Ground floor, Suite 01, 20 Chandos Street
St Leonards NSW 2065
PO Box 21
St Leonards NSW 1590

T 02 9493 9500
F 02 9493 9599
E info@emmconsulting.com.au

www.emmconsulting.com.au

12 April 2019

Independent Planning Commission NSW
Level 3, 201 Elizabeth Street
SYDNEY NSW 2000

Re: SSD 7172 Hume Coal Project & SSD 7171 Berrima Rail Project – Response to submission by Mr Derek White

1 Introduction

This submission seeks to clarify a number of technical aspects that have been raised by Mr Derek White during the IPC Public Hearing for the Hume Coal Project and Berrima Rail Project, and in two subsequent written submissions.

Most of the issues raised by Mr White are already addressed by information provided within the Hume Coal Project Environmental Impact Statement (EIS) and/or in the Hume Coal Response to Submissions Report (RTS). In addition to the EIS and RTS, this submission references additional reports which have been prepared by Hume Coal's technical experts, including Palaris (2019a), Palaris (2019b) and QPS (2019), to further explain the studies undertaken by Hume Coal during the project design and subsequent assessment phase.

2 Issues raised

2.1 Rejects Management

Mr White raises a number of concerns regarding Hume Coal's intention to use underground reject emplacement to dispose of coal washery wastes. These issues are summarised below along with a response from Hume Coal's technical experts.

Mr White makes the statement that 'No mine in Australia places 100% of its rejects material underground as soon as it is produced'.

Underground coal backfill pumping systems are in successful operation in many places, both in Australia and overseas. It is also noted that, as described in the EIS for the Hume Coal Project (EMM 2017), emplacement of rejects underground will not commence until 12-18 months after mining commences. This will allow sufficient time to effectively establish the underground emplacement system.

While backfill systems are not common in Australian coal mines, globally there are a large number of coal mines that pump 100 per cent of their waste products underground soon after they are produced. Pumping backfill into operating coal mines has been practiced all over the world in locations as diverse as Germany, Poland, USA and China. China, as the largest coal-producer in the world, has a large number of backfill applications.

An Australia based example of underground reject emplacement is the Metropolitan Coal Mine near Helensburgh in NSW. The placement of coal rejects in underground workings was successfully developed to pilot phase at the mine (Tarrant et al, 2012), and was expected to advance to full scale emplacement of all coal rejects underground. The main driver for the work was to reduce and eventually eliminate the number of coal reject trucks passing through Helensburgh. The intention was to further develop the technology to potentially reduce subsidence by emplacement behind the longwall face.

Underground emplacement into unused workings commenced at Metropolitan in May 2011. The range of pumping distances required was between 0.5 – 8 km. Subsequent testwork was conducted (Worsley et al 2015) using a 100 mm NB pipe loop connected to the backfill pilot plant. Coal rejects used for the demonstration were comprised of a typical mix of ultra-fine, fine and coarse particles ranging to ~15 mm with the percent solids and process water adjusted to a target range of 74-76% w/w. It is noted that at Metropolitan, pumping rejects into a goaf environment competes with a collapsed goaf, whereas at Hume Coal emplacement will be into open and downdip roadways.

Palarski (1994) reported that tailings have been used as backfill in Polish coal mines since 1893. In 1924, Germany developed a goaf filling method, and from 1970 the pneumatic goaf stowing method was widely used (Anon, 1988) and the filling rate reached 57% (Voss, 1983).

Mez and Schauenburg (1998) provide a detailed description of the backfilling of caved-in goafs with pastes at Walsum Colliery in Germany.

An improved goaf stowing method was developed in China in 1980 and by 2016 was used in more than 60 mines. As of Feb 2016, the mines utilising the goaf slurry backfill method included:

- Shandong Provence (38 coal mines including FeiCheng, Zaozhunag, Zhibi, Jining and Linyi)
- Heibei Provence (10 coal mines including Jizhing Energy Group and Feng Feng)
- Henan Provence (No. 12 coal mine in Ping Ding Shan area)
- Anshui Provence (Yang Zhuang)

There has been extensive research on this topic for a considerable period. For example, in 1990, Wollongong University awarded a PhD (Hii, 1990) on using coal washery refuse for underground strata control. Internationally, a large number of papers have been published on emplacing rejects slurry backfill into operating underground coal mines. The following is a very brief summary of some of the papers identified from a basic literature search.

- Chang et al (2014) gave a general overview of the implementation of paste backfill technology in Chinese coal mines, including the common practice of including fly ash in the mixture of crushed coarse, fines and tailings.
- Xu, Xuan and He (2014) reported that the Fengfeng, Jiaozuo, Zibo, Xinwen, Zaozhuang, Feicheng and other mining bureaus have applied the pumped backfill technique.
- Xuan, Jialin and Zhu (2013) gave a more detailed review of backfill mining practice in China coal mines, including providing the details of 11 mines disposing of coarse waste rock as backfill.
- Zhang et al (2019) gave considerable detail on the properties and application of backfill materials in coal mines in China, including 60 coal mines using either high water content or cemented backfill. The authors gave a number of case studies and noted that that the coal rejects are crushed finer than at least 20 mm.
- Yang et al (2015) investigated the influence of fly ash on the performance of high concentration cemented backfill material in coal mine. A concrete pump with a capacity of 80 m^3/hr, along with a general seamless steel pipe with an inner diameter of 150 mm, was used.

- Yang (2015) reported on the pumping characteristic of coal ash slurry in high concentration cemented backfilling. The frictional resistance loss for the conversion of unit length loss was 3.77 kPa/m.

- Basu (1997) completed a feasibility of hydraulic backfill pumping into a thin seam coal mine.

Mr White stated that "Hume Coal will require a tailings dam to manage reject material in the event of a system failure". This is described by White as a 'safety net'.

Chapter 2 of the Hume Coal Project EIS (Volume 1) (EMM 2017) provides a detailed project description of the proposal. Table 2.1 within Chapter 2 provides a project overview, and the following is an extract from the Coal Reject Management section of this table:

> "The Coarse and fine rejects from the CPP will be processed and then pumped underground to voids in the mine.
>
> Initially, while underground void space is being created, coal rejects will be stored in one or more temporary surface emplacements which, when full, will be top dressed and re-vegetated.
>
> There will also be an emergency reject stockpile near the CPP to allow coal processing to continue if there is an interruption to underground emplacement, such as during maintenance of the pumping plant."

As is evidence above, the Hume Coal Project design includes an emergency reject stockpile to manage reject material in the event of a system failure. A tailings dam, as claimed by Mr White, will not be required.

Mr White questioned whether the fill can successfully be pumped for up to 10 km.

The longest pump distance required for the Hume Coal Project will be about 12 km. There are numerous examples around the world of pastes and slurries being pumped long distances, and significantly over 10 km and in several examples in excess of 100 kms. For medium to long paste pumping distances, piston pumps are preferred (QPS 2019). Two companies dominate the medium to long distance paste pumping market (MW Wirth and Geho). Geho pumps have been included in the conceptual design of the underground emplacement system for Hume Coal.

Some examples of Geho installations for pipelines greater than 10 km long are shown in the table below. The number of examples indicate that pumping a high-density slurry as part of the Hume Coal Project is feasible.

