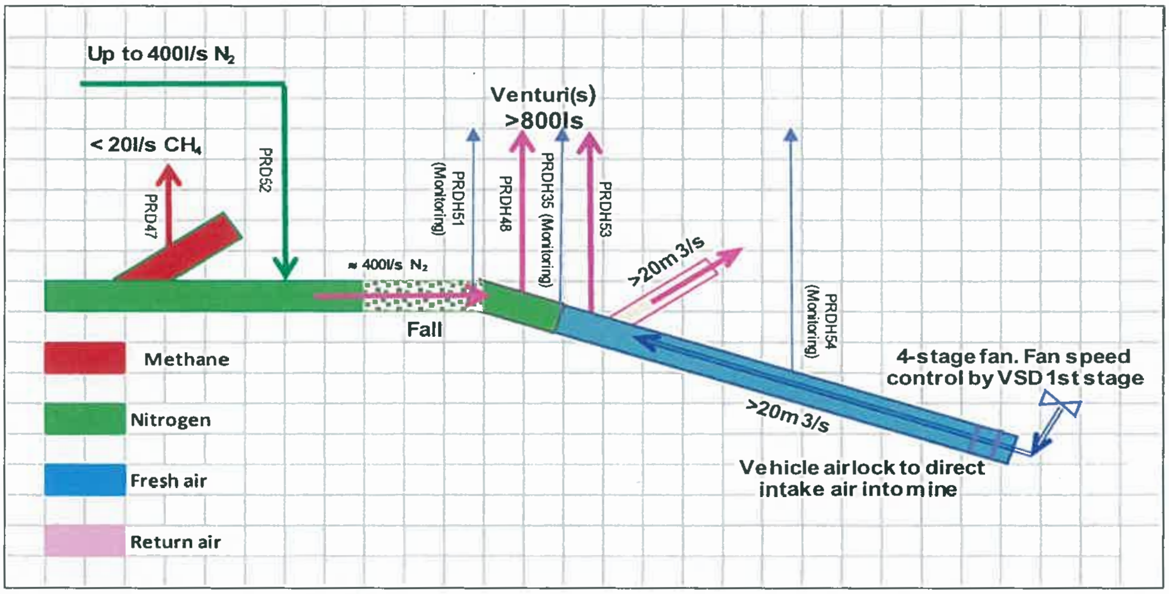


Figure 3: Small tunnel ventilation arrangement post break-through

8. Undertake ventilation arrangements to ventilate PBIS.
9. Construct VCD inbye PBIS. *

*Required due to the extended period required for forensic work to be conducted in PBIS.

10. Fresh-air introduced inbye PBIS via drainage pipe in VCD, monitored at PRDH35.
11. VCD deconstructed (or entry through airlock doors) when fresh air at PRDH35 monitoring point.
12. Install a suitable ventilation arrangement to ventilate remainder of drift from the VCD to roof fall. This will be a slow deliberate process to avoid forcing air into the fall area.
    a. Electric fan c/w exhaust or force ducting installed on the surface at the small tunnel portal.
    b. Electric fan c/w exhaust or force ducting installed underground at a suitable location.
13. Construct rated seal in close vicinity to roof fall. (Fig.4)

