



## Berrima Colliery



*July 2022*

# ***Berrima Colliery Rehabilitation Management Plan July 2022***

## **Summary Table**

Name of mine	Berrima Colliery
Rehabilitation management plan commencement date	2 July 2022
Rehabilitation Management plan revision dates and version numbers	2 July 2022, Version 1
Mining leases	Consolidated Coal Lease 748, MPL603 and 604
Name of lease holder	Boral Limited
Date of submission	1 July 2022

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# 1. Introduction

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This Rehabilitation Management Plan (RMP) covers the period from 1 July 2022 to 1 July 2025 for Berrima Colliery and the former Loch Catherine Colliery within Consolidated Coal Lease 748 as shown on Plan 1a. This RMP covers the continuation of final rehabilitation work and implementation of the passive water treatment process at the Berrima Colliery Pit Top. Boral considers the completion of the passive water treatment system as being part of the final mine closure activities as it satisfies the outstanding issues associated with dealing with the groundwater discharge from the mine. It is recognised that this aspect of the mine closure has yet to be approved by the Resources Regulator.

Boral considers the passive treatment system as being a long term sustainable reuse of the mine site however this RMP does not propose to relinquish CCL748 over the underground mining or pit top surface infrastructure domains. There may be opportunities to reduce the extent of CCL748 but these will be discussed in more detail with the Resources Regulator.

To facilitate the pumping of groundwater to the pit top for treatment, a series of additional underground bulkheads will be installed. As these will effectively flood the pit bottom area, normal access to the workings will be prevented. The Resources Regulator has indicated that a re-entry plan will be needed should access to the workings be required some time in the future. The development of the re-entry plan will be completed within the term of this RMP.

During the period when access to the mine workings is unavailable, an application to remove certain statutory positions, inspection requirements and similar obligations under the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 will be made.

This RMP has been prepared in accordance with Clause 9 of Schedule 8A to the Mining Regulation 2016, and recognises that ongoing environmental obligations are required to be met including continued environmental monitoring, management and rehabilitation at the site. It replaces the existing approved Stage 1 Final Closure Mining Operations Plan (MOP). This RMP provides no additional information or closure commitments other than those previously contained in the Stage 2 Final Closure MOP which were still subject to ongoing discussions with the Closure Working Group (CWG) at the time the RMP process came into effect.

This RMP adopts the new regulatory framework established by the Mining Amendment (Standard Conditions of Mining Leases – Rehabilitation) Regulation 2021 which came into force on 1 July 2022. The contents of this RMP have been developed following four years of investigations into methods to deal with the mine discharge. These investigations were detailed in the Stage 1 Closure MOP and the results have been progressively reported to relevant stakeholders and the community members of the CWG. These investigations, including the results of an updated groundwater model have led Boral to the conclusion that the long term sustainable and environmentally responsible solution to the mine groundwater discharge is to pump the water from the mine to a purpose built passive treatment system at the current pit top prior to discharge back into the Wingecarribee River.

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The new discharge point back into the Wingecarribee River would be accessible from the existing mine bridge allowing easier inspection and monitoring. This new discharge point would require a modification to the existing Environmental Protection Licence. Treating the water on the surface at the current pit top provides significant benefits over the existing underground treatment system including removal of the statutory provisions for the operation of an underground coal mine and reduced operating and maintenance costs.

Treating the water at the surface also increases the flexibility needed in the treatment process to ensure that the water quality is maintained at or better than the historic discharge quality. This flexibility may include additional pH adjustment, aeration or settlement time which can be difficult to manage within the confines and restrictions of an underground mine. It also provides the ability to beneficially reuse the water and it is Boral's intention to obtain separate approval to transfer this groundwater to the Berrima Cement Plant via an overland pipeline within the existing railway corridor.

The proposed rehabilitation works have been designed around achieving the repurposing of the site. This will include the use of some buildings at the pit top, dam structures, hardstand, access and services. The Berrima Colliery coal workings will be sealed but in accordance with an approved re-entry plan. The work will adhere to Clause 35 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014, but the seal design will include pipework to access the flooded mine workings. In accordance with Schedule 3, Clause 10 of the same regulation, the sealing work will be classed as a High Risk Activity and will be subject to detailed risk review and assessment. The re-entry plan will be developed in consultation with the Resources Regulator.

The ventilation facilities will be removed but the bridge over the Wingecarribee River will remain. The Loch Catherine site will be rehabilitated and the four mine entries sealed. All excess privately owned land around the immediate pit top facilities will be made available for sale. This RMP also covers the final resolution of groundwater supply and subsidence related issues within the previous mining area. The specific activities covered by this RMP are detailed in Table 6.1 Completion Criteria.

## **1.1 History of Operations**

Berrima Colliery operated between 1926 and November 2013 supplying coal primarily to the nearby Berrima Cement Works, owned by Boral. The decision to cease production at Berrima Colliery was outlined in Boral's media release on 23 October 2013 which cited planning uncertainties associated with the ongoing legal challenges brought about by the Southern Highlands Coal Action Group and supported by the Environmental Defenders Office.

On the 1<sup>st</sup> July 2014 it was announced by Boral that approval was being sought from the State Government to permanently close the mine. Following this announcement there were meetings with NSW Department of Planning & Environment – Resources Regulator and the Environment Protection Authority (EPA), Water NSW and Department of Primary Industries - Water in August 2014.

A Final Closure Plan MOP was lodged on November 2015 however given the complexity of some aspects of the final closure arrangements, the Resources Regulator requested that final closure process be staged. The Stage 1 Closure Plan MOP was approved on 22<sup>nd</sup> October 2019 and covered a period of scientific investigations and preparation works which

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would lead to final closure. The Stage 1 Closure MOP included the construction of a series of seven underground bulkheads designed to test the assumptions of the original groundwater model.

The results of this work used to update the groundwater model, the results of which are attached as Appendix B. The updated model confirmed that given the design of the mine coupled with the highly permeable overlying strata, it is not possible to prevent groundwater from entering the Wingecarribee River at the existing point source. However, by maintaining the water level at or near the top of the bulkheads by pumping to the surface as currently proposed will reduce the discharge to minimal levels.

This has led Boral to determine that the only long term solution is treat the water at the existing pit top and either discharge back into the River or beneficially reuse the water that would otherwise discharge from the mine by constructing a pipeline from the Berrima Colliery Pit Top to the Berrima Cement Plant.

At this point it would be inappropriate to hold a mining title over an industrial activity that is unrelated to coal mining or processing. It is likely the application for relinquishment will be made at the end of 2024 and after the transfer of the section of CCL748 which exists along the rail line between the Berrima Cement Plant and the Main Southern Railway.

## **1.2 Consents Leases and Licences**

Berrima Colliery currently operates under the provisions of the Mining Act 1992, Section 109 of the Environmental Planning & Assessment Act 1979 and Protection of the Environment Operations Act 1997.

Berrima Colliery currently holds the following approvals and licences:

- Consolidated Coal Lease 748
- MPL 603 and MPL 604
- Environment Protection Licence 608
- Groundwater Access Licence 10WA118776

Project Approval 10\_0172 issued under Part 3A of the Environmental Planning and Assessment Act in June 2012 was rescinded to the Land and Environment Court in June 2014. Subsidence Management Plan approval 08/2956 was allowed to lapse in September 2014 while the 2013 SMP modification for 406 and 407 Panels was not enacted as mining ceased. Authorisation 7063 was allowed to lapse in August 2015 and was subject to formal relinquishment in February 2019.

MPL603 and MPL604 run on the northern and southern side of the rail spur between the Berrima Cement Plant and the Main Southern Railway line as shown on Plan 2d. There is also a section of CCL748 which also extends along this section of the spur line. As the cement plant still uses this railway line along with two other users, it is not subject to any closure activities. An application will be made to separate the section of CCL748 which extends from the cement plant to the Main Southern Railway Line. This section of CCL748 may then be amalgamated with the adjacent MPL603 and MPL604 into a single title to be held by Boral Cement Limited.

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Berrima Colliery currently does not have approval to carry out coal extraction activities. Existing use rights remain for care and maintenance activities. Closure activities are covered by the Mining Lease and provisions of the Mining Act 1992 and Mining Regulation 2016.

### **1.3 Proposed and Future Operations**

Under this RMP, all rehabilitation activities leading to lease relinquishment for all areas other than the pit top water treatment facility, will be undertaken. This includes repurposing the previous pit top area to passively treat the mine water prior to discharge or reuse, sealing of the Loch Catherine entries, rehabilitation of disturbed areas that will be subject to sale and removal of any remaining monitoring equipment within the previous extraction area.

#### **1.3.1 Period**

Under the rehabilitation reforms, RMP documents have a life of three years. Therefore the effective period of this RMP will be 1 July 2022 to 1 July 2025.

### **1.4 Land Ownership and Land Use**

The Berrima Colliery Pit Top and Loch Catherine sites are owned by Boral. The land above the previous extraction area and historical underground workings is predominantly privately owned. All land required to support the passive water treatment and transfer system will remain while any excess Boral owned land will be rehabilitated to a standard suitable for private sale. Rehabilitation work will involve normal preparation for sale activities which would provide a return on the sale value. These activities would include removal of any rubbish, debris, fencing repairs and paddock improvements but also may extend to obtaining Council consent for building envelopes, boundary realignment or subdivision to maximise the value of the land.

### **1.5 Consultation**

There has been significant ongoing consultation with government organisations since Boral notified that it would seek final closure approval. The consultation effort has principally been related to the various options surrounding final closure. This issue has resulted in delays to the approval of the Final Closure Plan and has in effect resulted in the need for a staged approach to final closure. Key agencies involved in the process since 2013 include:

- Department of Planning and Environment - Resources Regulator
- Environment Protection Authority (EPA)
- Department of Primary Industries - Water (DPI-Water)
- NSW Office of Environment and Heritage
- WaterNSW
- Wingecarribee Shire Council

Consultation will continue during the approval process for the final closure plan and has been facilitated by the establishment of a Community Working Group (CWG). The CWG has met regularly since mid-2018. The CWG meetings are independently chaired and include the following government agencies:

- ❑ NSW Resources Regulator.
- ❑ NSW Environment Protection Authority.
- ❑ Water NSW.
- ❑ Wingecarribee Shire Council.

There are six community representatives in the CWG as well as Dr Ian Wright from the University of Western Sydney who has been previously involved in water quality and aquatic ecology studies. Key Boral representatives attend each meeting and provide an update on the closure activities. The meetings cover all aspects of the mine closure process and communication strategies.

The communications strategy also includes newsletters which are available to the local community, community open days and a dedicated website which hosts up to date information on the closure process, environmental studies and monitoring data as well as the minutes for the CWG meetings.

### 1.5.1 Government Review of the Previous Stage 2 MOP

Following the lodgement of the Stage 2 Final Closure MOP on 11<sup>th</sup> November 2020, the Resources Regulator issued a request for additional information (reference MAAG0009122). Additional information was also provided by the EPA via an email on 5<sup>th</sup> March 2021. The requested information centred on updating the groundwater model to consider the additional data that has been derived from the existing seven bulkheads installed in the underground workings in May 2019 and the repercussions of this on the proposed final closure scenario outlined in the Stage 2 MOP. The comments provided are summarised in the following table.