Table 2.1 Geoho piston pump >10 km long pipeline installations (QPS 2019)

Location	Mine	Company	Application	Type	Length (km)	Year
Argentina	Alumbrera	Minera Alumbrera	Concentrate	copper	310	1997
Indonesia	Batu Hijau	Newmont	Concentrate	copper	18	1999
China	Da Shong	Kunming Iron and Steel	Slurry	Iron ore	171	2007
Indonesia	Grasberg	Freeport	Concentrate	copper	120	2004
India	Hy-GradePellets		Slurry	iron ore	268	
China	Jianshan		Slurry	Iron ore	100	
Chile	Los Pelambres	Minera Los Pelambres	Concentrate	Copper	120	1996
Brazil	Minas Rio	Anglo American	Slurry	Iron ore	529	2014
Chile	Collahuasi	Minera Dona Inés Collahuasi	Concentrate	copper	203	1998
NZ	Glenbrook	New Zealand Steel	Slurry	Iron sand	18	1986
Brazil	Paragominas	Mineracão Bauxita Paragominas	Slurry	Bauxite	244	2007
Brazil	Samarco	Vale	Slurry	Iron ore	396	2008
USA	Smoky Canyon	Simplot	Concentrate	Phosphate	100	1990

Mr White raised concerns that the pumping rejects material poses significant risk of pipe blockages or failures in the system creating safety hazards.

It is acknowledged there is some risk of blockage occurring within the reject emplacement pipelines, particularly in the early stages as experience is gained with the piping system interactions and operational processes are refined. A robust instrumentation and control system will therefore be implemented.

If a pressure drop within the reject emplacement line is identified, then the pumping speed will be increased, the reject material slurry will be made more dilute or the feed will be isolated from the pipe experiencing pressure drop and water will be introduced. Production will continue if a blockage occurs via alternative (redundant) pipes.

The system to be used for the project has been designed with one piston pump per pipeline and an extra on-line backup pump and pipeline. In addition, there will be one surface recycle pipe per pipeline. The redundancy built into the system will require three pipelines to allow reticulation if and as required for delays or breakdowns, or placement on the surface emergency stockpile.

By measuring the flow rate, density, and pressure loss across and along the horizontal length of pipe, an indication of the backfill properties can be determined. This allows corrective measures to be implemented at the backfill plant or, if necessary, to take pre-emptive action to avoid a blockage of the distribution system.

The risk of pipe failure is controlled by 'factors of safety' in the piping specification. In sensitive areas the reject emplacement pipe will be encased for further protection in the case of rupture. The pipeline wall thickness will also be regularly measured.

Mr White raised concerns that the pumping rejects material poses significant engineering and safety challenges associated with the emplacement of reject within the headings. This included potential for the placement of rejects to require the use of a bulldozer to ensure panels are adequately filled.

In order to emplace the reject material underground, it is necessary to develop a method that will allow personnel to safely deliver reject material to the furthest point of each plunge created as part of the proposed mining method. This delivery method will have to be remotely operated as plunges will remain unsupported (ie no roof support devices such as roof bolts will be installed) and it is therefore not possible for personnel to enter these areas.

Hume Coal plan to utilise a modified air/hydraulic track mounted (AHTM) drill rig to carry out the process of reject emplacement (refer to Figure 2.1). An AHTM drill rig is a piece of machinery commonly used underground for the installation of rock bolts in the underground roadways. These machines comprise a track mounted drilling mast where all motors are driven by compressed air (rotational motor, feed motor and tram motor). The rotational and feed motors are used for drilling and installing the rock bolts whilst the tram motor drives the tracks which are used for manoeuvring the machine.

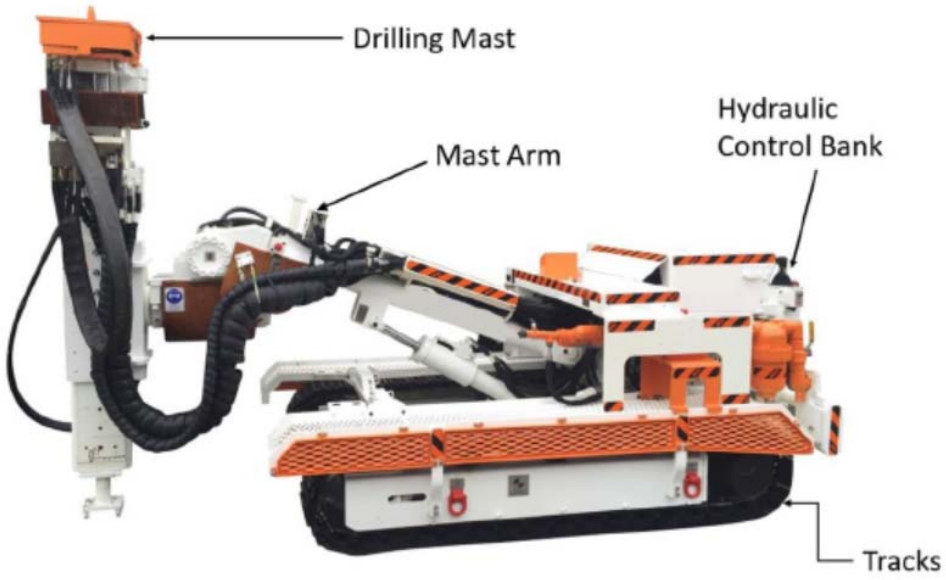

Figure 2.1 Example of AHTM Drill Rig (Palaris 2019)

Hume Coal will collaborate with the equipment manufacturer (OEM) to modify the AHTM rig in order to remove the drilling mast and replace it with a discharge nozzle that will mount onto the mast arm. This nozzle will be used as a discharge point to distribute and emplace the reject material. A discharge line of 90 mm internal diameter transporting the reject material would then be connected to the nozzle as a means of feeding the reject to the discharge point.

Additionally, Hume Coal will collaborate with the equipment manufacturer (OEM) to remove the hydraulic control bank that operates the tracks and mast from the body of the machine by the use of umbilical hydraulic lines extending from the rig to the entrance of each plunge. By doing this, the equipment operator will be able to activate all functions of the rig remotely.

A further requirement to be addressed will be the ability to recover the rig remotely in the event of an equipment malfunction when pumping in the plunges. As plunges are unsupported, a remote recovery device is mandatory to avoid personnel having to enter unsupported roof areas. This will be achieved by the use of a recovery strap attached to the AHTM rig and deployed as the AHTM rig enters each plunge. In the event of a breakdown, the strap can be attached to an underground tractor type machine (LHD) and recovered from the plunge so it can be repaired.

Mr White stated that Hume Coal will be unable to extract water from sealed panels once filled with rejects.

Hume Coal does not need or intend to extract water from sealed panels once filled with rejects.

In times of low rainfall, Hume can either extract water from sealed and unsealed downdip panels that do not have reject emplaced or can access water supply from bores nearby the mine. Hume hold almost 2 GL of groundwater shares in the Upper Nepean Zone 1 Management Zone, and only need to licence the maximum take in one year of mining, year 17. At year 17 there will be many panels without reject emplacement that are full of water that could be used for supply if required.

Mr White provided commentary on a study conducted for the Tahmoor Coking Coal Project (Tahmoor), which evaluated options for disposal of coal reject material. Mr White drew comparison between the Hume Coal Project and Tahmoor. Specifically, Mr White highlighted that the Tahmoor study concluded that placement of 100% of rejects underground was not feasible due to physical constraints and the lack of availability of fill preparation plants.

Backfill disposal at Tahmoor Coal was considered in an options study (Appendix U of the Tahmoor South Coal EIS (AECOM 2018) "*Rejects Disposal Study Report*").

For underground coal rejects emplacement, the use of additives was envisaged to improve the slurry rheology. No details were provided within the report on the modifier selected. The backfill produced had to be able to permeate through collapsed goaf and be resistant to re-fluidization. Both the options of pumping low density (30-50% solids w/w) and high-density slurry (75-85% solids w/w) were investigated. The addition of a paste thickening plant was required to thicken the tailings for the high-density pumping option.