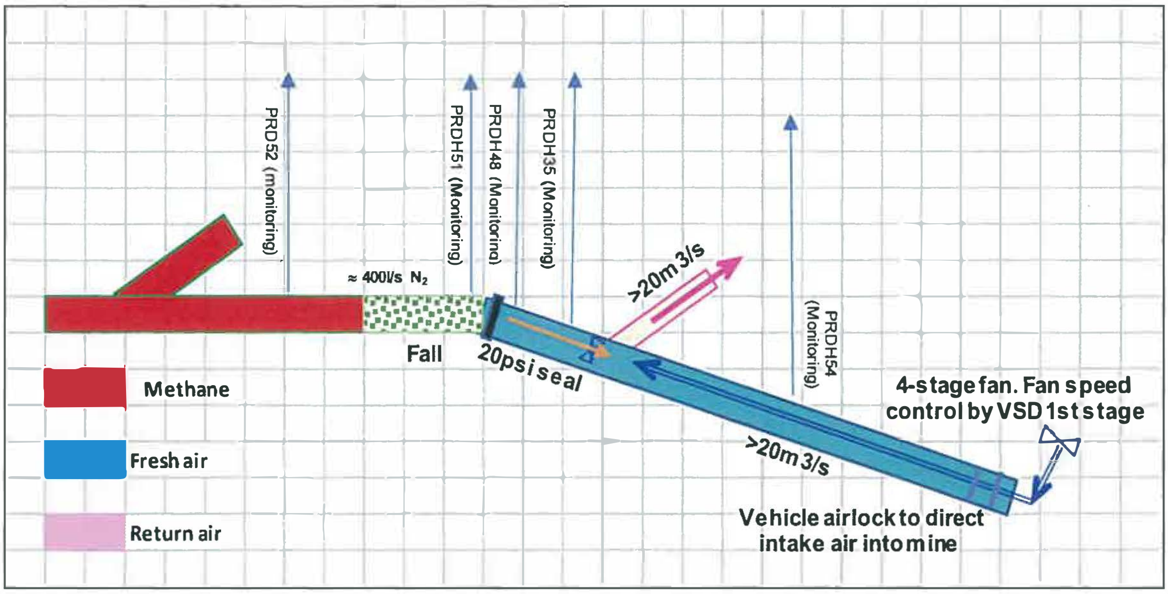


Figure 4: Option A - Drift re-ventilated, fall sealed

5.3 Option B – Single Entry

1. Nitrogen-inertisation of the mine workings will continue throughout the re-entry phase to maintain a positive static pressure inbye the roof fall, relative to the drift.
2. Re-ventilation will be incremental using force-ventilation. The duty of the 4-stage fan will be increased commensurate with advance. Beyond the ventilation arrangements common to both options (detailed in 5.1), the following defined stages have been identified:
    a. Extend the fresh air fringe in the drift to the PRDH54 TBS point using venturis at PRDH48 and 53 to draw fresh air through the drain in the 170m seal (bend removed); breach the 170m barrier
    b. Recovery of the drift from 170m seal to PRDH54. A pause in advance is planned 200m outbye of the PRDH54 monitoring point to consolidate and verify the process prior to resuming recovery. The 1.4m diameter lay-flat duct will be extended in 5m 10m or 20m lengths, depending on the application and circumstances. (Fig. 4)
    c. Recovery of the drift from PRDH54 to PBIS. Control of the nitrogen-fresh air fringe will be maintained by adjusting the nitrogen injection rate at the inbye boreholes and by adjusting the exhaust rate of the venturis. A diffuser will be attached to the end of the ventilation duct from this point to maintain control of the ventilation pressure thus avoiding unwanted fresh air penetration beyond the planned advance point. (Fig, 5)
    d. Reventilation of PBIS. It is anticipated that accumulations of methane in this area will be confined to isolated pockets due to the PBIS roadways being at a significantly lower RL than the collar of the decanting boreholes (PRDH48 and PRDH53). Normal degassing procedures will be used for the

recovery of PBIS (removal of residual nitrogen and isolated methane accumulations.

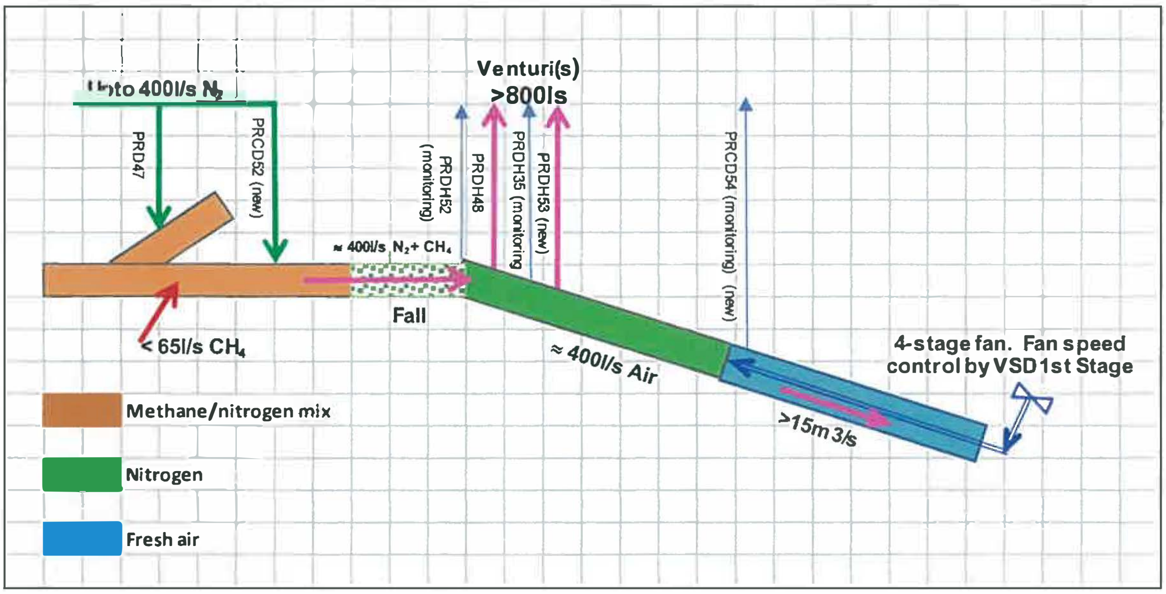


Figure 5: Recovery of the drift from portal to PRDH54 sampling point.

e. Construction of a VCD1 inbye PBIS. Process described in 5.2 – 9 above.

f. Reventilation of PBIS to PRDH53. Process described in 5.2 – 10 and 11 above. The venturis may be shut down at this stage, subject to methane management. Inbye nitrogen injection maintained, possibly at a slower rate.

g. Reventilation of PRDH53 to the rockfall in slow increments, monitoring constantly with HHGD. Safe working conditions in terms of airflow will be maintained using a dissipater to avoid forcing fresh-air into the roof fall. It is considered prudent to advance immediately to the rockfall (wooden walkways required over the debris field and recognising the possibility of remedial roof support) and to construct a rated VCD. This is in recognition of the prolonged period that may be required for forensic examination of the extensive spread of explosion-propelled debris. (Fig. 6)