**Table 1.1 – Government Review of Stage 2 MOP**

<b>Authority Requirement</b>	<b>Results of Assessment</b>
Resources Regulator letter MAAG0009122	
Model a no pump scenario with projected water discharge volumes and quality e.g. what happens if Boral can no longer maintain a pump to dewater the mine/long term full closure	The groundwater model was updated and the results presented in Appendix B. The updated model confirmed the results of the 2015 model that due to the permeability of the overlying sandstone and the direction of fall of the seam, any attempt to fully seal the mine with bulkheads will fail to stop the flow of water being discharged from the mine
Quantify the effectiveness of the bulkheads at retaining groundwater e.g. what percentage of water bypasses through the strata	The groundwater study demonstrated that the bulkheads were effective at retaining groundwater only when pumping at a rate that avoids saturation of the overlying strata. The model found that without pumping the long term discharge from the drain adit would be similar to the historic average at 2.6 ML/day which means up to 93% of the water will ultimately bypass the bulkheads.
Under the no pump scenario consider the effectiveness of additional bulkhead installations to further reduce the impact on the environment from discharge water e.g. Scenario 1 - fully sealed option with installation of the 14 underground seals.	The groundwater modelling found that, irrespective of the number of bulkheads installed, the long term discharge would be similar to the historic groundwater discharge rate.

Environment Protection Authority	
Provide the confidence-level classification for the re-calibrated model in accordance with the Australian Groundwater Modelling Guidelines.	The model is still referred to as Class 1 under the Australian Groundwater Modelling Guidelines.
Revised model conceptualisation should provide more detail using data collected after the 2015 report. The conceptual model should explain (qualitatively and quantitatively) observed groundwater behaviour in the mine and region.	The data used to recalibrate the model has included actual recorded discharge data, bore data within the mining area, seepage data from the bulkheads already installed and additional survey data of the underground workings. Details of the model and observed groundwater behaviour is described in full in Appendix B of this RMP
The EPA understand a large amount of flow and pressure head data is available since installation of bulkheads in the mine providing the opportunity for model verification be undertaken. The results of verification should be provided and if verification is not undertaken, reasons should be given for not doing so	The model verification process is described in Appendix B. The model was calibrated to piezometric heads and outflows with a cumulative mass balance error of below 1%. As described in the Australian Groundwater Modelling Guidelines (Barnett et al, 2012), an acceptable level of error is less than 10%.
The principal output of concern to environmental regulators is the volumetric flow rate from the adit discharge under the proposed scenarios, and also the groundwater flow exchange with the Wingecarribee River. These model outputs should be presented numerically and graphically with realistic estimates of the uncertainty of the results	Appendix B provides graphical results of the revised groundwater model and includes an analysis of the long term implications for the Wingecarribee River. The updated model indicates that the proposed additional four bulkheads around pit bottom will increase water levels in private water supply bores by 1 to 2 m but will only provide an inconsequential benefit to groundwater contribution to the Wingecarribee River.

The updated model confirms the original groundwater study that given the design of the mine coupled with the highly permeable overlying strata, that it is not possible to prevent groundwater from entering the Wingecarribee River at the existing point source. However, by maintaining the water level at or near the top of the bulkheads by pumping to the surface as currently proposed will reduce the discharge to minimal levels.

## 2. Final Land Use

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### 2.1 Regulatory Requirements for Rehabilitation

Berrima Colliery does not hold an approval under the Environmental Planning and Assessment Act 1979. There are also currently no specific rehabilitation activities required by the Environment Protection Licence. The regulatory framework for the rehabilitation therefore rests solely with the Mining Act 1992 and Mining Regulation 2016. The rehabilitation objectives and completion criteria are therefore based on the previous Final Closure MOPs that have been provided to the Resources Regulator as well as the specific requirement under the Environment Protection Licence to develop a passive water treatment plant at the pit top.

The Colliery's Environment Protection Licence (EPL 608) which specifies that the licence holder is to install a passive water treatment system and pipeline to the Berrima Cement Works. Condition U1.1(3) of EPL 608 also specifies that an environmental assessment be prepared that identifies potential environmental impacts from the construction and operation of the facility and which provides details of any necessary mitigation measures. This approval is currently being sought and once obtained there will be an additional regulatory requirement covering the ongoing industrial usage of the surface facilities.

### 2.2 Final Land Use

This RMP describes the Stage 2 final closure rehabilitation activities at Berrima Colliery which have progressed under the previous Stage 1 Closure MOP. Activities described in this RMP include the establishment of a passive treatment system at the current pit top however this RMP does not propose to relinquish CCL748 over the underground mining or pit top surface infrastructure domains. There may be opportunities to reduce the extent of CCL748 but these will be discussed in more detail with the Resources Regulator.

The key elements of the closure process will be as follows:

- Where reasonably practicable the conclusion of all remaining landowner issues within the mining area.
- Removal or making safe all subsidence monitoring pegs within the mining area.
- Rehabilitation of the vibrating wire piezometer sites BH62 and BH63.
- Transfer of ownership of any remaining water supply infrastructure if reasonably requested by the landowner or removal of any remaining water supply or monitoring equipment as reasonably requested by the landowners.
- Install 4 additional underground bulkheads around the pit bottom area to provide an area to pump water from the mine without the need for further underground access, except as agreed with the Resources Regulator under an approved mine re-entry plan. The pumping equipment will be located at the drift roadway at pit bottom.
- Water transfer system from the underground bulkheads to the pit top utilising the existing drift bridge and cutting.

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- ❑ Seal the main drift entrance to the satisfaction of the Resources Regulator but to include provisions for water to be pumped from the underground workings. The drift entrance will still need to be accessed by a controlled system of entry to be designed and installed to the satisfaction of the Resources Regulator. The underground coal workings will be sealed
  - ❑ Remove the ventilation fan and seal the fan entry to the satisfaction of the Resources Regulator.
  - ❑ Seal the Loch Catherine Mine Entries as approved by the Resources Regulator.
  - ❑ Construct a passive (primary) water treatment facility at the current Pit Top.
  - ❑ Demolition any remaining surface infrastructure not required for the water transfer project.
  - ❑ Install an overland pipeline from the Pit Top to the Berrima Cement Plant using the existing railway easement. This aspect does not form part of mine closure and is being considered as a stand alone project.
  - ❑ Undertake final rehabilitation as necessary for the private sale of any remaining land owned by Boral that is surplus to requirements.

Specific activities covered by this RMP are described in the following sections. These include activities that were not completed under the Stage 1 Closure MOP. Further details of rehabilitation activities are provided in Section 5.

### **2.2.1 Pit Top**

The Pit Top will be repurposed as part of the proposed water transfer project. This will involve the removal of the conveyors, crusher, product loading bin and associated structures. The office, bathhouse, workshop, storage shed, dams, water supply tanks and services will remain. The mine access bridge of over the Wingecarribee will remain.

The Pit Top will house a simple passive water treatment process consisting of above ground tanks, series of settlement ponds and pumping equipment as shown on Plan 4a. The settlement ponds will be used to aerate the water to facilitate settlement of iron and manganese. Some additional chemical oxidation may be used as well as flocculants.

The existing dams will be used and additional dams constructed for both stormwater control and settlement of solids from the treatment process. The two existing concrete tanks will be retained for general water supply and firefighting purposes while the additional settlement dams and tanks will be installed to receive raw groundwater prior to treatment. Treated water can then be returned to the Wingecarribee River or be pumped via a pipeline laid predominantly underground from the Pit Top to the Berrima Cement Plant.

### **2.2.2 Product Stockpiles (Loch Catherine Site)**

The existing coal storage facility at the adjacent Loch Catherine site will be rehabilitated to a standard suitable for resale. The rehabilitation work began at the end of 2018 and is described in Section 5.1.8. Access to the Loch Catherine drift will remain until these entries are sealed and then rehabilitated.

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### 2.2.3 Extraction Area

The regular monthly subsidence monitoring ceased in May 2014, being 7 months after coal extraction ceased which was followed by a final survey in May 2015 being 19 months after coal extraction ceased. Boral sought approval to cease subsidence monitoring but was subsequently required to undertake additional monitoring of the GPS. The GPS locations included various structures and dams around the mining area. This will be undertaken as part of this RMP following which the monitoring pegs and base station will be removed or made safe, as described in Section 5.1.11. As access to a critical property located in the middle of Southwest 1 Panel has remained unavailable, it has not been possible to undertake any further surveys of the original subsidence lines. This is because the original subsidence lines are made up of a series of pegs located 10m apart and need to be surveyed together to determine incremental movement along the panel.

### 2.3 Domains

Previous MOPs divided the site up into both operational and rehabilitation domains. As the site has been subject to rehabilitation activities for several years, the previously described operational domains are no longer relevant while the secondary or rehabilitation domains have been expanded. This is particularly relevant given that some of the previous operational domains will continue but with different functions while the primary mining domains will be subject to lease relinquishment.

The previous Stage 1 MOP described 11 primary domains and two rehabilitation domains. These primary domains are shown on Plans 2a to 2e. This RMP divides the site into the following final land use domains which are shown on Plans 4a to 4c:

- ❑ Private agricultural land. This domain represents the previous extraction area which currently is subject to monitoring activities but will be unencumbered on completion of monitoring activities and lease relinquishment.
- ❑ Primary Water Treatment. This domain covers the pit top area previously described by 7 separate operating domains. Under this RMP, the water treatment operation will continue at the pit top and will not be subject to lease relinquishment. It has been noted as an industrial land use.
- ❑ Loch Catherine Mine Entries and Drift – Native Forest. As described in the Stage 1 Closure MOP, these entries will be sealed and the area returned to native forest. The lease over the Loch Catherine site will be subject to lease relinquishment to allow private sale.
- ❑ Overland pipeline to Berrima Cement Plant. This secondary domain covers the continued use of the original railway easement to transfer water to the cement plant. The land is privately owned and the pipeline will continue post lease relinquishment.
- ❑ Rehabilitation suitable for sale. This domain covers all remaining areas that are not required for the ongoing water transfer project.

### 2.4 Mine Sealing

Berrima Colliery originally had a total of five mine entries, as shown on Plan 2c. These were referred to as:

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- ❑ Main drift portal – this is the main men and materials entrance to the mine and is also used for the coal conveyor leading to the surface, air intake and services.
  - ❑ Fan portal – this entry is located adjacent to the main drift portal and houses the ventilation fan.
  - ❑ Drain adit – this is the original mine entry dating back to 1872 and is located above the Wingecarribee River approximately 700 m south of the main drift portal. This adit is used to discharge groundwater collected within the mine.
  - ❑ Two entries located near Bowmans Creek.

Under the previous Stage 1 Closure MOP, the two Bowmans Creek entries and Drain Adit were permanently sealed with the latter having permanent drainage facilities installed. Under this RMP the main drift and fan portal entries will be sealed. The fan portal will be sealed in accordance with NSW Trade and Investment Mine Safety guidelines (MDG 6001 – Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams).