Within the options report, a capital and operating Cost-Benefit Analysis (CBA) was provided. This CBA was used to assess the rejects disposal options and the continued surface emplacement at the mine was selected, primarily due to it being the lowest capital and operating cost option.

This reinforces the point that the main constraint to the use of underground emplacement in the Australian coal industry has been the higher cost. However, environmental considerations will lead to increasing use of the technology in Australia.

It also needs to be noted that the situation at Tahmoor Mine is different to Hume, in that Tahmoor is an operating, longwall mining operation. The mine has been operating for 40 years and was constructed without the infrastructure to enable underground emplacement. Further, there is limited void space available for underground emplacement in a longwall mine due to the caving in of overburden material following coal extraction (ie the goaf), as illustrated in Figure 2.2. This is different, and more challenging than Hume Coal's proposal, where roadways will remain intact and be able to accept the emplacement methodology.

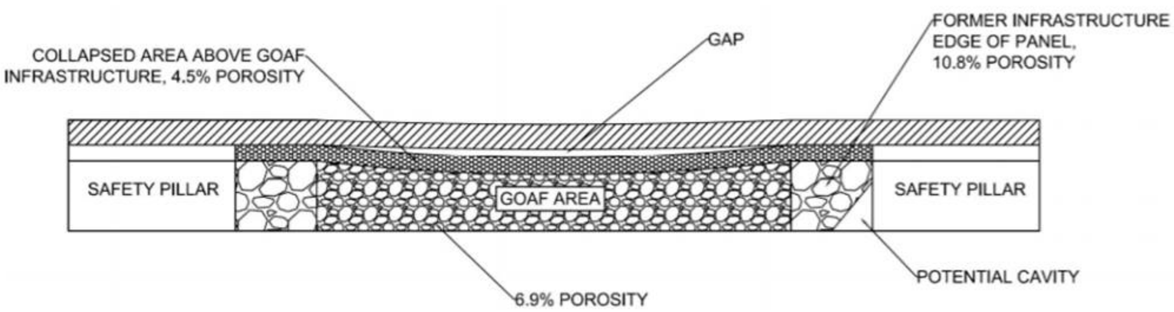

Figure 2.2 Theoretical porosities in and along the goaf (AECOM 2018)

2.2 EIS Adequacy

Mr White raises a number of concerns in both his presentation to the IPC Public Hearing and in his supplementary submission relating to the level of detail relating to rejects management that Hume Coal have provided within the EIS. These issues are summarised below along with a response from Hume Coal's technical experts.

Mr White states that the management of rejects underground has not been adequately addressed in the EIS.

The management of coal reject material is detailed in the following section of the EIS (EMM 2017):

- Section 2.8: Coal Washing and Progressing within Volume 1 of the EIS;
- Section 6.4: Rejects Emplacement within the Project Evolution and Alternatives chapter of Volume 1 of the EIS;
- Section 8.7.2: "Water Quality Effects of Co-disposed Reject" within Volume 4A of the EIS.

Further information was also provided within Chapter 10: Rejects Management of the RTS Report. This chapter included additional information on the method of rejects emplacement, the management of the temporary rejects stockpile and the interaction of rejects material with groundwater and surface waters.

In addition to the work undertake for the EIS (EMM 2017) and RTS (EMM 2018) reports, Hume Coal commissioned Palaris Australia to produce two reports that provide further detailed descriptions of the proposed reject emplacement process and schedule:

- Hume Coal Reject Emplacement Schedule (2019) and;
- Hume Coal Reject Emplacement Methodology (2019).

A summary of the key elements and findings of these reports are provided below.

As stated in the EIS (EMM 2017), rejects initially generated by the project from the first panel in the western area of the mine will be stored on the surface in the temporary surface reject stockpile. This will equate to approximately 500,000 tonnes of rejects. This reject will be scheduled for eventual underground delivery during the life of the project.

The indicative schedule of reject emplacement is shown in Figure 2.3. The first panel to be emplaced is circled in red.

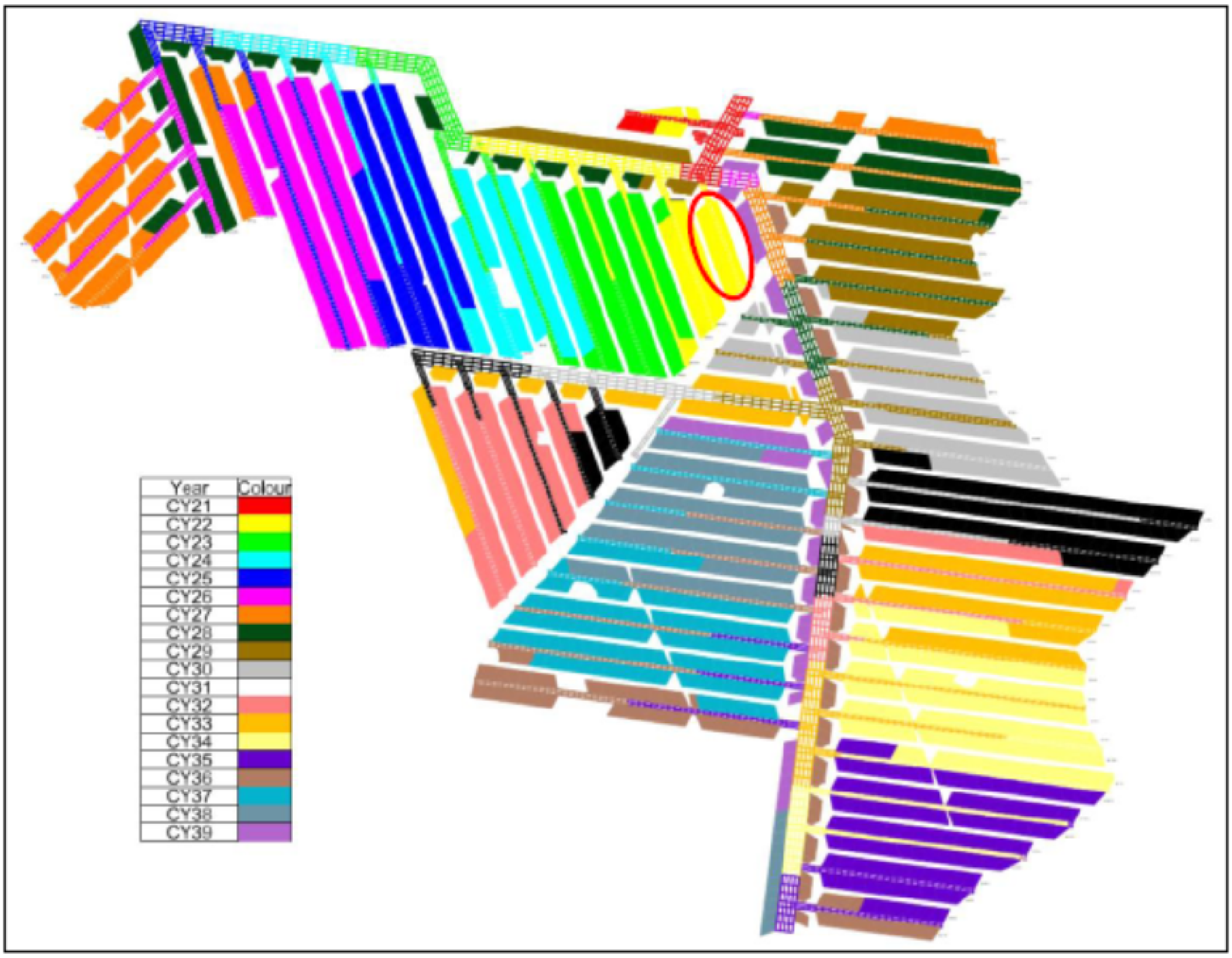

Figure 2.3 Indicative rejects emplacement schedule

This schedule was developed by Palaris using the Deswick mine planning software, which is a well-known mining simulation software package.