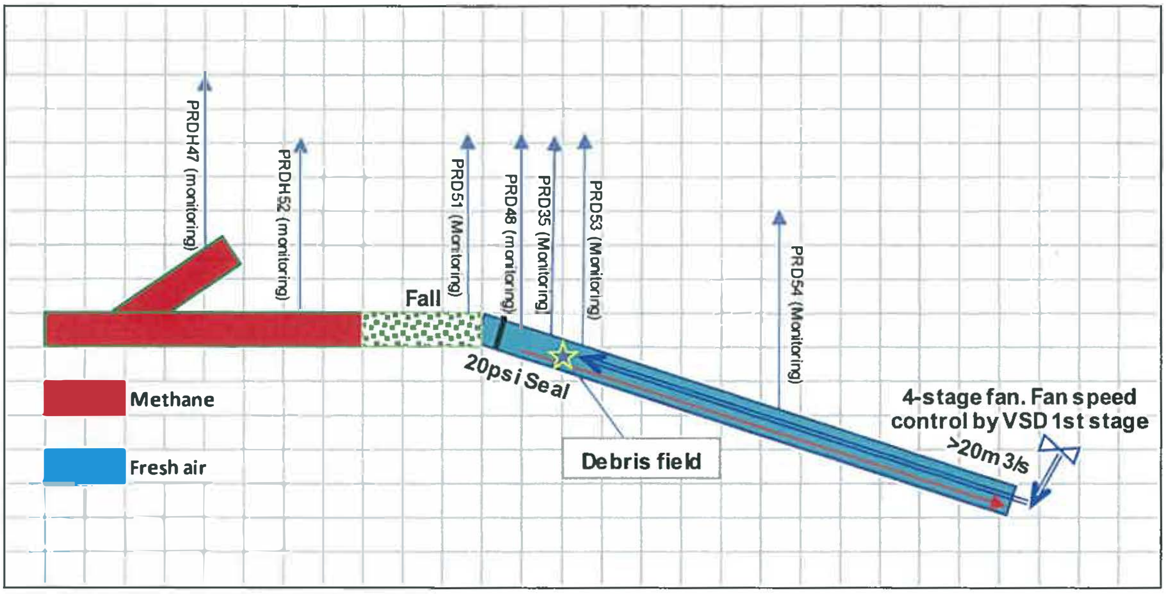


Figure 6: Option B, drift reventilated, fall sealed

6. Concluding the project

Both ventilation options will provide an end state where the drift is effectively ventilated, and the mine workings are sealed with a rated VCD (Type C – 20psi) pending a decision on the future of the mine. It should be noted that a seal maintenance regime and mine atmosphere monitoring programme will be required in the interim.

End of document

ANNEX C

NEW ZEALAND POLICE SUPPORT TO PIKE RIVER RECOVERY AGENCY INITIAL FORENSIC EXAMINATION PLANNING CONSIDERATIONS

1 INTRODUCTION

1.1 On 31 January 2018 the Pike River Recovery Agency (PRRA) was established by an Order in Council. The strategic objectives of the Agency are to conduct a safe manned re-entry and recovery of the Pike Mine drift to:

1.1.1 Better understand what happened at the Pike River Mine in 2010 and help prevent future mining tragedies;

1.1.2 Give the Pike River families and victims closure and peace of mind; and

1.1.3 Recover remains where possible.

1.2 The New Zealand Police operation in support of the PRRA is a crucial aspect to the outcome of this project. Forensic examination of as much of the Pike Mine drift as safely possible focuses on the collection of evidence and the repatriation of any human remains found is the main supporting effort.

1.3 This plan outlines the initial planning considerations for the Police operation.

2 SITUATION

2.1 PRRA is conducting a formal risk assessment process to examine the three re-entry options recommended to the Minister Responsible for Pike River Re-Entry (the Minister). The review of this process concludes on Tuesday 16 October 2018 with a high-level review panel examining the recommendations made by the risk analysis workshop and the subsequent review of that analysis.

2.2 The Chief Executive of PRRA has requested an overview plan for the supporting Police forensic examination of the drift, should formal permission to re-entry the drift be granted.

3 MISSION

3.1 New Zealand Police are to provide forensic examination planning and expertise on re-entry to the Pike Rive mine drift in order to assist the PRRA achieve its strategic objectives

4 EXECUTION

4.1 __Purpose__: To carry out a forensic examination of the Pike River mine drift to locate and recover any human remains if possible, and to search for evidence relating to the investigation to establish the cause of the explosion that claimed 29 lives.

4.1.1 Key Tasks:

- Selection of appropriately qualified and capable police forensic specialists

- Procurement of specialist equipment for underground forensic operations

- Completion of task specific training programme for police personnel to conduct underground operations
- Completion of task specific training programme for PRRA underground staff in specialist police roles such as Disaster Victim Identification (DVI), search techniques, exhibit handling and photography

- Forensic examination of the Pike River mine drift, from the portal to as close to roof fall as technically feasible, including a detailed search of the portal environs and sediment ponds

- Engaging qualified experts to examine underground electrical equipment and infrastructure, both in-situ and above ground if possible, and obtaining expert reports on the findings.

5 ENDSTATE

5.1 Complete a forensic examination of the drift to enable the recovery, identification and safe return of any human remains if possible, in consultation with the Pike River families and local Iwi; and to locate evidence relating to the cause of the explosion in accordance with best practice and evidential standards.

6 OVERVIEW

6.1 Prior to the re-entry of the drift, police will carry out a forensic search of the area surrounding the portal, including the river bank opposite and the section of the drift outbye of the 30m seal. The planned examination will include forensic photography, laser scanning and surveying as well as a full forensic search of the area by Police Specialist Search Group (SSG).