As shown on Plan 5a, the sealing of the men and materials entrance will consist of three bulkheads at seam level around the pit bottom area and a forth seal in the drift just above the coal seam. The drift seal will be equipped with pumping infrastructure. The remaining drift decline will be repurposed for water supply. The current metal gates at the entrance to the drift will remain and access will be available to the drift seal and pumps. Ventilation will be provided separately and only when access is required. Boral will seek approval from the Resources Regulator to relinquish the mining lease over these facilities.

The sealing of the Loch Catherine adits were approved under the State 1 Closure MOP and will be completed under this RMP. As described in Section 5.1.10, the sealing activities involve filling Adit 1 with local rock material using an excavator, installing steel grate barriers within Adits 2 and 3 and erecting an additional steel barrier fence between Adits 2 and 3. The barrier fence will prevent access to Adit 4 which lies below an unstable section of cliff which is not safe to work beneath.

The design allows bats to enter and exit the old mine workings and the site will be rehabilitated on completion.

## **2.5 Building and Structure Removal**

All buildings and structures not required to support the water treatment and transfer project or future divestment for a rural residential use will be demolished and removed. This will predominantly involve all coal handling and transfer infrastructure. Methods will comply with Australian Standard AS 2601 Demolition of Structures. This includes the requirements to reduce the risk of injury to workers and the public as well as specific procedures for manual and mechanical techniques, use of earthmoving equipment, protection of the immediate environment and general health and safety provisions.

Buildings to remain, including the mine office and bathhouse complex have been subject to asbestos removal and clearance certification. The engineering office, workshop and storage shed will remain and where necessary refurbishment to ensure fit for purpose. The mine bridge over the Wingecarribee River will remain to support the passive surface treatment process. This process is described in the following section.

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## 2.6 Passive Surface Treatment of Mine Water

Since the closure of Berrima Colliery in 2014, the primary environmental issue has been the discharge of mine water to the Wingecarribee River. While the mine was operating, the discharge was actively managed within the underground workings through a simple aeration and settling process. Without this passive treatment process, the discharge water would contain elevated minerals. It was therefore necessary to maintain an underground treatment system during the closure process to ensure an acceptable discharge quality which is in line with historic levels.

Following engineering, geotechnical and groundwater investigations it was determined that it was not possible to seal the mine workings in a manner which would contain the water within the mine. The groundwater modelling has shown that the bulkheads are only effective in containing water to a few metres above the bulkheads for a relatively short period of time. As the mine workings become flooded and the pressure increases, the water seeps from the Lower Hawksbury Sandstone and the mine void, ultimately equalling the historic discharge from the mine. The end result of an attempt to fully repressurise the groundwater would be short lived with groundwater passing over the bulkheads and discharging into the river at the existing drain adit. The rate of discharge would ultimately be around 2.6 ML/day which is only slightly less than the historic average.

Boral has determined that the only realistic long term solution is to pump the mine water to the surface for treatment prior to releasing back into the Wingecarribee River. By essentially replicating the underground passive treatment system on the surface at the existing pit top facilities reduces both cost and complexity compared to ongoing treatment within the underground mine. As shown on Plans 5a and 5b, the surface treatment system would consist of a 6 ML multi cell dam which would allow the water to be aerated and settled several times. Limestone would be used to raise the pH as needed to assist in mineral settlement. The cells will be linked but also isolatable to assist with sediment clean out. From the final cell, the water can be sent to either a discharge point for return to the river from a new licensed discharge point. The new discharge point would see the water enter the Wingecarribee River in a more accessible location near the mine bridge.

Although ponds are preferred, above ground tanks may also be incorporated into the system. The use of tanks can assist with water pumping and transfer or the mixing of additives and aeration. As shown on Plan 5b, the two existing tanks which were used for firefighting purposes will be retained for onsite usage such as wash down, dust suppression and ablutions.

The proposed surface treatment of the mine water also presents an opportunity to pump the water to the Berrima Cement Plant via a pipeline located along the existing railway easement. The cement plant currently uses around 600,000 litres per day which is obtained from a licensed pump out from the Wingecarribee River upstream of the township of Berrima. The ability to transfer water to the cement plant will provide security of supply which can be severely restricted during times of drought.

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## 2.7 Activities over the RMP Term

This RMP covers all remaining activities leading to the relinquishment of the mining lease over the mining area, Loch Catherine sites, and the old railway easement leading to the cement plant. The section of CCL 748 between the Cement Plant and the Main Southern Railway Line will be either transfer to the Berrima Cement Plant or otherwise amalgamated into the adjoining MPL 603 and MPL604. In summary, activities to be undertaken under this RMP include:

- Finalise all outstanding land owner issues within the previous SMP area and remove remaining monitoring equipment.
- Continue monitoring of the additional ambient water quality sites until such time as the Environment Protection Licence is modified to reflect the water transfer operation;
- Repurpose existing buildings and sheds to cater for the water treatment and transfer project and remove any remaining coal handling infrastructure;
- Rehabilitate the Loch Catherine Coal Stockpile area as outlined in this RMP;
- Installation of the additional internal bulk heads around the pit bottom area and install pumping equipment;
- Complete the Loch Catherine Mine Entry seals or approved barriers;
- Rehabilitate the Loch Catherine Drift cutting on completion of the barrier construction as outlined in this RMP;
- Remove ventilation equipment and install a permanent seal on the fan entry;
- Weekly inspections of surface infrastructure and pollution control systems until such time as the pit top has been repurposed;

Consultation with regulatory authorities will continue over the RMP period, specifically in relation to the proposed final land use and mine entry post installation of bulkheads around pit bottom.

### 2.7.1 Water Management Improvements

Since the commencement of the closure process, Boral has implemented several phases of water management improvements. These commenced with establishing an underground passive limestone treatment system involving aeration and settlement prior to discharge into the Wingecarribee River. The system was designed in consultation with the EPA and Resources Regulator. This included the installation of a separate pump line from the flooded section of the mine workings which discharged into a previously dry roadway within the old workings. The roadway was lined with limestone aggregate while aeration was provided by an intervening above ground metal sump. Additional monitoring points within the river have been established and sampled on a monthly schedule since the beginning of 2018, to verify the improvements in water quality. The additional monitoring points are described in the following section and shown on Diagram 1.

Under the previous Stage 1 Closure MOP seven underground bulkheads were strategically installed for the purposes of verifying the conclusions from the original groundwater model which had determined that it was not possible to completely seal the mine. The bulkheads were installed in May 2019.

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The bulkheads raised the flooded section of the mine in some parts to a point above the level of the roof. This resulted in some minor water migration through the overlying strata above the bulkheads due to increase water head. The purpose of the bulkheads was to provide additional data to refine the 2015 groundwater model which is contained as Appendix B.

Data gathered since the installation of the bulkheads has included water level and pressure behind the bulkheads, pumping rates, leakage and water quality. This data was then used in the updated groundwater model along with more accurate seam floor data, permeabilities and water level data from groundwater bores.

### **2.7.2 Environmental Monitoring Activities**

Environmental management and monitoring activities are undertaken accordance with the Environment Protection Licence (EPL) 608. On 21<sup>st</sup> December 2017, the EPA varied EPL 608 to include additional conditions in relation to water treatment and management prior to discharge. These conditions were satisfied with the final reporting lodged with the EPA in February 2020. The Resources Regulator has also requested additional monitoring activities during the closure process. A summary of the current monitoring program is provided below, however the program will likely reduce once the pit top water treatment project is operational. The current monitoring sites are shown on Plans 3b and 3c.

#### **Water Discharge**

Water that accumulates in the underground workings currently discharges via the drain adit into the Wingecarribee River. The water was allowed to build up behind the bulkheads in order to generate data to verify the veracity of the 2015 groundwater model. In December 2019 pumping through the underground treatment system recommenced to maintain the water level at the highest bulkhead. The volume discharged is currently around 1.9 ML/day. This compares to a long term average of around 2.7 ML/day when the mine was operating.

The recalibrated groundwater model has indicated that if the level of water behind the bulkheads is allowed to increase, say in the event of cessation of pumping, the discharge from the adit will eventually reach around 2.6 ML/day. This is due to the high permeability of the overlying Hawkesbury Sandstone and the original design of the mine workings which naturally drain to the lowest point in the mine, being the licensed drain adit point.

Water discharge volume and water quality will continue to be monitored at the licensed point (Adit Discharge) on a monthly basis in accordance with the current EPL conditions. These conditions are expected to vary when the pit top water treatment project has been commissioned as access to the current licensed discharge point within the underground workings will not be available.

#### **Wingecarribee River Water Monitoring**

EPL 608 specified ambient water quality monitoring in the Wingecarribee River to be conducted for a two year period which ended in early 2020. The original 4 monitoring locations within the Wingecarribee River consisted of two sites upstream of the discharge point and two downstream of the discharge points (Plan 1c). These monitoring sites were augmented to include additional sites to provide a better indication of water quality downstream of the mine discharge. These additional monitoring sites, shown on Plans 3b

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and 3c and described below will not be required once the water treatment and transfer project is operational as the discharge from the adit drain will be minimal and a new discharge point from the pit top will be established.

- ❑ Upstream at the mine entry bridge). This site provides an immediate upstream water quality control.
- ❑ 1 km downstream of the adit discharge, provides data on discharge mixing within the river.
- ❑ 2 km downstream but upstream of the confluence with Medway Rivulet. Located just upstream of the first natural inflow into the river, this site provides further data on mixing within the river.
- ❑ Medway Rivulet (reference site). This site is not influenced by either the mine discharge or other water quality influences such as the sewage treatment plant and runoff from agricultural land.
- ❑ 3 km downstream of the adit discharge. This site provides data on the mixing zone after the influence of the Medway Rivulet.

The timing of the river monitoring generally corresponds to the discharge monitoring.

These additional sites are generally monitored monthly within a day of the licensed ambient sites being monitored in accordance with the EPL as amended on 21<sup>st</sup> December 2017. Variations to the EPL are likely to occur during the course of final closure and the monitoring program will be adapted as required or as otherwise directed by either Resources Regulator or EPA. Access to the discharge point and the immediate upstream site has proved difficult to achieve with an acceptable level of risk. As a result, the licence now includes the river below the access bridge as an alternative to the 100 m upstream site, as shown on Diagram 2 and Plan 3c. This point will likely remain once the surface passive treatment system is installed as the treated return water will enter the Wingecarribee River at this location.

Once the surface water treatment system is in place, an application will be made to the EPA to modify the EPL to allow the relocation of the main mine discharge point from the adit to the pit top to allow the treated water to pass back to the river at a different location. The entry point of treated water will likely be just upstream of the existing mine bridge allowing easy access to the river should further monitoring of the river be required. This removes the issue of inaccessibility of the current discharge point. Initially, approval will be sought to discharge the same volume back into the river however over time and once the overland pipeline project is installed, the volume discharged back into the Wingecarribee River will be significantly lower than historically.