For the process to be continuous, it will be necessary to have multiple sites set up simultaneously within a panel. This will allow for one drill rig (refer Figure 2.1) to be mobilised and set up whilst at least two rigs are working (1 pumping and 1 backup). The process for reject emplacement is described below and illustrated in figures 2.4 to 2.11. This process is based on a typical panel found on the Eastern Domain of the mine where both sides of the gateroad can be filled.

The process is as follows:

i) Rig#1 is trammed to the end of the penultimate plunge of the web panel to 10m from the face (approximately 110m from the start of the plunge). This fill be site #1 as shown in Figure 2.4 below.

ii) Rig#2 is trammed to the end of the last plunge to 10m from the face. This will be site #2, a backup and then the active site once site #1 is filled.

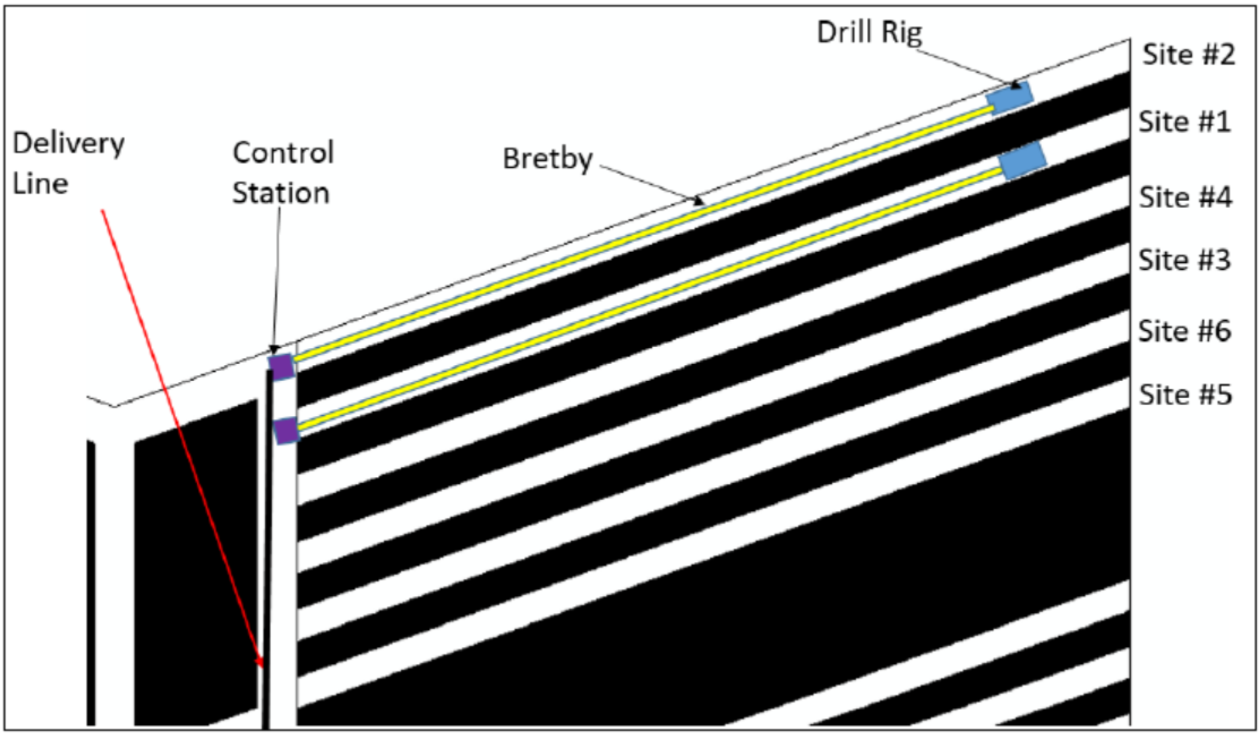

Figure 2.4 Drill rig set up

iii) A dumping line will need to be set up on the opposite side of the panel where Rig#3 is set up as shown in Figure 2.5 below.

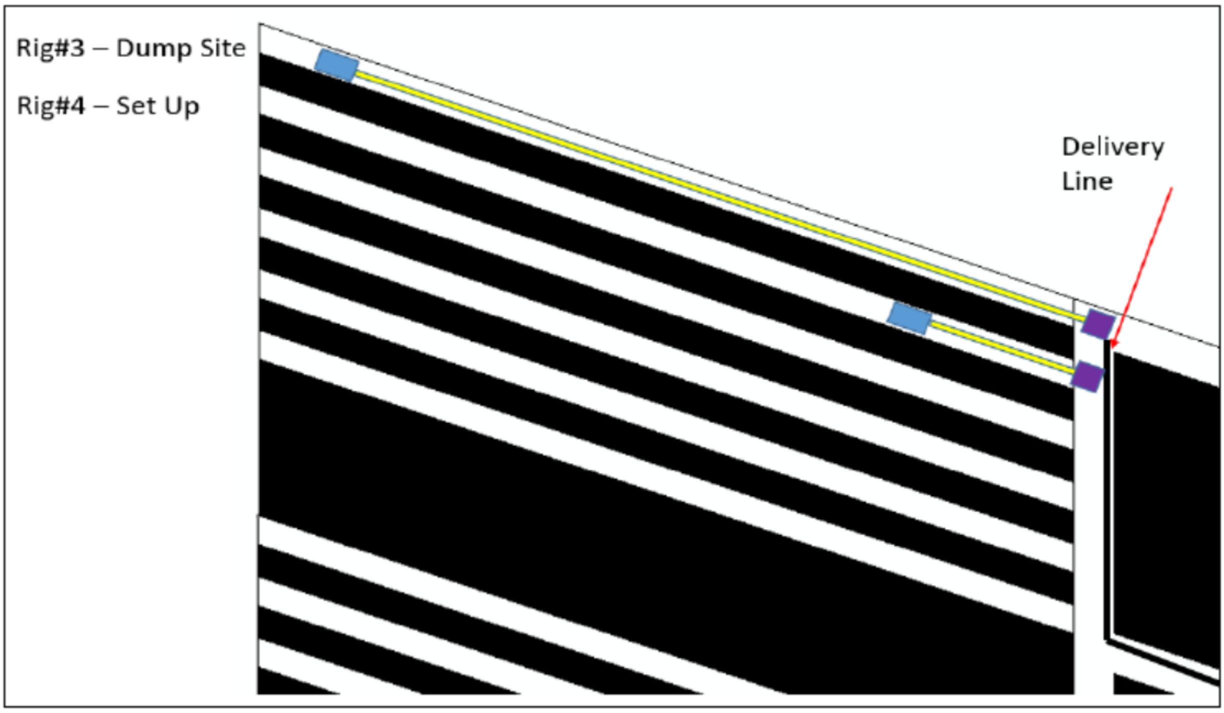

Figure 2.5 Opposite side – Dump site and set up of next site

iv) Rig#1 completes Pours 1 – 8 in Site #1 as it retracts out of the plunge (Figure 2.6).