6.2 The responsibility for providing safe manned re-entry of the drift in fresh air sits with the PRRA. Part of that role includes progressively deploying reconnaissance teams defined distances into the drift to assess the geotechnical integrity of that immediate area. Made up of underground staff, the primary purpose of this reconnaissance is to ensure that the drift is safe, and carry out hazard mapping. The teams will also carry out a 'forensic scan' in order to assist the forensic search team to plan the next phase. Once all safety checks and hazard mapping are done, necessary make-safe work will take place to ensure that area of the drift is safe to enter.

6.3 Once that has occurred, hand-over to the forensic search team will be formalised and in writing. The search area will be defined by the underground staff and marked. The size of the area is restricted by ventilation requirements and/or any hazards or obstacles encountered within the search zone, and is expected to be around 40m in length. The area will be forensically examined by search teams who will be accompanied by a contingent of underground staff for safety. The first stage will be digitally recording the area by way of photography, 3D laser scanning and mine surveyor.

6.4 The next stage features the search team that will replace the digital imaging team. Accompanied by underground staff, the search team will physically search the drift and any items, infrastructure and electrical equipment within that zone. Items of interest will be located, photographed, marked and plotted before being examined in-situ and/or seized for further examination by experts.

6.5 Once the forensic team has completed the search of the designated zone and all exhibit handling procedures have been completed, responsibility for the drift will be formally handed back to PRRA and the search teams will withdraw from the drift. Mining operations will take place to bring forward underground services to the edge of the cleared zone and remove any obstacles from the drift to allow access by underground vehicles up to that point. The safety reconnaissance phase will be repeated by underground staff who will proceed into the next area of drift to be searched, conducting and work required to make the drift safe before formally handing back to the forensic search team.

6.6 The forensic recovery process will repeat itself in stages of 40m at a time as outlined; made safe by PRRA experts, forensically photographed, scanned, surveyed and searched by the forensic team then handed back to PRRA at the completion of the search.

7 PHASES

7.1 The forensic examination of the Pike River mine drift will be conducted in four main phases, with a preliminary and sequel phase.

7.2 Preliminary Phase: This phase of the examination focusses on the area outside the portal, the river bank and the area 0m – 30m. It is planned for early November and can be carried out by Police staff without requirements for underground training or close supervision by PRRA staff, however there are zoning restrictions on cameras and equipment within the 5m exclusion zone.

7.3 Phase 1: **30m – 170m**. This phase involves dealing with the weirs and infrastructure located within this zone. The mine water will be diverted to the sediment ponds via a screen. The weirs will be pumped out to allow for the contents of the weir to be manually removed from the drift and searched on the surface. After the area is visually recorded and forensically searched, the infrastructure will be removed by PRRA to allow machine access to beyond the 170m barrier.

7.4 Phase 2: **170m – PBIS.** This phase involves the staged forensic recovery of the drift by way of the iterative process outlined above, whereby control of the 40m search zone alternates between PRRA and the forensic teams as progress is made along the drift. This phase will deal forensically with remote controlled robots, a loader, the conveyor belt and other items of interest.

7.5 Phase 3: **Pit Bottom in Stone.** This phase will focus on a methodical and extensive search of PBIS, utilising various electrical experts to examine the range of electrical equipment, pumps, variable speed drives and transformers installed in that area. The size of some items of equipment precludes removal to the surface for examination; in these instances expert investigation will occur in-situ. Search teams will comb through the coal processing area; large sumps, screens and flumes that may contain evidential material.

7.6 Phase 4: **PBIS – Roof Fall.** This area contains both challenges and opportunities. In terms of PRRA operations, the challenges involve controlling the migration of fresh air over the roof fall and ensuring the structural integrity of the strata in known problem areas, such as the Hawera fault. In terms of the forensic search teams, challenges exist in overcoming debris fields. Draft plans include the use of temporary stopping(s) inbye PBIS to control the nitrogen fringe, and progressive installation of roof supports to allow forensic examination to take place over shorter distances. The final search of the zone inbye of any temporary stopping and the roof fall may well be limited to a visual search by mines staff in BA.

7.7 Sequel Phase: Sediment ponds and any material removed from the weirs and drift. Areas will be set aside to allow for solid material to be spread out and dried before being searched. A plan will be developed to search the contents of the sediment ponds to ensure no evidential material is present.

8 TRAINING

8.1 Training of operational personnel will be carried out prior to the commencement of any underground operations. Selected police staff will be trained in underground procedures by Mines Rescue Service at the MRS facility at Rapahoe. This training will include a visit to the Oceana Gold underground mine in Otago to familiarise staff with underground conditions. Selected PRRA staff will be trained in DVI procedures, search techniques and exhibit handling practices. This training will be provided by specialist police at the Mines Rescue Station at Rapahoe.

8.2 Numbers of police staff able to undertake the Mines Rescue training course and underground induction at Oceana Gold is limited to 20, with scope for one additional member of PRRA. The number of PRRA staff to undertake DVI and search training has been estimated at 10. Preliminary dates set down for this training to occur is 26 November – 7 December 2018.

8.3 Joint training of police and PRRA staff will allow for:

8.3.1 A common understanding between PRRA and police of the procedures, conditions, equipment and terminology in use during the operational phase to recover the drift.

8.3.2 The ability of the selected police personnel to deploy underground, either as part of an authorised and planned forensic search examination, or alternatively in-extremis due to a significant discovery or occurrence that requires immediate underground deployment by police, for example discovery of mass fatalities.

8.3.3 In the event that police are not authorised to deploy underground, it allows for the ability of trained PRRA staff to carry out the underground forensic examination of the drift, closely supported by police on the surface.