Additional aquatic ecology assessments of the Wingecarribee River were undertaken during 2017 and 2018 by Niche Environment and Heritage as part of the requirements for the Performance Monitoring Program under EPL 608. The aquatic ecology study aimed to assess changes in macroinvertebrate composition and abundance along the mixing zone and over time, following the water treatment system installation. Sampling times and locations were taken in conjunction with the water quality testing. The results of the studies were reported in February 2020 and no further assessment is considered necessary.

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### **Dust Monitoring**

Given the lack of activity at the pit top, dust monitoring has been discontinued and is no longer a requirement of the EPL.

### **Subsidence Monitoring**

Coal extraction ceased in October 2013 and all subsidence monitoring was discontinued following the last survey of 11<sup>th</sup> May 2015. Subsidence monitoring was undertaken monthly up until 20<sup>th</sup> May 2014. A final survey was taken 12 months later, on the 11<sup>th</sup> May 2015. On 1<sup>st</sup> August 2019, approval was received from the Principal Subsidence Engineer – Mine Safety Technology to cease subsidence monitoring and removal of the subsidence pegs with the exception of the approved GPS monitoring points. These points exist on certain structures such as major dams and buildings as well as the South West 1 Panel slope. All subsidence data has been provided to the Resources Regulator and Subsidence Advisory NSW.

Due to continued access problems, the central portion of South West 1 Panel cannot be surveyed. Given the subsidence measurements are taken along the panel at 10 m intervals with two cross line surveys, the lack of access to the central part of the panel prevents any additional surveys from being undertaken.

## 3. Rehabilitation Risk Assessment

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### 3.1 Environmental Risk Assessment

The following key risk assessments and management activities have been undertaken to date:

- Initial risk assessment. High Level to identify the issues.
- Feasibility Assessment for sealing. Identified residual risks requiring detailed Technical Assessment.
- Technical Assessments – Hydrogeological and Engineering.
- Withdrawal from 400 Panel Risk Assessment. Determine the safe sequence of removal and specified equipment to be recovered.
- Design and Installation Risk Assessment for seals. By experienced mine seal designer and contractor.
- Surface demolition and Bridge Removal.
- Asbestos Containing Materials Risk Assessment and Management Plan. Berrima Colliery now has an Asbestos site register.
- Preparation of a Review of Environmental Factors covering the final closure activities.
- Undertaking a NorBE Assessment which found that the project will have a long term neutral impact on receiving waters but highlighted the risk of a deterioration of water quality.

The risk assessment process commenced in late 2014 which was updated by additional risk assessments in 2015, 2016, 2017, 2018 and 2020. The scope of the risk assessment was as follows:

- Identify key environmental issues relevant to the closure of Berrima Colliery.
- Assess the environmental and engineering risks associated with sealing the mine.
- Identify risk reduction controls which can be adopted to manage the identified risks.
- Verify that the risk reduction controls will be effective in managing those risks to a level acceptable to Boral.
- Identify additional specific issue risk assessments that would be required during the closure process.

The initial risk assessment also identified several specific specialist studies that were required including preliminary engineering design, contamination assessment, heritage study and groundwater study. This additional data was then used in the follow-up risk assessment review. The risk assessment process has also identified many additional specific risk assessments covering individual tasks such as, installation of bulkheads, water quality deterioration, water treatment, and development of safe access within the Berrima mine as well as to the Loch Catherine mine entries.

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As required by Resources Regulator in the Section 240 Notice of 3 April 2018, consideration has also been given to public safety, bushfire and the bat colony located at the Loch Catherine entries.

### **3.2 Risk Assessment Summary**

The risk assessment process covered the following risk categories:

- Legal and Regulatory.
- Environmental, Community and Statutory.
- Hazards and Safety.
- Technical Issues.

The outcomes of the risk assessments have been provided in the both the Care and Maintenance MOP and Stage 1 Closure MOP. These outcomes are valid for this RMP. The primary risks for the RMP are related to water discharges and final sealing. The primary risk categories are related to water quality improvements, management of the surface, remediation and demolition. These are discussed in more detail in the following sections.

#### **3.2.1 Environmental Risk Management**

Berrima Colliery operated under a series of environmental management plans. The mine also operates under an approved Mine Safety Management System. The existing management framework will extend until final closure activities have been completed.

#### **3.2.2 Water Drainage**

The key environmental issue associated with closing Berrima Colliery is the longstanding water drainage into the Wingecarribee River. This aspect was subject to detailed investigations which has led Boral to propose that the mine be sealed but with the inclusion of water treatment and transfer to the Berrima Cement Plant. The recalibrated groundwater model has confirmed that any attempt to fully seal the mine would fail due to the permeability of strata above the coal seam and the original design of the mine workings which naturally flow to the drain adit. The key findings of the updated model are summarised below:

- Due to the high permeability of the sandstone strata above the Wongawilli Seam and the direction of fall of the seam, any attempt to fully seal the mine with bulkheads will fail to stop the flow of groundwater being discharged from the mine.
- Under any “no pump” or fully sealed scenario, groundwater will build up behind the in-seam bulkheads to a point where lateral seepage around and over the bulkheads will occur. This seepage will enter the drain adit and discharge from the current licensed discharge point at a long term rate of approximately 2.6 ML/day which is only slightly less than the historic discharge average.
- Constructing additional bulkheads will not materially change the volume of water being discharged from the mine or the baseflow contribution to the Wingecarribee River.
- It is likely that without treatment, the discharge will be heavily mineralised on release to the Wingecarribee River.

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- ❑ The existing seven bulkheads plus the additional four bulkheads around the pit bottom area will increase water levels in private water supply bores by 1 to 2 m but will only provide an inconsequential benefit to groundwater contribution to the Wingecarribee River.

The updated model confirms the original groundwater study that given the particular design of the mine coupled with the highly permeable overlying strata, that it is not possible to prevent groundwater from entering the Wingecarribee River at the existing point source. However, by maintaining the water level at or near the top of the bulkheads by pumping to the surface as currently proposed will reduce the discharge to minimal levels.

The water treatment and transfer project will provide water supply security for the cement plant which currently sources water from Wingecarribee River but has in the past purchased town water for its raw water and process water demand. The transfer project will significantly reduce the discharge from the drain adit however will include an additional overflow discharge point at the pit top near the bridge. Any monitoring conditions attached to this discharge point will be subject to negotiation with the EPA.

### **3.2.3 Contamination Issues**

A Phase 1 and 2 Site Contamination Assessment was undertaken by DLA Environmental covering the pit top and Loch Catherine Coal Stockpile Area which was undertaken during 2014 as part of the Closure Plan for the Colliery. These studies are the equivalent of the Preliminary Site Investigation (PSI) and Detailed Site Investigation (DSI) as currently defined under the National Environment Protection (Assessment of Site Contamination) Measure. A total of 60 surface and subsurface soil samples were taken at targeted locations.

Although the current land use is commercial/industrial, the assessment took into account potential future land uses by adopting the most conservative Health Investigation Levels (Residential A criteria). By achieving this criterion in the remediation work eliminates site contamination as an issue in any potential future land use for the site.

The results of the assessment found that there was some hydrocarbon contamination between the workshop and storage shed and around the apron of the diesel tank. These areas were targeted as there was visual evidence of previous minor spillages of fuel and oil. The test results showed only one result exceeding the Commercial/Industrial D criteria and a further 4 locations exceeding the Residential A criteria. The remaining sample sites met the more stringent Residential A criteria although several sites registered contamination levels above the level of laboratory detection.

The investigation showed that the site is suitable as is to continue as an industrial site however some remediation would be required to meet the Residential A criteria. The Recreation/Open Space criteria is less stringent than the Residential A criteria but essentially would require the same process of remediation. The methods of remediation are provided in Chapter 5 for each relevant domain.

### **3.2.4 Noise and Dust Management During Rehabilitation**

The majority of the demolition works associated with rehabilitation activities were completed under the Stage 1 Closure MOP. The construction of the passive treatment

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system will generate very minor levels of noise and dust. The colliery currently has a dust monitoring network covering the pit top, Loch Catherine and Medway Village area and these sites will remain during the rehabilitation program to assess the performance of dust mitigation strategies.

Noise monitoring occurred while the colliery was operational but has ceased during the Care and Maintenance and final closure program. When operational, the colliery operated a front end loader at the Loch Catherine Site and forklift and front end loader at the pit top. Trucks also loaded, unloaded and transported coal through the Village of Medway.

During Care and Maintenance and the Stage 1 activities, noise was reduced to minor sources including the surface trial activities, compressors, the winder associated with the dolly car and minimal surface vehicle movements. Unlike the operational phase of the mine, these activities do not occur at night or on weekends. Similarly during the RMP closure activities, any minor activities associated with the construction of the passive treatment system will occur during daylight hours only so the potential for adverse noise impacts will be minimal.

In past operations, noise complaints usually occurred during the early morning or evening periods. It is proposed to undertake the new dam construction activities between standard daylight hours of 7 am to 6 pm Monday to Friday. In this way, the potential for intrusive noise or otherwise generation of complaints is considered minor.

### **3.2.5 Traffic Management During Rehabilitation**

The rehabilitation work will require the delivery of plant and equipment, removal of rubbish and debris and delivery of general stores which will generate minor truck traffic through the village of Medway. When operational, the mine transported all coal produced by truck and the expected truck traffic during rehabilitation activities will be significantly less than previously experienced. Berrima Colliery operated with a Driver Code of Conduct which will be used for all truck movements to the site with the exception of the previously self-imposed 30 km/hr limit within the Village precinct. The current traffic limit is 50 km/hr which will be observed.

### **3.2.6 Geology and Geochemistry**

The Hawkesbury Sandstone is the main landform influence around Berrima Colliery although a small section of Wianamatta Shales exists above sections of the extraction area. The Hawkesbury Sandstone is a flat lying massive quartzose sandstone approximately 150 m thick and often represents the main cliff forming sequence. The overlying Wianamatta Group is a sequence of shales with minor interbedded sandstones laid down in the Middle-Triassic Period after the Hawkesbury Sandstone. Neither group has been known to display particular geochemistry that is limiting to rehabilitation activities, however the high permeability of the lower Hawkesbury Sandstone is the primary limiting factor in the ability to fully seal the mine.

It is known from drilling at Berrima Colliery that the Hawkesbury Sandstone consists of two separate bands. The upper band is more iron rich while the lower band is coarser grained and lower in iron. The Wongawilli Seam is lower in iron than other minerals.

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The primary source of minerals come from igneous intrusions which occur throughout the local area and to a lesser extent the upper Hawkesbury Sandstone. It is likely that these geological features will continue to be the primary influence on water quality discharged during the term of this RMP which will continue until the permanent water treatment system at the pit top is installed.

### **3.2.7 Spontaneous Combustion**

There has been no incidence of spontaneous combustion at the mine or Loch Catherine coal stockpile area during the history of Berrima Colliery. The risk of spontaneous combustion occurring is negligible and hence not considered a risk to the future rehabilitation of the site. Testing for propensity for spontaneous combustion indicated very low propensity - CB3 Technical Report\_TR6\_Delta Mining\_Berrima Colliery.