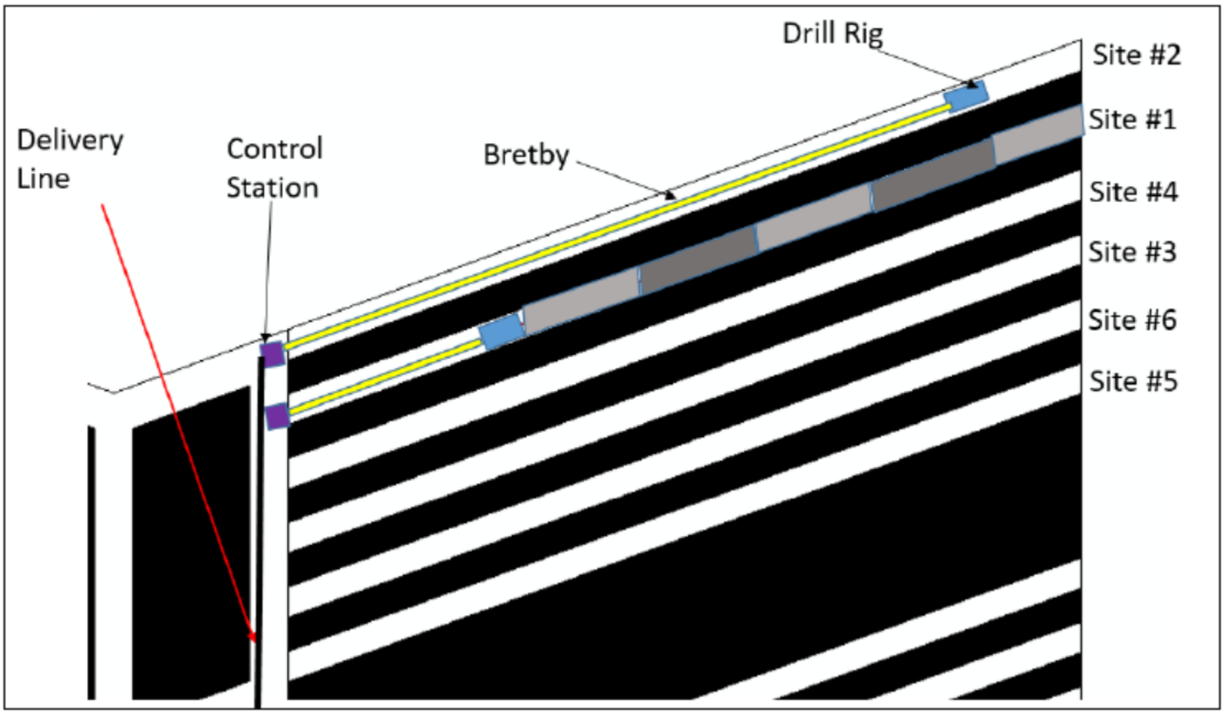

Figure 2.6 Filling plunges

v) Once the last pour is completed, the delivery line is switched to Rig #2 so it can start pumping as Rig #1 is set up in the following site (Figure 2.7). By this point in the process, 2 x rigs are set up on the opposite side of the panel, Rig#3 becomes the backup rig and Rig#4 will be the dumping site.

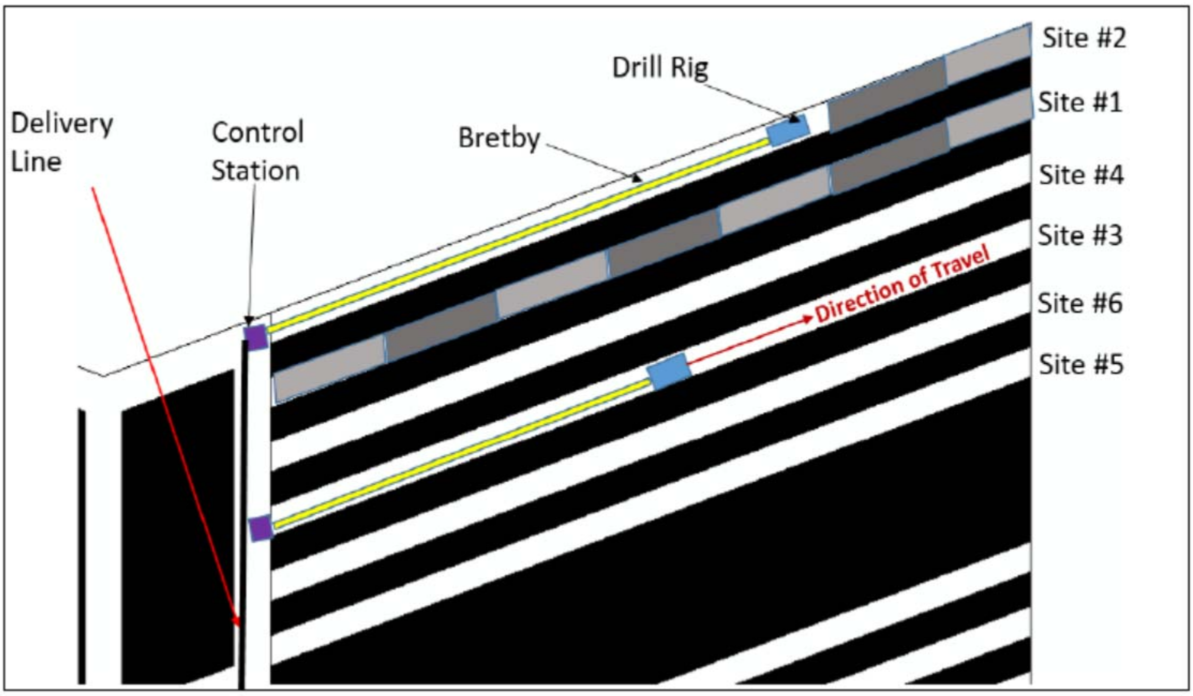

Figure 2.7 Subsequent site setup

vi) Rig#2 will complete all 8 pours in the plunge and it will also complete an additional pour on the gateroad is it retracts back to site #4. This is shown in Figure 2.8. The process is then repeated until all sites are filled.

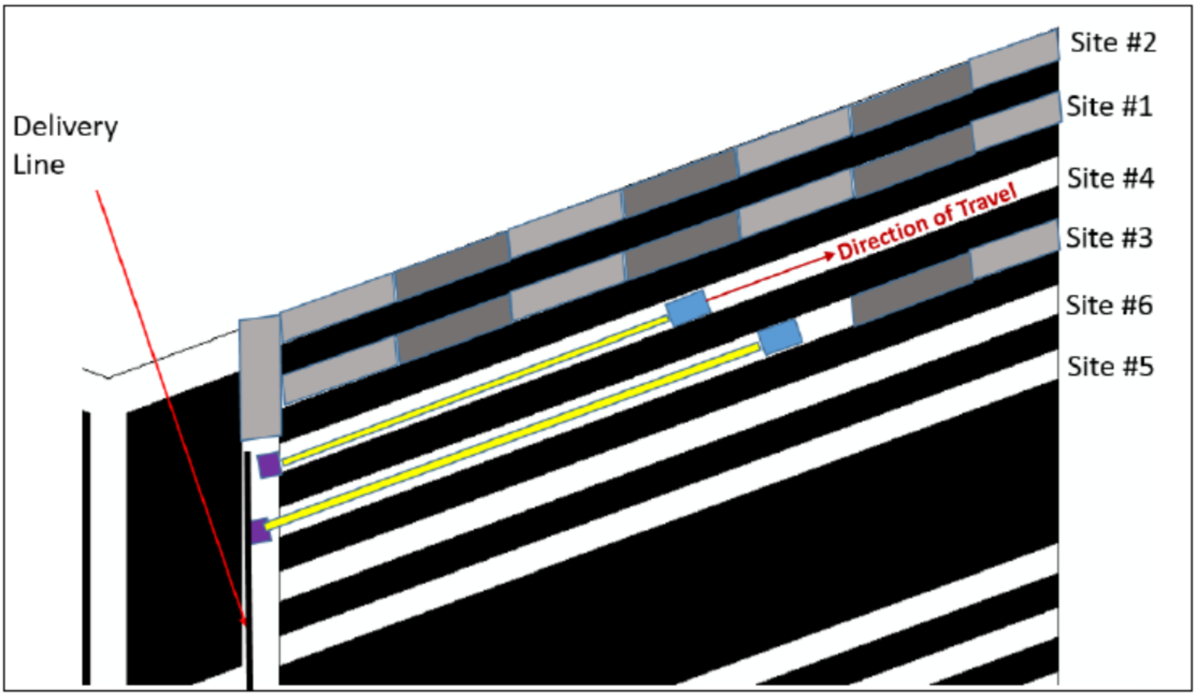

Figure 2.8 Gateroad pour on extraction

vii) After Rig#1 completes site #5 it will move to be set up into site#1 of the next web panel. This site then becomes the dumping site as Rig#3 and Rig#4 commence the same process on the opposite side of the panel as shown below in Figure 2.9.