8.4 Selected Police staff likely to be trained include:

Specialist Search Group (SSG)	11
Disaster Victim Identification (DVI)	3
Forensic Photography	2
Exhibit Group	2
Investigation Group	2
TOTAL	**20**

9 LOGISTICS

9.1 Underground operations will require Police to procure and supply specialist equipment to support the health and safety of its personnel and the conduct of the forensic operation. The following items are indicative of the items required:

- Specialist PPE, including respirators, gloves, overalls
- Intrinsically safe lighting, both mounted and hand held units
- Intrinsically safe camera and 3D recording equipment
- Non-metallic tools and crime scene aids
- Medical support supplies
- Exhibit bags, labels, storage boxes
- Office furniture, cabinets, shelving
- Computers, phones, printer/scanner, radios

COMMAND AND CONTROL

Role	Rank / Name	Cell	Email
Officer In Charge	Detective Superintendent Pete Read	[redacted]	[redacted]
Investigation Manager	Detective Senior Sergeant Grant Collins		
O/C SSG	Senior Sergeant [redacted]		
O/C DVI	Inspector [redacted]		
O/C Photography	Senior Sergeant [redacted]		
O/C Exhibits	Detective [redacted]		
File / Exhibits	Detective [redacted]		

10 POLICE OPERATIONS BASE – PIKE RIVER MINE SITE

10.1 Main Police Block: During the re-entry operation police will operate from one of the buildings in the amenities block at the mine site. The designated building is a stand-alone single storey structure, situated south of the main administration building containing the control room and lamp room, and is currently used by contractors employed by the Department of Conservation working on the Pike 29 track. It will be vacated prior to operations commencing.

10.2 The amenities block will be shared with Mines Rescue Service who currently have a dedicated area at the northern end of the building for equipment. The MRS room can be locked off from the remainder of the Police area, with independent access. This will enable police to lock down the remainder of the building to non-authorised personnel.

10.3 Security plans for the building, including new locks for the exterior and interior doors, are currently being developed by MBIE as part of the overall security plan for the Pike River Mine Site. Police are consulting with MBIE as to operational security requirements.

10.4 Secure Vehicle Bays: A second area will be set aside exclusively for police use. This area is adjacent to the lamp room and features a covered concrete area with four large vehicle bays. The bays will have lockable gates installed and each bay will be screened off.

11 EXHIBITS AND EQUIPMENT STORAGE

11.1 An area within the secure Police Block will be set aside as a dedicated secured exhibits store. The secure store will be used to hold small to medium sized exhibits seized as part of the forensic examination of the drift. Responsibility for managing the Exhibit Store will be that of O/C Exhibits: Detective [redacted] To ensure evidential integrity, best practice procedures will be followed as set out in a detailed Exhibit Management Plan.

11.2 Large exhibits such as mining plant, vehicles or equipment removed from the drift for further examination and/or storage will be secured in the designated secure covered area adjacent to the lamp room. Large exhibits will be stored and examined in this area.

11.3 DVI: The Disaster Victim Identification team will operate from one of the rooms in the Police base. An area outside the Police base has been set aside for the placement of a refrigerated shipping container for DVI use in the event that human remains are located in the drift. Further details on the size and placement of the DVI container will be covered in the Exhibit Management Plan.

11.4 SSG: Specialist Search Group will be based within the Police block. There will be a secure area set aside for storage of the groups' equipment and clothing along with an administration area. In terms of searching, the bulk of the searching work will be done underground, however in some cases material from the drift will be physically removed in containers and transferred to a designated area for drying and searching by SSG staff. Clean up and hose down activities will comply with all resource and environmental consents.

11.5 Coordination of all specialist police groups within the designated police areas, including deployment in and out of the mine drift during search operations, and movement within the overall site environs shared by PRRA and contractors will be set out in the Scene Coordination Plan, yet to be drafted.

12 COMMUNICATIONS

12.1 Police Information and Communications Technology (ICT) group are currently looking at existing infrastructure and signal strengths at the Pike River Mine Site in order to assess communication options for Police staff working on the various phases of the forensic examination of the drift.

12.2 Computer Network: Police ICT have carried out preliminary investigations into current site communication infrastructure and radio repeaters. Those investigations indicate that it may be possible to utilise existing fibre optic lines and establish a fibre link between the Amenities block and the Police Network via the Greymouth Police Station. This would enable Police to install sufficient connections at the Operations Base at the mine site to meet DVI, SSG, Exhibit and Photography requirements, as well as providing scan / print facilities and desk phones.

12.3 Radio Network: Initial investigations by ICT indicate that Police radios will operate within the environs of the amenities block (excluding the exclusion zone) to allow communications between staff working on the surface.