To avoid any risks, the Colliery has a gas monitoring system (gases sought CO and CH<sub>4</sub>) situated at the main fan. The monitoring system is connected to an external gas monitoring system and also to an external alarm. Monitoring confirms that the Colliery has little, or no gas make and there is no evidence of heating anywhere within the Colliery workings.

### **3.2.8 Materials Prone to Acid Mine Drainage**

There is little potential for the generation of acid forming materials during the rehabilitation of the site, as the surface geology of the pit top and Loch Catherine is Hawkesbury Sandstone. The Wongawilli Seam has not been known to generate acid drainage. As part of the final closure and rehabilitation of the site, the main mine portals will be sealed but the discharge of water from the underground workings may continue. Long term water quality monitoring shows that the average pH of the discharged mine water is near neutral (6.5 to 7.5) and poses no risk of acid mine drainage.

Acid mine drainage generally occurs from the oxidation of sulphide rich minerals which cause high sulphate levels and in turn produce sulphuric acid. As pH falls, metals and metalloids become soluble and leach into receiving waters.

The prime sulphide responsible is pyrite (FeS<sub>2</sub>) which first oxidises to produce sulphate (SO<sub>4</sub><sup>2-</sup>) and ferric iron (Fe<sup>3+</sup>) and subsequently Ferric hydroxide Fe(OH)<sub>3</sub>, which precipitates out as an orange sediment and sulphuric acid H<sub>2</sub>SO<sub>4</sub>. Once the reaction has occurred pH falls and more metals become soluble. The process accelerates as the pH falls below 3.5.

Although some pyritic minerals occur within the Hawkesbury Sandstone, it is overwhelmingly neutral to alkaline. The Wongawilli Seam is characteristically low in iron. However, there are igneous intrusions within the mine which are the prime sources of sulphide minerals. These areas can initially produce metal drainage which are then neutralised but, in the process, increase salt and mineral content in the discharge. The consequences of these processes include the need to maintain adequate settlement and storage of precipitated minerals prior to discharge.

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### **3.2.9 Mine Subsidence**

Berrima Colliery ceased coal extraction in October 2013 and is defined as a non-active mine. The liability for the repair or compensation for subsidence damage as defined under the Coal Mine Subsidence Compensation Act 2017, rests with Subsidence Advisory NSW. Claims for compensation can be made irrespective of whether damage is caused by an active or non-active mine. On 1<sup>st</sup> August 2019, approval was received from the Principal Subsidence Engineer – Mine Safety Technology to cease subsidence monitoring and removal of the subsidence pegs with the exception of the approved GPS monitoring points. These points exist on certain structures such as major dams and buildings as well as the South West 1 Panel slope, however access to private property is not available for a critical property within the previous mining area which makes future subsidence monitoring problematic. Boral will comply with any additional requests for information from either the Resources Regulator or Subsidence Advisory NSW.

### **3.2.10 Erosion and Sedimentation Control**

The area of disturbance at Berrima Colliery is very small, essentially comprising of the pit top facility and Loch Catherine stockpile area, both being located on a surface geology of Hawkesbury Sandstone with little to no topsoil. Much of the surface is sealed with concrete drains and gutters. Where drains, gutters, diversion banks and dam inlets have not been constructed with concrete, they have been stabilised with vegetation to prevent erosion. Dam outlets, spillways and high velocity drains have rock filled gabions to diffuse flow and prevent erosion.

No soil stockpiles, spoil piles or tailings dams exist at Berrima Colliery. With the existing mitigation measures in place and due to the stable nature of the site it is considered that erosion and sedimentation do not pose a risk to future rehabilitation works.

It is proposed to keep the current drainage system in place during the earthworks component with all runoff reporting to the existing dam structures. These dams will remain on completion of the works to contain runoff until vegetation is self-sustaining and runoff is clean.

At the beginning of 2019, erosion and sedimentation controls were installed along the drift leading to the Loch Catherine mine entries. Controls have been based on the principles specified in the "Managing Urban Stormwater: Soils and Construction – 4<sup>th</sup> Edition", Landcom 2004 (Blue Book) and the series Managing Urban Stormwater: Soils and Construction - Volume 1 and Volume 2E Mines and Quarries. On completion of the final sealing of the entries, permanent stability controls and rehabilitation will occur.

### **3.2.11 Soil Types and Suitability**

Due to the geology of the locality, very little to no topsoil is present at the pit top and Loch Catherine stockpile area, and together with the small disturbance area no topsoil stockpiles exist at the site. On final rehabilitation of the site, growing material and soil ameliorants would have to be brought in for successful rehabilitation to occur. The natural subsoil material surrounding the site is weathered sandstone. This subsoil will be achieved by ripping the existing surface sandstone prior to adding soil ameliorants.

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Prior to preparing surfaces for revegetation, soils surrounding the site will be benchmarked by sampling for structure, organic matter, mineral/nutrient content (Nitrate, Phosphate, Potassium, Sulphate, Calcium, Magnesium, Iron, Manganese, Zinc, Copper and Boron) cation ratios, pH and salinity. The results will be the benchmark for a manufactured sandstone topdressing material capable of sustaining a Mittagong Sandstone Woodland. This will be done irrespective of any final land sale options that may arise.

Soil quality and depth is a key risk to successful rehabilitation. The level of soil fertility required to support a given ecosystem varies according to topography, aspect and the store of nutrients held in the standing biomass. Although the surrounding soils may appear infertile, because they support a mature woodland with around 35-75 kg of P/ha, 500-700 kg Ca/ha and 500-1000 kg K/ha in the standing canopy, the ongoing nutrient returned to the soil needs to be considered in establishing the required topdressing media. By achieving this, the land will also be suitable for normal landscaping works associated with building envelopes connected to any future land sales.

### **3.2.12 Flora**

Vegetation within and surrounding the surface facilities has been mapped as 'Mittagong Sandstone Woodland', with some areas of 'Wingecarribee Woodland' within the moister gullies. It has also been described by Tozer et al (published 2010) as 'Wingecarribee-Burraborang Sandstone Forest. None of the communities mapped within or adjacent to the Colliery are listed as threatened under relevant legislation (*Commonwealth Environment Protection & Biodiversity Conservation Act 1999 & NSW Threatened Species Conservation Act 1995*).

The condition of the vegetation is good, with only a few discrete areas of weed invasion close to existing infrastructure. Previous vegetation surveys of Berrima Colliery by OzArk EHM note that most of the vegetation surrounding the surface facilities is regrowth from previous clearing associated with historical mining operations and activities.

One ROTAP species (Rare or Threatened Australian Plant listed in Briggs & Leigh 1996) – the mallee tree *Eucalyptus apiculata*, occurs near the colliery pit top. Most of these trees have been previously sign posted and will be avoided during the final rehabilitation earthworks.

A flora and fauna survey was previously undertaken around the pit top and Loch Catherine as part of the EA studies. No threatened flora or fauna will be impacted during the mine closure activities. During 2018, a revised Review of Environmental Factors was prepared in support of the Final Closure Plan. This report assessed the potential impacts of the final closure of the Colliery on native flora and fauna, including threatened species. The approval process for the final closure of the Mine considers potential benefits arising from rehabilitation activities on the surface as well as groundwater discharge in the Wingecarribee River. An additional Review of Environmental Factors will be required to support the current final land use which incorporates long term passive water treatment.

### **3.2.13 Weed Invasion and Control**

Although the Berrima Colliery surface facilities area is small, there is ongoing potential for weed invasion. The colliery surface area has been subject to previous targeted spraying of weeds within and immediately surrounding the pit top and Loch Catherine area. The

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program will continue during the rehabilitation program. Once the site has been repurposed and the mining lease has been relinquished, ongoing land management will occur in accordance with Boral Group standard requirements.

#### **3.2.14 Fauna**

Four threatened fauna species have been identified as being of particular relevance to the Colliery and surrounding area. It is probable that other threatened fauna species could also occur within the area surrounding the surface facilities. Some species are nomadic, undertake seasonal migrations, and/or enter periods of torpor during winter. The rehabilitation program will ultimately enhance the habitat value of the site by recreating a woodland community. Although some bats have been sighted from time to time in the underground workings, given the level of activity underground, there are no roosting colonies. As occurred during the sealing of the Bowmans Creek adits, care will be taken in the final sealing of the main colliery entries that no roosting bats become trapped within the workings. For the Loch Catherine entries, the sealing program allows space for bats to exit and re-enter the Loch Catherine mine workings.

#### **3.2.15 Slopes and Slopes Management**

The pit top and Loch Catherine Sites are located on relatively flat ground on top of a sandstone ridge. Both sites have drift cuttings used to access mine portals which will require stabilisation works. There are no other specific considerations of slopes during any final rehabilitation activities.

#### **3.2.16 Bushfire Management**

Under the *Rural Fires Act 1997*, there are obligations that must be met with respect to managing the land. In summary, these include:

- Occupiers of land are to extinguish fires or notify firefighting authorities immediately.
- It is the duty of the owner or occupier of land to take practicable steps to prevent the occurrence of bush fires on, and to minimise the danger of the spread of bush fires on or from that land.

The Colliery maintains a reticulated fire line around the surface facilities. Hydrants are distributed on site to provide the protection with diesel pump. These facilities will continue to be maintained until the site has been repurposed.

#### **3.2.17 Public Safety**

Site security provisions during this RMP as well as the final rehabilitation program will include:

- The main entrance will be locked when no personnel are present on site;
- The private haul road has gates and will be locked when no work is occurring at this site;
- No public visitors will be allowed on site without prior approval;
- Visitor inductions are undertaken and inspections supervised by colliery personnel;
- The mine property is appropriately fenced with signage and security systems;

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- ❑ The site will remain private land when rehabilitated and will remain fenced and locked.

These are standard security systems operated by Berrima Cement personnel which will continue once the site is repurposed as a passive treatment area and water transfer facility.

### **3.2.18 Regulatory Requirements**

The Mining Act 1992 (the Mining Act), and the revised Mining Regulation 2016 amongst other legislative instruments, places controls on exploration and mining, the disposal of mining waste, land rehabilitation, and environmental management activities. There are several specific guidelines issued by Resources Regulator covering the sealing of mine entries, calculation of rehabilitation bonds and closure planning. Under the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014, the final sealing of the adits is considered a High Risk Activity and will therefore be subject to detailed risk review and assessment. The results of this assessment will be provided to the Resources Regulator prior to the seals being installed.

The operation holds an Environmental Protection Licence (EPL) issued under the Protection of the Environment Operations Act 1997. This licence covers the discharge of water from the mine as well as some surface operational activities. The license currently stipulates the location and type of monitoring to be undertaken. The license has been recently amended to address the current discharge but will be modified further as the mine progresses to final closure. It is Boral's intention to ultimately change the scheduled activity of the EPL from coal mining to contaminated groundwater treatment or alternative licenced activity in consultation with the EPA.