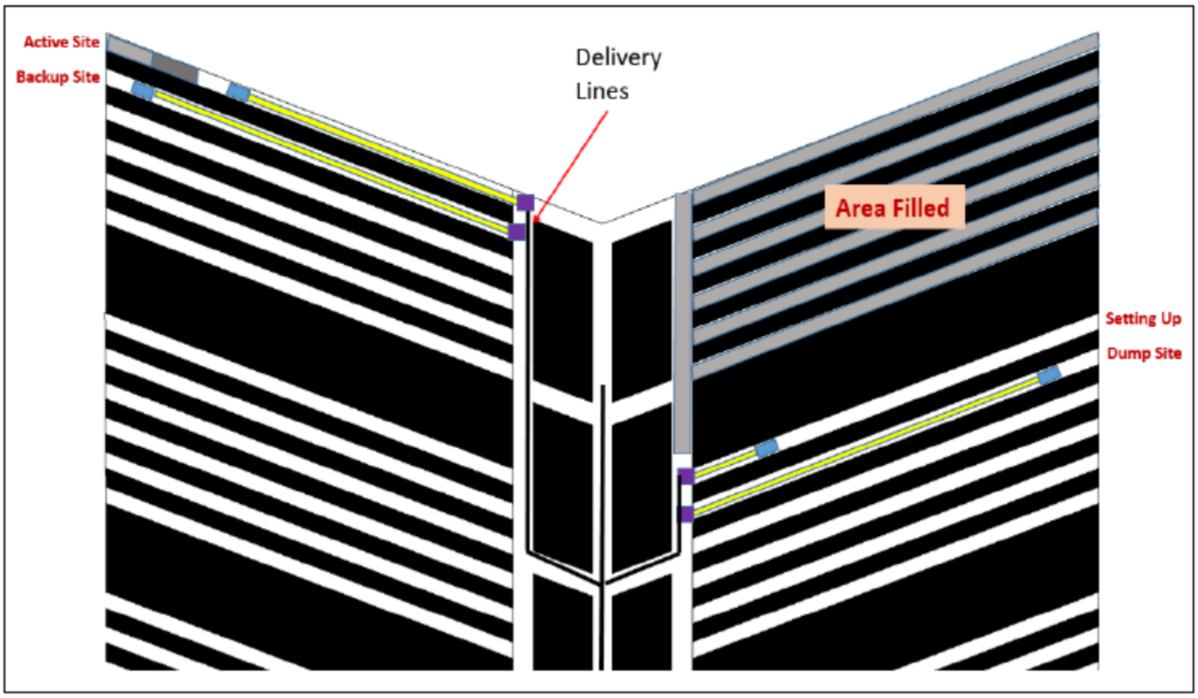

Figure 2.9 Full panel view

viii) Rig#3 will fill the left hand side (LHS) of the gateroad on retreat as Rig#2 did on the right hand side (RHS). This can be seen in Figure 2.10.

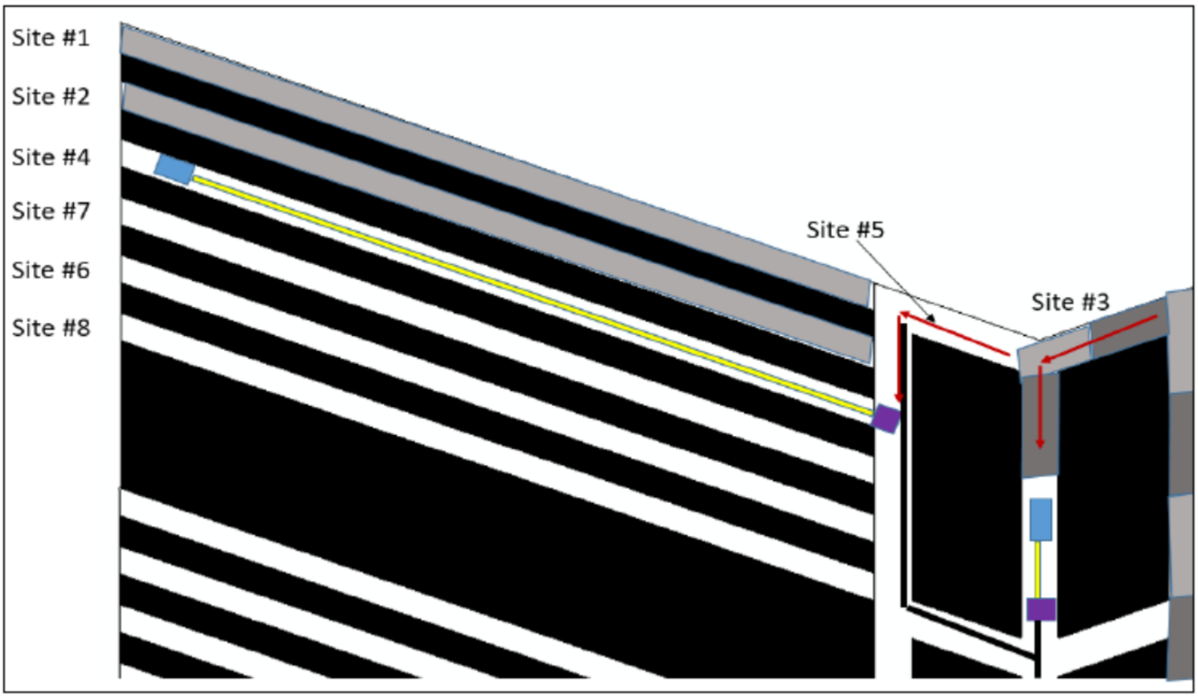

Figure 2.10 LHS Gateroad filling

ix) This left and right fill process is then repeated on all individual web panels as the process retreats out of the gateroad, towards the Main Headings (entrance to panel). When all the plunges and the gateroads are filled, bulkhead seals will be installed at the entrance of the panel as shown in Figure 2.11 below.