ANNEX D

Pike River Recovery Agency Workshop Attendance Table

Pike River Recovery Agency Workshop Attendance Table

ANNEX D

Note: denotes "Active Listener" or non-technical status (present at activity but not actively influencing)

NAME	AREA	ORGANISATION	ROLE	Concept Dev 30 Apr-03 May 18	Concept Refine: 12-13 Jun 18	Peer Review Activity: 29 Jun 18	Detailed Task Analysis:08-09 Aug 18	Forensic DTA 21 Aug 18	WRAC: 10 – 21 Sep 18	Formal Review: 01-02 Oct 18	Executive Review: 16 Oct 18	Detailed Vent Planning: 23-25 Oct 18
Dr. Roy Moreby	Technical	Morvent Mining	Ventilation Engineer	✓	✓					✓		✓
John Rowland	Technical	Dallas Mining	Ventilation Engineer	✓	✓					✓		✓
Lincoln Smith	Technical	TerraFirma Ltd	Mining Operations	✓	✓							
Stuart MacGregor	Technical	TerraFirma Ltd	Geotechnical Engineer	✓	✓				✓	✓		
Robin Hughes	Technical	PRRA	Ventilation Engineer	✓	✓		✓		✓			✓
Mark Edwards	Technical	Kenyon International	Forensic Specialist	✓								
Iwan Witt	Technical	Kenyon International	Forensic Risk Management	✓								
Craig Smith	Technical	TerraFirma	Mining Engineer	✓								
Borys Poborowski	Technical	TerraFirma	Ventilation Engineer	✓		✓				✓	✓	✓
Chris Lee	Technical	OEC	Geotechnical Engineer	✓	✓		✓			✓		
Victor Romero	Technical	McMillian Jacobs	Geotechnical Engineer	✓		✓				✓	✓	
Dave Stewart	Technical	Minserv	Mining Engineer	✓	✓					✓		
Darryn Brady	Technical	Serinus Pty	Gas Chemist	✓		✓				✓		
Tony Forster	Technical	Advisor to Pike Families	Mining Engineer		✓					✓	✓ (D)	
Andy O'Loan	Technical	MBIE	Mining Advisor							✓		
Gavin Forsyth	Technical	Independent Miner	Shift Supervisor						✓			
Richard Banks	Technical	Independent Miner							✓			
Vincent Wehner	Technical	Independent Miner							✓			
Doug Burt	Technical	Independent Miner	H & S Advisor							✓		
Geoff Rubbo	Technical	Independent Miner								✓		
Richard Tacon	Technical	Bathurst Mining (CEO)	Mining Executive								✓ (D)	
Rob Fyfe	Advisory	Advisor to Minister	Risk Management Executive		✓				✓	✓	✓	
Dave Gawn	Management	PRRA	Chief Executive	✓	✓		✓		✓	✓	✓ (D)	
Dinghy Pattinson	Management	PRRA	Chief Operating Officer	✓	✓		✓	✓	✓	✓	✓ (D)	

Greg Duncan	Operations	PRRA	Mine Underwriter	✓			✓			✓		
NAME	**AREA**	**ORGANISATION**	**ROLE**	**Concept Dev 30 Apr-03 May 18**	**Concept Refine: 12-13 Jun 18**	**Peer Review Activity: 29 Jun 18**	**Detailed Task Analysis:08-09 Aug 18**	**Forensic DTA 21 Aug 18**	**WRAC: 10 – 21 Sep 18**	**Formal Review: 01-02 Oct 18**	**Executive Review: 16 Oct 18**	**Detailed Vent Planning: 23-25 Oct 18**
Kirk Neilson	Operations	PRRA	Mine Deputy	✓			✓		✓			
Matt Coll	Operations	PRRA	Mechanical Superintendent				✓			✓		
Danie Du Preez	Operations	PRRA	Electrical Superintendent	✓			✓		✓			
Barry McIntosh	Operations	PRRA	Control Room Supervisor	✓			✓		✓			
Tjaart Heersink	Operations	PRRA	Engineering Assistant	✓			✓		✓			
Lloyd Steward	Management	PRRA	Senior Project Manager						✓	✓	✓	
Priscilla Page	Advisory	WorkSafe NZ	Mines Inspector	✓					✓			
Dave Bellett	Advisory	WorkSafe NZ	Deputy Chief Inspector	✓						✓		
Bryan Harrington	Advisory	WorkSafe NZ	Mines Inspector	✓	✓				✓		✓	
John Ewen	Advisory	WorkSafe NZ	Mines Inspector		✓				✓			
Trevor Watts	Advisory	Mines Rescue NZ	General Manager	✓	✓		✓			✓	✓	
Paul Moffitt	Advisory	Mines Rescue NZ	Station Manager	✓					✓			
Andrew Watson	Advisory	Mines Rescue NZ	Training Manager	✓								
Brian Robinson	Advisory	Mines Rescue (UK)	Independent Advisor (Families)		✓							
Anna Osborne	Pike Families	Family Reference Group	Chairperson	✓	✓		✓	✓	✓	✓		
Bernie Monk	Pike Families	Family Reference Group	Member	✓	✓		✓		✓	✓		
Sonya Rockhouse	Pike Families	Family Reference Group	Member							✓		
Rob Egan	Pike Families	Family Reference Group	Advisor	✓	✓							
Tony Sutorius	Pike Families	Family Reference Group	Advisor		✓				✓			
[redacted]	Pike Families	Family Member	[redacted]						✓			
[redacted]	Pike Families	Family Member	[redacted]						✓			
Emma Cummins	Corp Support	PRRA	Assistant to FRG Chair				✓	✓	✓	✓	✓	✓
John Roseveare	Advisory	PRRA	Private Secretary to Minister				✓	✓	✓	✓	✓	
Grant Collins	Operations	NZ Police	Liaison with PRRA				✓	✓	✓	✓	✓	
[redacted]	Operations	NZ Police	Detective					✓		✓		