Berrima Colliery holds a Groundwater Licence issued by the DPI-Water under the Water Act 1912 which has been converted to a Groundwater Access Licence under Water Management Act 2000. This licence is held by Boral Limited and covers the extraction of groundwater within the underground workings.

Watercourse crossings and works undertaken within 40 m of a river may be considered a controlled activity under the Water Management Act 2000 and therefore may require approval from the DPI-Water. The groundwater naturally enters the mine which then drains into the Wingecarribee River which forms part of the Warragamba Dam catchment.

The Contaminated Land Management Act 1997 and State Environmental Planning Policy No. 55 (Remediation of Land) are also relevant when considering potential contamination around the workshop and infrastructure sites. This legislation is administered by the Environment Protection Authority. A separate Contamination Assessment covering the pit top and Loch Catherine sites was previously undertaken and provided to relevant government agencies as part of the 2015 Final Closure MOP. Although not approved at the time, it is understood that there are no outstanding issues in relation to the contamination assessment and therefore this work will proceed under this RMP.

Similarly, Heritage Assessment was undertaken in accordance with the Heritage Act 1977 and included in the 2015 Final Closure MOP. The results of the assessment indicated that no further approvals or application to the Heritage Council of NSW is required. Demolition of buildings not required to support the water treatment and transfer project will occur under this RMP.

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The construction of the new dams at the pit top may require approval from Wingecarribee Shire Council under Part 4 of the Environmental Planning and Assessment Act 1979 (as amended) or through the Department of Planning, Industry and the Environment as per the potential synergies with the Berrima Cement Works. The Berrima Colliery pit top is zoned E3 Environmental Protection under the Wingecarribee Local Environmental Plan 2010. Development which is permitted with consent include water storage facilities which may be triggered as part of the water treatment and transfer project. Advice will be sought from the Wingecarribee Shire Council and the Department of Planning, Industry and the Environment in this regard.

## 4. Rehabilitation Objectives

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### 4.1 Alternative Final Land Uses

The Stage 1 Closure MOP described several different potential land uses. After detailed consideration, Boral has determined that the final land use would be consistent with the previously suggested Light Industrial but with the specific purpose of pit top treatment and supplying water to the Berrima Cement Plant. This will require pumping water from the underground workings, treating the water to suitable standard and pumping the water via a largely underground pipeline to the cement plant. The route of the pipeline will follow the existing railway easement which is covered by CCL748.

Alternative land uses still exist for the remaining privately owned land however for the purposes of this RMP, the land will be rehabilitated to a sufficient standard to secure private sale.

### 4.2 Proposed Final Land Use

After careful consideration of the potential alternative land uses and solutions to the sealing issues presented during the closure process, Boral has determined that the only sustainable long term solution is to establish a pit top passive water treatment system for waters to either be discharged or to supply process waters to the Berrima Cement Plant or other potential users. This land use would be considered industrial under current Resources Regulator guidelines.

Excess land not required for the passive water treatment system will be subdivided into blocks of no less than 40 ha which is permissible under the current zoning provisions and minimum lot size. The subdivision would hold the pit top area in a separate holding to allow for the ongoing use as a water treatment and transfer facility.

In order to achieve this final land use, the decontamination activities as detailed in Section 3.2.3 will proceed in conjunction with the building repurposing and structure removal. The building envelopes will need to be certified as meeting the Residential A criteria of the National Environment Protection (Assessment of Site Contamination) Measure to support future applications to Wingecarribee Shire Council.

There may be further development options for the land to the north of Medway Village. Discussions with the local Council will be held to determine what opportunities are available for this site.

The remaining lease area consists of privately owned land. There are some remaining mine related monitoring equipment located above the previous extraction areas. These include subsidence pegs and groundwater monitoring equipment. In order to avoid ongoing impacts on existing private land uses, the subsidence pegs will be either removed or made safe. Two vibrating wire piezometers will be removed, and the land rehabilitated to the equivalent pasture. Piezometers located in production bores will either be removed or relinquished to the owners. Sign over to the respective land owners will be documented and evidence provided to the Resources Regulator.

## 5. Final Landform and Rehabilitation Plan

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### 5.1 Domain Selection

As the colliery has been in the process of rehabilitation since 2014 and no longer has any operating based domains. All domains are now discussed as progressive rehabilitation domains.

#### 5.1.1 Domain 1 – Repurposed Pit Top Water Treatment Area

This domain consists of the original Pit Top area. Under this RMP, the entire Pit Top will be repurposed for the water treatment and transfer operation as shown on Plan 4a. The facilities that will remain will be:

- ❑ Office and Bathhouse building with a First Aid room and training room. Built between 1924 and 1926, this building consists primarily of concrete block and brick construction with an iron roof. The rear has some timber framing and there is an awning at the front and back. The previous asbestos cement roof and gutters have been replaced and the asbestos fiber flashing around the boiler and hot water pipes have been removed. The building was subject to an initial asbestos survey which identified some asbestos fibro sheeting under the eaves which was removed in 2020. Under this RMP, this building will remain as is and provide amenities for any workforce attending the site to maintain the water treatment system.
- ❑ Workshop, oil separator, storage sheds and open stores area will remain but be repurposed for the water treatment operation. These structures are free of asbestos and will function in a similar manner as they did when the mine was operational. All mining based stores will be removed and replaced with suitable stores to support the ongoing treatment, pumping and water transfer activities.
- ❑ Compressor building will remain but it is likely that two of the three compressors will not be required and will be removed once the final seals are in place.
- ❑ Self banded diesel fuel tank will remain until the final seals are in place and then removed if not considered necessary to support the water treatment and transfer operation.
- ❑ Spray Irrigation area and AWTS Tanks will remain but will be modified to cater for the new water treatment dam. As the workforce engaged in the water treatment and transfer operation will be very small, the modification will not affect the effectiveness of the sewage treatment plant.
- ❑ Demountable shed with separate envirocycle septic system will remain as is and service the water treatment and transfer operation.
- ❑ Pollution Control Ponds, water tanks and substation will remain to service the water treatment and transfer operation. Two additional settlement ponds will be constructed to cater for additional settlement from the water treatment process.

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- Access roads, carparks and landscaping will remain to service the water treatment and transfer operation. This includes the separate railway cutting/haul road which will be utilised to house the pipeline. The pipeline will extend along the railway easement to the Berrima Cement Plant.

The Heritage Study contained in Final Closure MOP found that the mine buildings may have local heritage significance but do not represent items worthy of preservation. The buildings will be retained for repurposing and remain as an example of the areas mining history.

The bushland surrounding the pit top is largely natural however there is some general debris within portions of the area which is regularly removed. Items that will be removed from Domain 1 are listed below:

- Crushing and screening equipment;
- Loading bin;
- Coal handling conveyors;
- 450 tonne surge bin;
- Truck loading bin;
- Dolly car and winder building.

### **5.1.2 Domain 2 – Drift Cutting and Bridge**

The drift cutting and bridge over the Wingecarribee River will remain after closure and will provide access to the pumping equipment within the decline. The drift cutting will also house the water supply pipeline as well as power and communications between the control room and the pumping infrastructure.

### **5.1.3 Domain 3 – Loch Catherine Coal Storage Area**

This satellite stockpile area was the original pit top for the Loch Catherine Mine which closed in the 1960's and was used as a separate coal storage area by Berrima Colliery. This 2.5 ha site consisted of a coal pad on natural sandstone rock with an established drainage system. The original topsoil and clay were stripped and removed over 90 years ago.

Under the previous Stage 1 Closure MOP the coal stockpile and coal pad was removed. This area is used to access the Loch Catherine Mine Entries and drift and therefore no other rehabilitation work will be undertaken until the mine entries and drift are rehabilitated. Once the rehabilitation work has been approved by the Resources Regulator the land area will be prepared for private sale. This will some final cleanup with a similar final land form including the outer bund, water storages and access road.

### **5.1.4 Domain 4 – Loch Catherine Mine Entries and Drift**

Domain 4 consists of the four entries associated with the Loch Catherine Colliery and the associated 240 m long drift cutting located on the western end of the Loch Catherine Coal Storage Area (Domain 3). The original dimensions of the entries are:

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- ❑ Adit 1 (Fan) – 5.2 m long and 1.78 m high;
  - ❑ Adit 2 (Belt road) – 2.6 m long and 1.93 m high;
  - ❑ Adit 3 (Roadway 1) – 5.5 m long and 3.73 m high; and
  - ❑ Adit 4 (Roadway 2) – 4.3 m long and 2.28 m high.

While Adit 2 and 3 opening dimensions are largely unchanged, significant rock fall has occurred at Adits 1 and 4 which has now reduced the clear openings as indicated below:

- ❑ Adit 1 (Fan) – 4.8 m wide and 1.2m high
- ❑ Adit 2 (Belt Road) 3m wide and 1.88m high
- ❑ Adit 4 (Roadway 2) – 4.0 m wide 1.0m high

The adits are located below a cliff line which has been previously assessed as being unstable as evidenced by numerous rock falls. As shown on Plan 1d, there are two benches in front of the adits, the first runs level against the adits while the second represents a continuation of the drift alignment and runs below Adits 1 to 2. This second bench supported a timber bin and deck structure which extended a platform against the upper bench. The timber structure has become dilapidated resulting in the stable section of the upper bench becoming very narrow, particularly near the first adit.

Previously risk assessments dating back to 2004 determined that working on the upper bench in front of the adits was inherently unsafe, that the probability of rock falls was almost certain, the exposure to the hazard would be continuous and that the consequences would be very serious including fatality. On this basis, the approved closure plan of 2004 involved construction of a fence across the drift cutting to prevent access to the adits.

In response to a request from the then NSW Trade and Investment – Resources and Energy in August 2011, a new Sealing Plan and Review of Environmental Factors (REF) was prepared and lodged in September 2011. Approval to proceed was obtained on 14<sup>th</sup> February 2012 following further modification to the fence location to include the bottom bench to prevent access to climbers coming up from the Medway Rivulet gorge. These modifications to the fence location was requested by the department. The REF noted that the Eastern Bentwing Bat and Eastern Horseshoe Bat roost in the entries indicating that permanent access for bats would be necessary. The REF included an assessment of up to 400 m of track development and the vegetation along the bench in front of the four adits. The assessment found that the vegetation communities to be disturbed represented regrowth with no hollow bearing trees present. No rare or endangered flora or fauna species would be impacted as a result of access development. The site was inspected by representatives of OEH, WaterNSW and Resources Regulator at the time.

Work commenced on the access track development, as provided for in the February 2012 approved adit sealing methodology. Further engineering and risk assessment work undertaken by Boral again highlighted the high risk nature of working underneath the cliff line. A review of the previously approved methodology has since been undertaken in consultation with Resources Regulator and the Inspector of Mines. This review included accessing the Loch Catherine workings by drone to determine the conditions and stability of the underground workings and vertical cliff faces, site inspections by earthmoving and scaffolding contractors and further environmental investigations.