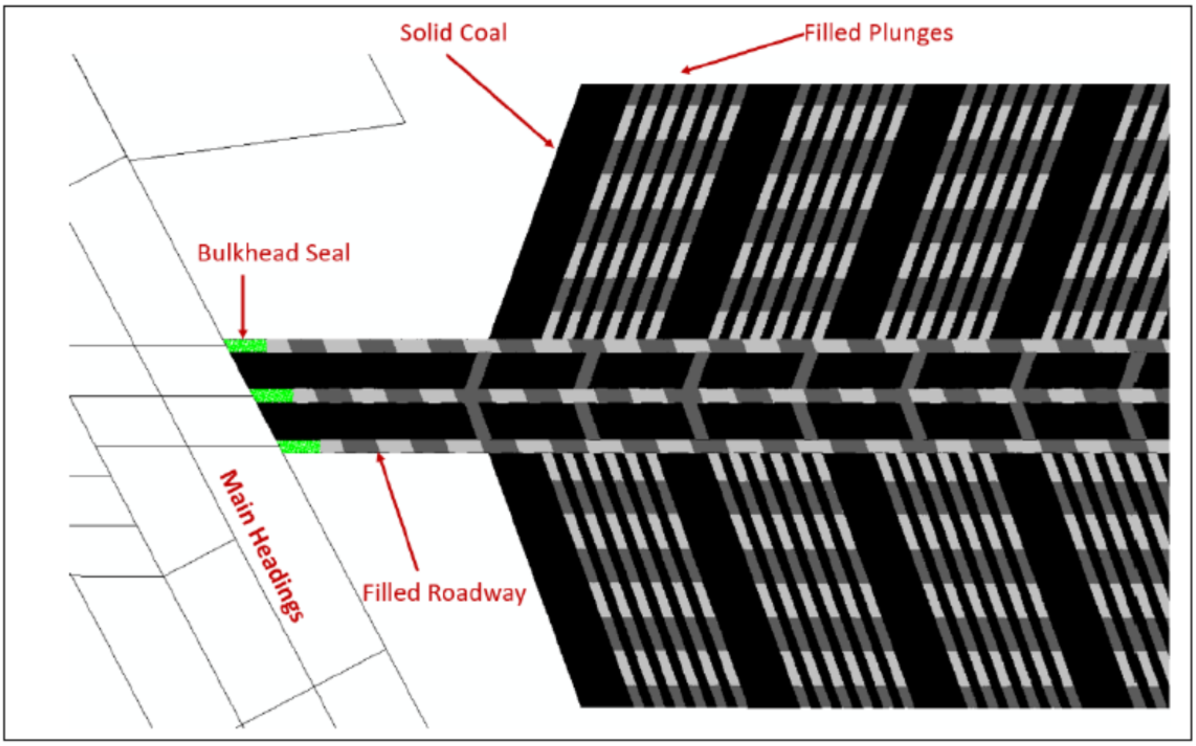

Figure 2.11 Sealed panel

It is important to note that the backfill process will commence once mining has been completed in each panel. When multiple panels are being separately mined there will be opportunity to expand the system to be available to be used in several different areas concurrently. The system has a high degree of flexibility and scalability and therefore can be changed to match any production profile for the mine.

In addition to the Palaris report, Hume Coal commissioned Quality Process Solutions (QPS) to prepare a concept deign report for the proposed reject emplacement (QPS 2019). This report included a literature review of where rejects have been, and are, disposed of underground (the results of which are detailed in the first response in Section 2.1 of this submission). This report found that many mineral processing plants dispose of reject as paste fill (a substance that behaves as a solid until a sufficiently large load or stress is applied, at which point it flows like a fluid). A paste also requires a reasonably high fines content and must have at least 15% of the particles finer than 0.02 mm. The Hume Coal backfill will be extremely variable, ranging from 100% coarse (-50 mm) to 100% thickener underflow (-700um). This essentially discounts the use of a paste backfill which requires a reasonably consistent size distribution. A high-density slurry will therefore be used at Hume Coal.

QPS (2019) investigated the possibility of using either centrifugal pumps or positive displacement pumps to move the rejects underground, with the centrifugal pump option rejected due to the high number of booster pumps required. A high-density slurry disposal using piston pumps was found to be the most appropriate way of emplacing the rejects underground. The design backfill solids concentration is 60-70% w/w, which was selected to give an acceptable compromise between the risk of blockage at higher % solids, and the high wear at lower % solids.

A minimum pipeline velocity of approximately 2 m/s will be used to reduce the risk of particle setting of the 8 mm slurry, and a maximum velocity of approximately 3 m/s to limit the pressure loss due to friction.

Mr White was concerned that Hume Coal's mining experts lack of experience in "underground fill systems".

The Hume Coal Project utilised technical experts from multiple fields to design its reject emplacement system. A summary of the experts involved is provided in the response to the next point below. All reports are also listed in the reference list to this submission.

Mr White stated that Hume Coal has not undertaken studies to investigate the process of transporting the materials via the pipeline.

Extensive investigations have been completed to confirm that the process of transporting the materials via the pipeline is a viable option for the project.

In early 2014, QCC Resources completed a high-level concept design report titled “Hume Coal Project Paste Disposal of Reject” and provided a cost estimate for the disposal of rejects as pumped backfill with a topsize of 8 mm.

Following this report, borecore reject and tailings samples were sent to Golder Associates (Golder) Research and Development Facility in Melbourne for testing.

In December 2014, Golder issued report “Hume Coal: XRD – Mineralogical Assessment” within which Golder reported the results of X-ray Diffraction (XRD) of each rejects sample. The Hume coal reject samples were gathered from different laboratories having been subjected to other test work. The coal reject samples were separated into different size and density ranges. These samples, for each borehole, were blended together to form a composite sample that was considered representative of each drill core.

Golder later released a report “Coal Rejects Evaluation for Underground Disposal Report, April 2015” providing the results of further test work.

RGS Environmental Pty Ltd (RGS) also completed a literature review for Hume Coal of discoverable information on the use of underground storage areas for backfilling coal reject materials and mixing these materials with cement. RGS submitted a report titled "Literature Review – Underground backfill Using Coal Reject and Cementing November 2015".

RGS concluded that backfill was a well-established technique that has been used at an increasing number of underground mining operations in NSW, Australia and overseas over the past three decades.

All of these above-mentioned reports and studies informed the final reject emplacement methodology and design, as described in the Hume Coal Project EIS (EMM 2017), for which approval is sought.

In addition to the above works, and as described in the response above Hume Coal commissioned Palaris Australia to produce two reports that provide further detailed descriptions of the proposed reject emplacement process and schedule, and another QPS:

- Hume Coal Reject Emplacement Schedule (Palaris 2019);
- Hume Coal Reject Emplacement Methodology (Palaris 2019);
- Hume Coal CHPP Backfill Concept Design Report (QPS 2019).

2.3 Economics

Mr White stated that the proposed Hume Coal reject management process is likely to be large and complex. He raised concerns that the size and complexity of the process would impact upon the project economics.

As a coal reject disposal method, backfill is typically more expensive (per tonne of coal reject) than normal surface emplacement methods and is generally not the lowest cost option, and so is not normally used in Australia unless there is a specific reason. However, to meet the highest possible environmental standards, Hume Coal have selected 100% underground backfill for rejects disposal.

BA Economics was commissioned by Hume Coal to prepare an economic impact assessment of the proposed Hume Coal Project. This assessment, which found that the project's benefits will far outweigh its costs, included the costs associated with the proposed reject emplacement system.

2.4 Water Impacts

Mr White raises a number of concerns in both his presentation to the IPC Public Hearing and in his supplementary submission relating to the potential for the Hume Coal project to impact upon both surface and groundwater. These issues are summarised below along with a response from Hume Coal's technical experts.

Mr White raises a concern that there will need to be a large stockpile of waste given that early production will be from high-waste content areas. Surface water management will be greatly complicated by the scale of the large reject stockpiles and processing facilities.

The project includes a temporary reject emplacement area for the stockpiling of waste material extracted before underground emplacement areas are available. The surface water management system has been designed to accommodate this stockpile. As described above, this stockpile will only be used for the first 12-18 months of the mine life to store rejects extracted from the first western panel, until a completed panel is available to store rejects underground. Once no longer needed, the emplacement of the rejects from this stockpile will be scheduled into the reject emplacement schedule over the life of mine.

The impact of the Hume Coal Project on the surrounding surface and groundwater systems and the proposed management actions are described in detail in both the EIS (EMM 2017) and in the revised Water Impact Assessment within the RTS (EMM 2018).

Additionally, before the commencement of operations, a detailed Water Management Plan will be developed by Hume Coal in conjunction with the NSW Department of Planning and Environment (DPE) and the NSW Department of Industry-Water. This plan must be approved by DPE before operations can commence.