Mark Fergus	Operations	NZ Police	National DVI Manager					✓				
NAME	**AREA**	**ORGANISATION**	**ROLE**	Concept Dev 30 Apr-03 May 18	Concept Refine: 12-13 Jun 18	Peer Review Activity: 29 Jun 18	Detailed Task Analysis:08-09 Aug 18	Forensic DTA 21 Aug 18	WRAC: 10 – 21 Sep 18	Formal Review: 01-02 Oct 18	Executive Review: 16 Oct 18	Detailed Vent Planning: 23-25 Oct 18
[redacted]	Operations	NZ Police	OC Specialist Search					✓				
[redacted]	Operations	NZ Police	Detective							✓		
Peter Read	Operations	NZ Police	Detective Superintendent (S.I.)							✓		
Richard Chambers	Operations	NZ Police	Assistant Commissioner							✓		
John Bone	Operations	ESR	General Manager							✓		
Jim Knowles	Advisory	JK Group	Facilitator	✓					✓	✓	✓	
Sally McPhee	Advisory	JK Group	Senior Consultant						✓			
Deane McNulty	Advisory	MEM	Facilitator	✓			✓					
Karl Maddaford	Management	PRRA	Plans Officer/Report Assistant	✓			✓	✓	✓	✓	✓	✓

ANNEX E

DETAILED COST ANALYSIS REPORT

Methodology

The detailed costs analysis for the three technically feasible re-entry options (Small Tunnel, Single Entry, Large Diameter Borehole) were analysed by industry mining experts and a draft budget was formed for each option as a standalone project. A Detailed Task Analysis for all three options outlined the job steps and from this each task was risks assessed by the experts. Once all of the job steps had been identified the detailed cost analysis was broken into four phases:

1. Drift Re-entry Preliminary Phase
2. 170m Re-entry Phase
3. Main Drift Re-entry and Recovery Phase
4. Rehabilitation and Hand over to Department of Conservation

Each phase of the budget has its own work programme with numerous tasks to be completed before the next phase can begin. A monthly budget has been allocated for every individual task. This illustrates the differences and complexity of each option as well as showing the level of detail the budget has gone through to get to the final costings. A separate costings exercise was undertaken with in the Pike River Agency for an Office Budget for the life of the Agency, this has been included in the operational budget. Keys assumptions for both the operational cost analysis and office budget are outlined below.

Key Notes:

- A primary contractor was considered in the early stages of the project, it is an extremely costly option and the Agency was unsuccessful in attracting a compliant proposal. The Agency has hired additional staff to carry out re-entry operations itself, however provision has been made to utilise contractors on an 'if and when required' basis.
- The detailed cost analysis utilised the expertise of mining personnel as well as in house Agency knowledge to complete the final budgets.
- Areas of highest financial risk to the project which could lead to budget creep are drilling operations (unknown geological conditions), small tunnel construction, electricity cost (Nitrogen plant running 24/7), unknown drift conditions for re-support work, helicopter operations and resourcing. All of these areas had the highest contingency allocation.
- Contingency has been calculated on an uncertainty scale Very Low 0%, Low 3%, Moderate 10%, High 15% this is due to each activity being different in nature and some activities have low uncertainty and some high, hence the weighting scale.
- Procurement outcome of the RFPs are largely unknown at this stage due to three technically feasible options on the table. More certainty will be known once a preferred option is chosen, as some options have a higher procurement value than others i.e. Small Tunnel Vs LDBH V Single Entry

- The uncertainty around single entry option is moderate to low due to no construction of a small tunnel or a large diameter borehole required. Uncertainty surround Small Tunnel and LD bore hole is very high.
- The agency $10.155m includes the year to date operating costs of the Agency to June 2018 (office and mine) total $2.135m (excludes the Agency set up/fit out of $343K), and includes a 20% contingency across the board.
- The agency requires $50,000 capex for ongoing office equipment, which is excluded from the $10.155m
- Excludes the Independent Advisor cost of $75,000 (non-departmental budget), with an actual spend to date of $15,000.

Key Assumptions

- Re-entry and recovery plan executed and mine site surrendered to DOC by 31 December 2019 (assumes all consents etc. approved (DOC, WorkSafe), including the sealing of the mine for Single Entry option only.
- Timelines surrounding Large Diameter borehole construction and Small tunnel construction are largely unknown at this stage, however indicative time frames have indicated these two options would extend the timeline out by 5 - 7 months compared to Single Entry. Mine site surrendered to DOC by May 31 2020 for Small Tunnel and Large Diameter borehole.
- Implementation of the disestablishment plan of the Agency by the end of June 2020 - Greymouth office closes, staff in roles no longer required are off boarded and assets are surrendered, records are transferred to designated agency and the wind down of the Agency has concluded. All accountability and reporting obligations met. This period is also a contingency for the sealing of the mine and the surrender of the mine site to DOC if the Agency faces adverse uncontrollable conditions or risks.
- Contingency period: Greymouth office closes by 30 September 2020 (includes contingency period, external audit conducted, last remaining staff are off boarded by 30 September 2020 and all accountability and reporting obligations met) including the transfer of the records.

Option A: Small Tunnel Summary of Costs ($49M)

Notes:

- The uncertainty around the small tunnel option is very high due to the location (Pike Stream) and weather as it is likely this tunnel will be driven during the winter months which means a lot of downtime due to not being able to fly personnel in and out of the site. This could have serious ramifications on the budget as the time delay could be significant. Hence the increased budget for this option.
- Increased items such as insurance, labour, helicopter flights (2000 plus helicopter flights just for muck removal of the small tunnel), Agency life expectancy and the electrical reticulation system for the underground operations have all contributed to the increase in the 'Most likely' scenario. Increased time to obtain consents, construction design and tunnel driveage have also contributed to the increase in cost.
- The 'Most Likely' value is the preferred budget scenario.
- Increased 'Most Likely' scenario is also attributed to the longer life span of the Agency which is a direct result of increased time for Small Tunnel construction.