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This additional work was not able to determine an acceptably safe method to access the adits in order to erect permanent barriers, including the current approved external adit fencing arrangement. Various options were developed including:

- Accessing the bench in order to construct a manproof fence to prevent future access to either the bench or individual adits as per the current approval.
- Accessing the adits from the external bench and filling them with available rock rubble using an excavator.
- Accessing the underground workings and constructing the barriers from within the mine.

For each option, several methods and sub-options have been explored including:

- The use of remote controlled mobile plant to undertake the work in unsafe areas below the cliffline.
- Using various sizes of mobile plant to undertake components of the external adit filling.
- Using a long reach excavator located in a safe zone to progressively remove loose rocks from the escarpment above one or more of the adits.
- Using a combination of internal and external access to individual adits.
- Different locations for the external fence which may avoid rock fall areas.
- Using different barrier types such as rock fill, concrete blocks, heavy gauge stainless steel mesh with internal bolting, inflatable bags and pumped concrete. Combinations of different methods has also been considered.

A common component was the need to complete the access to the bench in front of the first adit. This work, which is described below as Step 1, was completed in December 2018 following a separate approval by the Resources Regulator. Following completion of Step 1, the proposed final barrier option became clear and is described below as Step 2. Subsequent steps involve implementation and final rehabilitation.

### **Step 1 – Access to Bench Adjacent to Adit 1**

Step 1 was completed in December 2018 and involved the following activities:

- Establishing access along the existing decline to Adit 1. This work was separately approved by the Resources Regulator and involved clearing vegetation to a minimum width of 3m along the decline and expanding to approximately 6m wide opposite Adit 1. Total vegetation clearing was approximately 500 m<sup>2</sup>. The Resources Regulator has previously advised that a Part V approval under the Environmental Planning and Assessment Act 1979 has already been completed which includes vegetation clearing.
- Develop the access sufficiently to accommodate the excavators and personnel using a suitably equipped vehicle approved by the Mine Manager.
- Install appropriate erosion and sedimentation controls as outlined later in this section.
- Develop a suitable turning area near the base of the drift.
- Develop a material stockpile area near the base of the drift.

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- Assess and then develop suitable access to the bench past Adit 1, if considered safe to do so. This component will likely involve stabilising earthworks on the lower bench and intervening batter slope between the two benches.

The now completed Step 1 included the installation of the initial soil and water management controls to safeguard against erosion and sedimentation impacts within the Medway Rivulet. The controls will be based on the principles specified in the "Managing Urban Stormwater: Soils and Construction – 4<sup>th</sup> Edition", Landcom 2004 (Blue Book) and the series Managing Urban Stormwater: Soils and Construction - Volume 1 and Volume 2E Mines and Quarries. The controls included:

- Directing runoff from the drift into side channels equipped with energy dissipation devices such as straw bales, rock rubble and/or sand bag check dams. The structures are located at approximately each 10 m drop in elevation with a minimum of one every 50 m linear distance.
- Directing runoff from the base of the drift offsite via a protected channel. This involved the installation of a pipe laid beneath the drift to assist in draining natural flows.
- Provision of additional temporary silt containment primarily using silt fencing with some straw bales located down the side channel. The silt fencing used will be removed prior to final rehabilitation and while access to the structures is still available. All metal stakes will be removed on final completion of the rehabilitation work.
- Vegetation will be cleared by the excavator with care not to overly disturb underlying soil and rock surfaces. If possible, root material will remain.
- All sediment and erosion control structures will be inspected and maintained to ensure their effectiveness throughout the entry barrier construction program. Inspections will occur following rain events.
- Sediment collected from the sediment control structures will be temporarily stored at the biological resources stockpile area near the base of the drift or if suitable, at the Loch Catherine coal storage area for use in final rehabilitation.
- Biological resources such as cleared vegetation and bush-rock will be stockpiled at a designated area along the drift and used in the final rehabilitation work.

Completion of Step 1 represented a hold point to allow finalisation of Step 2 and the approval of the selected barrier option and installation method. Step 1 was completed in December 2018 following approval by the Resources Regulator. Based on the results of the inspections, the following sealing activities form part of this RMP.

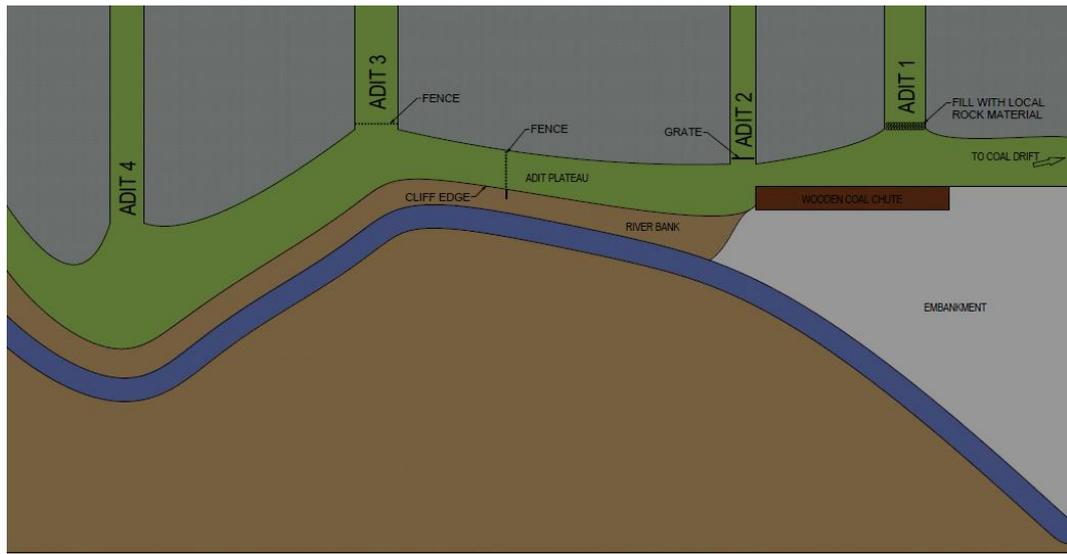
## **Step 2 – Determination of Preferred Barrier Option**

The adit sites have been subject to detailed inspection and evaluation following the completion of Step 1. This inspection has highlighted the access difficulties that will be encountered during the sealing works. A number of alternatives were assessed by Boral and the preferred barrier option is as follows:

- Fill Adit 1 with local rock material using an excavator.
- Adit 2 will be sealed by the installation of a 3 m wide and 1.88 m high steel grate with 20mm diameter horizontal bars at 180mm centers. There is a small bench at the adit entry which will be used to position the grate, approximately 3 meters in from the adit

opening. The design having horizontal bars will accommodate for the entry and exit of any local bat colonies.

- ❑ Adit 3 will be sealed in a similar fashion using the same horizontal bar arrangement but will be located approximately 4 m in-by of the adit entry.
- ❑ Adit 4 is unsafe to access due to the unstable overhanging rock cliff above the entry. The adit however will be sealed by constructing an additional steel fence barrier located on the bench between Adits 2 and 3 as shown in the sketch below. The fence barrier will overhang the bench to further exclude human access. Bat access to Adit 4 will remain unaffected.



**Diagram 1 – Plan view of Loch Catherine Closure Methodology**

### **Step 3 – Implementation of Approved Barrier Option**

Implementation will proceed once approval from the Resources Regulator and OEH is obtained. The work will necessarily involve some additional vegetation clearing which has regrown since the site was closed. Vegetation removal will be minimised where possible to allow for the construction of the barriers. Cleared vegetation will be stockpiled and used as brushmatting over the construction site on completion. It is anticipated that the construction of the approved barriers may take approximately 3 months to complete.

It is anticipated that this work will be completed in the first quarter of 2021.

### **Step 4 – Final Rehabilitation**

The rehabilitation of the decline will be done on retreat once the external fencing is in place. The work will include but not necessarily be limited to the following:

- ❑ Placement of a brass plaque adjacent to Adit 1 identifying the four adits as being the entries for the Loch Catherine Mine.
- ❑ Installation of permanent drainage systems if necessary.
- ❑ The vehicle turning area and material stockpiling area will be made free draining prior to covering in previously cleared vegetation.

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- ❑ Permanent cross banks no higher than 300mm will be established across the drift face. These will have a slope of no more than 2% towards the side drain. The cross banks are to be installed just up slope of each previously installed check dam located on the drift drain.
  - ❑ The dams are to be progressively cleaned out as the excavator moves up the drift and the collected material spread over the drift surface.
  - ❑ The excavator will scarify where possible the surface of the drift generally along the contour prior to placing previously cleared vegetation over the surface.
  - ❑ All equipment and facilities located at the top of the drift and within the Loch Catherine banded area is to be removed and the previous surface level re-established where practicable.

Details of the rehabilitation work is provided on Plans 4d to 4g. The work area will be inspected over a 12 month period following completion. Should natural revegetation not be evident at the end of this period then broadcast sowing of native shrub and groundcover species will be undertaken. The species to be used will be comparable with the surrounding Mittagong Sandstone Woodland. This secondary domain is shown on Plan 4c.

#### **5.1.5 Domain 5 – Underground Mine Entries (Excluding Loch Catherine Entries)**

There are five mine entries associated with Berrima Colliery. These are referred to as:

- ❑ Bowmans Creek Entries which were two separate intake air entries. They were not intended to be used for access and were otherwise unformed. These entries were sealed under the Stage 1 MOP. No further work is required for these seals.
- ❑ Drain Adit which represents the initial entry into the mine dating back to the 1870's. This adit was sealed under the Stage 1 MOP and includes permanent drainage provisions. This site represents the licensed discharge point for the mine into the Wingecarribee River. The adit is located in a slot canyon and due to close proximity of the historical workings to the unconsolidated talus slope below the cliff line, it has been deemed impossible to safely seal this adit without allowing for permanent drainage. To fully seal the mine at this point would invariably lead to water pressure buildup and destabilisation of the overlying talus and cliff line. No further work is required for this seal.
- ❑ Ventilation Shaft and associated fan infrastructure. This facility represents the return air point for the mine. This facility will remain in place until the new bulkheads have been installed. Once no longer needed, the fan unit, building and blast door structures will be removed. This will be followed by sealing the entry in accordance with Departmental requirements and final removal or making safe the access way.
- ❑ Main Entry which is used for workforce access and coal clearance from the mine. This entry will be sealed by a combination of underground bulkheads at seam level and an additional bulkhead within the sandstone section of the decline. The remaining decline and bridge will be repurposed as part of the water transfer project.

Under the Stage 1 Closure MOP, seven internal bulkheads were installed to enable additional repressurisation of the overlying strata. This work represents a variation on the

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partial sealing option as originally discussed in the 2015 Final Closure Plan. The purpose of the bulkheads was to gather data on the permeability of the seam and surrounding strata the results of which demonstrated that fully sealing the mine was not possible. The data gathered as a result of this work has led to the formulation of the final closure option as detailed in this RMP.

The location of the bulkheads enabled the natural section of flooded mine workings to be raised above the level of the roof. Pressurised water however commenced passing through the overlying strata after about 6 months despite attempts to seal the strata. At present it is estimated that no more than 100,000 litres per day seeps above and to a lesser extent, around the bulkheads.