Mr White raised concerns that there is a high risk of groundwater contamination from "additives introduced during processing and/or the rejects material itself".

The groundwater quality assessment in both the EIS (EMM 2017) and RTS report (EMM 2018) conclude that there will be negligible impacts to groundwater quality from the Hume Coal Project.

The risk of any potential impact to groundwater from the quality of coal reject slurry transferred into underground workings has been assessed as part of the RGS Hydrogeochemical Modelling Program and has been demonstrated to be negligible (RGS 2018). Further, to ensure excess alkalinity in backfilled coal reject materials, Hume Coal will add up to 1% limestone to the backfill to ensure that any residual risk of impacting groundwater at the site is negligible (QPS 2019).

The underground emplacement of tailings was a direct request of the NSW government to efficiently and safely deal with this waste stream. There are long term environmental benefits to permanently store tailings in underground workings behind bulkheads as mining progresses.

Also, currently (ie under a non-mining scenario) the hydraulic head (pressure) in the coal seam is lower than the immediately overlying Hawkesbury Sandstone. Thus, there is a downward hydraulic gradient (and potential downward flow path), from the overlying sandstone into the coal seam. It is expected that during mining this downward hydraulic gradient (ie from the sandstone into the coal seam) will remain, and following full recovery back to current natural condition, this same downwards hydraulic gradient will persist. This effectively means that there is no mechanism for upward flow of water to flow from the coal seam into the overlying Hawkesbury Sandstone currently, during mining, during recovery or post final recovery.

The Geosyntec (2016) report considers the conclusions of the groundwater modelling undertaken for the EIS, and the NSW Government independent expert reviews on subsidence and groundwater modelling. The Geosyntec (2016) work therefore robustly and adequately considers the likely risks to groundwater quality.

The results of the limestone-amended KLC tests indicated that the expected water quality resulting from rainfall infiltration into the reject stockpile presents a negligible risk to the baseline beneficial uses of Hawkesbury Sandstone groundwater resource.

If the coal rejects are managed appropriately the potential for adverse impacts to receiving groundwater is considered low as the water quality resulting from the reject emplacement is similar to the natural groundwater quality of the Wongawilli Coal seam.

Mr White raised a concern that Hume Coal has not undertaken adequate studies to investigate the amount of water required to transport rejects material or the pumping systems required.

Groundwater and surface water modelling has been undertaken by Hume Coal as a requirement of the environmental assessment and approval process and in accordance with regulatory guidelines to assist in impact predictions.

Numerical models, by definition, are mathematical simulations that attempt to replicate the complex real world situation using appropriate assumptions and field data. Sensitivity and uncertainty analysis are performed to reduce the uncertainty in the assumptions and increase the accuracy and precision of the models' predictions. The numerical modelling that has been undertaken for the Hume Coal Project as presented in the EIS and the RTS is above industry standards for consideration of uncertainty with model results. This modelling incorporates the water supply requirements of the rejects management system.

Extensive work has been undertaken to determine the pumping systems required for the proposed emplacement method. Initial assessments by Hume Coal's design team identified that centrifugal pumps were adequate for a medium density slurry with a short pipeline length, whereas positive displacement pumps are required for a high-density slurry with long pipelines. For intermediate systems, both centrifugal and positive displacement pump options were investigated to determine the most cost-effective solution over the design life of the system.

The centrifugal pump option was rejected due to the high number of booster pumps required. Hose pumps were similarly rejected. Consequently, a high-density slurry disposal using piston pumps was selected. A design utilising backfill solids concentration of between 60-70%, was selected to give an acceptable compromise between the risk of blockage at a higher percentage of solids, and the high wear at a lower percentage of solids.

2.5 Net Make-Up water

Mr White states that nearly a quarter of the net make-up water needs are to be provided by decant recovery of entrained water in the co-disposed rejects. He says this raises the significance of his concerns about the ability to drain water from paste fill, and that this is exacerbated by the majority of filled voids being in down-dip plunges. It is claimed that the ability to recover water from this source has been grossly over-estimated.

Hume can extract water from the active mining panels, sealed and unsealed downdip panels that do not have reject emplaced. Hume are not proposing and have never proposed to extract water from sealed panels with reject emplacement.

In the mid to later years of the project, the net demand is lower than the groundwater inflows to the mine sump and void so the demand is met by groundwater inflows. During the early years of the project, the net demand is higher than the groundwater inflows to the mine. There will be some water stored in panels (without reject emplaced) and groundwater extraction from bores can occur within the existing Hume Coal licence, of which the full volume is not required to account for inflows until year 17 of the project.

3 Conclusion

In summary, Hume Coal considers that the issues raised by Mr White in his submissions to the IPC have been adequately addressed in the Hume Coal EIS, RTS and subsequent documents. As further demonstrated in this submission, Hume Coal has engaged numerous suitably qualified experts to design a robust underground reject emplacement system, thus avoiding the environmental impacts associated with a permanent surface emplacement of all rejects. If additional information or clarification is required, Hume Coal would be pleased to make its experts available to discuss the matter further with the commissioners.

4 References

AECOM (2018) *Tahmoor South Project Environmental Impact Statement, Appendix U, Rejects Disposal Study*

Chang, Q., Chen, J., Zhou, H. and Bai, J. (2014) *Implementation of Paste Backfill Mining Technology in Chinese Coal Mines, The Scientific World Journal, V2014.*

Hii, J.K. 1(990) *Development and use of coal washery refuse for underground strata control*, Wollongong University PhD Thesis.

EMM Consulting (2017) *Hume Coal Project Environmental Impact Statement*

EMM Consulting (2018) *Hume Coal Project Response to Submissions Report*

Mez, W. and Schauenburg, W., (1998) *Backfilling of Caved-in Goafs with Pastes for Disposal of Residues, 6th International Symposium on Mining with Backfill*, Minefill 98, 245—248, Brisbane, September.

Palaris (2019a) *Hume Coal Project Reject Emplacement Methodology*

- (2019b) *Hume Coal Project Backfill Emplacement Schedule*

Palarski J., (1994) *Design of backfill as support in Polish Coal Mines*, The Journal of The South African Institute of Mining and Metallurgy, 94(8):218-226.

QPS (2019) *Hume CHPP Backfill Concept Design Report*

Tarrant, G., Gilroy, T., Sich, G., and Nielson, D. (2012) *Metropolitan Mine underground emplacement of coal rejects – A case study*, 12th Coal Operator's Conference, University of Wollongong & AusIMM, 52-59.

Xu, J., Xuan, D. and He, C., (2014) *Innovative backfilling longwall panel layout for better subsidence control effect—separating adjacent subcritical panels with pillars*, Int J Coal Sci Technol, 1(3):297–305.

Xuan, D., Jialin, X., and Zhu, W., (2013) *Backfill mining practice in China coal mines*, Journal of Mines, Metals and Fuels, 61, 225–234.

Yang, B. (2015) *The pipelines pumping characteristic of coal ash slurry in high concentration cemented material backfilling mining in coal mine*, Journal of Chemical and Pharmaceutical Research, 7(1):785-791.

Yang, B., Li, Y., Dang, P., Peng, Y and Wang, Y., (2015) *Influence of fly ash on performance of high concentration cemented backfill material in coal mine*, Journal of Chemical and Pharmaceutical Research, 7(2):351-356.

Zhang, Q., Hu, G. and Wang, X., (2008) *Hydraulic calculation of gravity transportation pipeline system for backfill slurry,* J. Cent. South Univ. Technol, 15:645−649.

Zhang, J., Li, M., Taheri, A., Zhang, Weiqing & Wu, Z. and Song, W., (2019) *Properties and Application of Backfill Materials in Coal Mines in China*, Minerals, 9:53.