Budget Item	Low case scenario (no contingency) ($m)	Most Likely value (geared contingency included) ($m)	High side of range (geared contingency +) ($m)
Drift re-entry preliminary phase	5.060	5.226	6.926
170m re-entry phase	5.639	5.866	6.452
Main drift re-entry phase (including tunnel construction)	21.228	24.524	26.976
Agency department operating costs, over Agency life until Sept 20	10.155	10.155	10.155
Rehab and handover to DOC	2.805	3.085	3.233
Total Operating cost	**44.887**	**48.856**	**53.742**

Option B: Single Entry Summary of Costs ($36M)

Notes:

- The uncertainty around single entry option is moderate to low as no construction of a small tunnel or a large diameter borehole required.
- Increased items such as insurance, labour (20 staff total for the Agency), helicopter flights, Agency life expectancy and the electrical reticulation system for the underground operations have all contributed to the increase to $36m in the 'Most likely' scenario - single entry
- The 'Most Likely' value is the preferred budget scenario.

Budget Item (Single Entry)	Low case scenario (no contingency) ($m)	Most Likely value (geared contingency included) ($m)	High side of range (geared contingency +) ($m)
Drift re-entry preliminary phase	5.059	5.226	7.298
170m re-entry phase	5.639	5.866	7.332
Main drift re-entry and recovery phase	11.579	12.493	13.742
Agency department operating costs, over Agency life until Sept 20	10.155	10.155	10.155
Rehab and handover to DOC	2.155	2.370	2.963
Total Operating cost	**34.587**	**36.110**	**41.490**

Option C: Large Diameter Borehole Summary of Costs ($41M)

Notes:

- The uncertainty around the large diameter borehole is high due to a drill rig not being available in NZ to drill an 800mm diameter hole to make it 600mm cased. Location and weather are also key cost contributors as it is likely this hole will be drilled during the winter months which means a lot of downtime due to not being able to fly personnel in and out of the site. This could have serious ramifications on the budget as the time delay could be significant. Hence the increased budget for this option.
- Increased items such as insurance, labour, helicopter flights, Agency life expectancy and the electrical reticulation system for the underground operations have all contributed to the increase in the 'Most likely' scenario, as well as unknown ground conditions and increased time to construct the drill site, obtain approvals and physically drill the hole.
- Increased 'Most Likely' scenario cost is also attributed to the longer life span of the Agency which is a direct result of increased time for Large Diameter borehole construction.
- The 'Most Likely' value is the preferred budget scenario.

Budget Item (LD BH)	Low case scenario (no contingency) ($m)	Most Likely value (geared contingency included) ($m)	High side of range (geared contingency +) ($m)
Drift re-entry preliminary phase	5.061	5.176	7.399
170m re-entry phase	5.639	5.866	7.332
Main drift re-entry phase (LD BH construction)	15.518	16.869	18.556
Agency department operating costs, over Agency life until Sept 20	10.155	10.155	10.155
Rehab and handover to DOC	2.255	2.480	3.100
Total Operating cost	**38.628**	**40.546**	**46.542**

Pike River Recovery Agency Office and FRG Budget ($10.155M)

Working assumptions for planning purpose

- Mine site and mine operation surrendered to DOC by 31 December 2019 (assumes all consents etc. approved (DOC, WorkSafe).
- Greymouth office closes by 30 September 2020 (includes contingency)
- Lease expires 31 January 2020 with one right of renewal for a further year to January 2021 - assumption will need to ' buy' out the 4 remaining months
- Annual rental increase of 5 percent
- $200,000 training and personal development
- All costs (time and travel) for technical expert alliance captured under the Mine cost centre
- Budget covers only the FRG travel and associated support costs including travel when engaging with Government.

Timelines - Based off working assumptions for planning purposes

- End of November 2018 - all 6 mine workers have started.
- 22 December 2018 (COB) to 6 January 2019 the Agency 'shut down' for Xmas break. Minimum manning for mine and office (skeleton crew) during this period. 1 months' notice in writing required to staff.
- By 7 January 2019 the Minister Responsible announces his decision regarding the re-entry and recovery of the mine drift. Dependent on decision: Staffs' IEAs will require amendment.
- Jan to June 2019 - the mine drift is re-entered as per operational plan - key milestone: Breaching the 30 metre seal in February 2019.
- June 2019 - Milestone to check on capability (roles) required moving forward.
- June 2019 to December 2019 – the mine site is rehabilitated as per agreement with DOC (could also be used as a contingency period for any of the above)
- December 2019 - mine site is surrendered to DOC as per MOU terms. Mine is abandoned and surrendered to DOC according to relevant Regulations.
- Office Closed for Xmas break 2019 (possible)
- By March 2020 - Roles not required, staff exit, including secondees having been given 3 months' notice.
- By June 2020 - the office in Greymouth closes, assets are surrendered. Remaining roles, staff exit not required.
- By 30 September 2020 - Contingency for closing the Office in Greymouth, external audit conducted – last remaining staff exit - estimate to be up to 4.