#### **5.1.6 Domain 6 – Mine Extraction Area**

The land above the underground workings is privately owned or Crown Land. Although Domain 6 is a primary domain its current land use will not change on final relinquishment. There are several groundwater monitoring sites however only two are dedicated for mine purposes which will be removed as part of final closure. The remaining monitoring points are existing private bores. The piezometers will be monitored for a period of 12 months if land access agreements are available or until the units are removed. It is anticipated that monitoring will cease by 30 September 2021. Further details of the reporting dates are provided in Section 10.1.

Activities proposed for this domain by the end of the term of this RMP include:

- Removal or making safe all subsidence monitoring pegs, structure monitoring sites and base station.
- Sign over ownership and ongoing maintenance of the two replacement bores to the respective land owners. This includes all remaining infrastructure associated with these bores.
- Removal and rehabilitation of the two vibrating wire piezometer sites.
- Removal of remaining four pressure transducer piezometers or sign over ownership to the respective land owners.
- Final documentation provided on exploration activities to confirm no residual rehabilitation liability exists.
- Undertake any remaining land surface stability works that may be a result of mine subsidence.

This work will be undertaken in consultation with Subsidence Advisory NSW. Should the Subsidence Advisory NSW require additional monitoring in relation to surface improvement, the relevant subsidence control marks will remain until advised by the Board that they are no longer required.

#### **5.1.7 Domain 7 – Railway Easement Including MPL603 and MPL604**

The original railway corridor was covered by MPL496 which ran from Berrima Colliery, through the Berrima Cement Plant and onto the Main Southern Railway line. This MPL was 20 m wide between the colliery pit top to the point where it crosses the Moss Vale to Berrima Road on the eastern side of the Cement Plant. From this point, MPL496 narrowed

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to 10 m wide for the remaining length to the Main Southern Railway line junction. MPL496 was subsequently consolidated into the Berrima Colliery Holdings under CCL748.

MPL603 and 604 were granted to ensure that the rail corridor was 20 m over its full length. The two leases begin at where the Moss Vale/Berrima Road crosses the rail track and they end at the Main Southern Rail Line at Berrima Junction. The MPLs are both 5 m wide and sit either side of the original MPL496, which now forms part of CCL748.

The railway corridor between the cement plant and the Main Southern Railway line is still in use by the Berrima Cement Plant and currently two other private companies. It is also part of the approved 2008 Moss Vale Enterprise Corridor Development Control Plan which specifically includes ongoing usage of the rail line to service existing and new industry within the industrial precinct. Therefore under this RMP, MPL603 and MPL 604 along with the portion of CCL748 between the Berrima Cement Plant and the Main Southern Railway Line will be separately transferred to the Berrima Cement Plant. Consolidation of the titles between the cement plant and the Main Southern Railway will then be sought from the Resources Regulator.

The section of CCL748 which runs between the Berrima Colliery pit top and the western side of the cement plant will be used for the water transfer pipeline. This section of CCL748 also houses the 33 kV transmission line which may not be needed to serve the water treatment and transfer project. An alternative power supply may be investigated.

Proposed works for Domain 7 will include:

- Removal of weeds along the railway embankment and easement.
- Repair of erosion and re-establishment of an access road along the easement.
- Repair of fencing and drainage.
- Installation of the underground pipeline including under-boring of the public road crossings.
- Community consultation with regard to the proposed construction activities and ongoing use of the land.

## **5.2 Domain Rehabilitation Objectives**

The overall rehabilitation objectives are provided in Section 5.1. Specific objectives for each domain are provided in the following table. The secondary domains, are noted on Plans 4a to 4c.

**Table 5.1 – Domain Objectives**

<b>Domain</b>	<b>During Closure</b>	<b>Post Mining - Final Closure</b>
Domain 1 – Clean Catchment	<ul style="list-style-type: none"> <li>- Keep clean and free from debris</li> <li>- Ensure drainage remains suitable for offsite discharge</li> </ul>	<ul style="list-style-type: none"> <li>- Remove any remaining debris and ensure runoff is clean.</li> </ul>
Domain 1 – AWTS	<ul style="list-style-type: none"> <li>- Maintain operability</li> <li>- Quarterly inspections of tanks and irrigation area</li> <li>- Ensure water levels remain optimal for effective treatment</li> </ul>	<ul style="list-style-type: none"> <li>- Will remain to support the ongoing water treatment plant site. Some modification will be required to accommodate the new water storage dam</li> </ul>
Domain 1 - Office and Bathhouse	<ul style="list-style-type: none"> <li>- Maintain all buildings in a clean and serviceable condition until no longer required</li> </ul>	<ul style="list-style-type: none"> <li>- Undertake historic study in accordance with Heritage Study report.</li> <li>- Buildings may remain to support the ongoing water treatment process</li> </ul>
Domain 1 - Infrastructure	<ul style="list-style-type: none"> <li>- Maintain in a clean and serviceable condition until not required to support underground closure activities</li> <li>- Undertake maintenance as required</li> <li>- construct new ponds and pipelines to support surface water treatment</li> </ul>	<ul style="list-style-type: none"> <li>- Decontaminate to acceptable levels for intended light industrial final land use.</li> <li>- Remove identified coal handling infrastructure only.</li> <li>- Create suitable topdressing material to support pasture.</li> </ul>
Domain 2 - Drift Cutting and Bridge	<ul style="list-style-type: none"> <li>- Maintain in serviceable condition</li> <li>- remove any remaining mining services when no longer required.</li> <li>- lay pipeline to deliver groundwater to the pit top</li> <li>- Bridge structure will remain at the end of this RMP period.</li> </ul>	<ul style="list-style-type: none"> <li>- Ensure drift cutting is stable and minimises erosion and sedimentation</li> <li>- Bridge structure to remain to provide support for the pipeline delivering water to the treatment plant.</li> <li>- Establish drainage embankments down drift to slow water velocity</li> </ul>
Domain 1 - Control Dams	<ul style="list-style-type: none"> <li>- Undertake weekly inspections and after rain events.</li> <li>- Clean out sediment as required or when capacity reduced by more than 30%.</li> <li>- Test pumps on a monthly basis.</li> <li>- undertake maintenance as required.</li> </ul>	<ul style="list-style-type: none"> <li>- Decontaminate to acceptable levels for intended light industrial final land use.</li> <li>- Ongoing cleanout as required to support the water treatment process.</li> <li>- Dams to be converted as required to support the final land use.</li> </ul>
Domain 3 - Loch Catherine	<ul style="list-style-type: none"> <li>- Undertake inspections after rain events.</li> <li>- Clean out contained sediment in the bund and dam structure when capacity reduced by more than 30%.</li> <li>- Maintain security systems after hours.</li> <li>- Remove any remaining coal stocks</li> </ul>	<ul style="list-style-type: none"> <li>- Spread outer bund material over prepared sandstone.</li> <li>- Create suitable topdressing material to support pasture.</li> <li>- Manage revegetation work until self-sustaining or until the property is privately sold.</li> <li>- Maintain sufficient access to facilitate sale of the property.</li> </ul>
Domain 5 - Mine Entries	<ul style="list-style-type: none"> <li>- Maintain in the two main entries serviceable condition until no longer required to support the construction of the remaining seals.</li> <li>- Removal all plant and equipment which may pose a risk to groundwater contamination.</li> </ul>	<ul style="list-style-type: none"> <li>- Install bulkheads around pit bottom at seam level.</li> <li>- Seal main drift entry above the coal seam inclusive of water pipeline leading to the water treatment plant.</li> <li>- seal ventilation drift entry and remove all fan infrastructure.</li> </ul>
Domain 4 – Loch Catherine Mine Entries	<ul style="list-style-type: none"> <li>- Construct barriers for the 4 adits to prevent human access</li> <li>- Stabilise drift cutting on completion of sealing activities</li> </ul>	<ul style="list-style-type: none"> <li>- Rehabilitate drift cutting with species comparable with Mittagong Sandstone Woodland</li> </ul>

Domain	During Closure	Post Mining - Final Closure
Domain 6 - Underground Mining Area	<ul style="list-style-type: none"> <li>- Continue liaison with landowners.</li> <li>- Continue groundwater monitoring network until September 2021 or as required by the Resources Regulator.</li> <li>- Continue liaison with Subsidence Advisory NSW and undertake any monitoring requested</li> </ul>	<ul style="list-style-type: none"> <li>- Remove vibratory wire piezometers once monitoring no longer required.</li> </ul>
Domain 7 – Railway Corridor pit top to cement plant	<ul style="list-style-type: none"> <li>- Control weeds within railway easement</li> <li>- Construct a pipeline between the pit top and the Berrima Cement plant to transfer water</li> </ul>	<ul style="list-style-type: none"> <li>- Existing 11 kV transmission line to remain to service water treatment plant</li> <li>- Relinquish CCL748 from the pit top to the Berrima Cement Plant.</li> <li>- Maintain easement in a serviceable condition</li> </ul>
Domain 7 – Railway Corridor cement plant to main southern railway	<ul style="list-style-type: none"> <li>- transfer portion of CCL748 from the cement plant to the Main Southern Railway Line to Boral Limited</li> <li>- ongoing environmental management in accordance with separate RMP</li> </ul>	No closure activities to be undertaken

### 5.3 Rehabilitation Phases

An outline of the rehabilitation phases for each domain is provided in Table 5.2.

**Table 5.2 – Rehabilitation Phases during this Stage 1 Closure RMP**

Rehabilitation Phases	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Domain 6	Domain 7
Construction	N/A						
Active Mining	N/A	x	x	x	x	x	x
Care and Maintenance	✓	✓	✓	✓	✓	✓	✓
Decommissioning	✓	✓	✓	✓	✓	✓	✓
Landform Establishment	N/A	✓	✓	✓	✓	✓	✓
Decontamination	N/A	✓	✓	✓	✓	✓	✓
Growing Media Development	N/A	✓	✓	✓	✓	✓	✓
Revegetation Establishment	N/A	✓	✓	✓	✓	✓	✓
Ecosystem and Land Use Sustainability	✓	✓	✓	✓	✓	✓	✓
Relinquished Lands	x	x	✓	✓	✓	✓	✓

This RMP covers all work leading to the partial relinquishment of the CCL748.

## **6. Performance Indicators and Completion Criteria**

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This RMP covers all remaining activities which will lead to the final closure of the Berrima Colliery and partial relinquishment of CCL748.

### **6.1 Performance Indicators**

The rehabilitation of the surface facilities area requires standard techniques. There is no potential for acid generation and minimal levels of contamination. The rehabilitation activities have been made simple with the repurposing of the pit top to service the water treatment and transfer project and private sale of any land not required to support the final land use activities. The key performance indicators relevant to the process of rehabilitation are as follows:

- Stable stormwater and pollution control systems to ensure runoff from the surface facilities during the closure works do not result in sediment laden runoff leaving any site.
- Nil additional hydrocarbon contamination during rehabilitation activities.
- Nil detectable sediment impacts within the Wingecarribee River during seal construction activities.
- Achievement of the Residential A contamination criteria as confirmed by laboratory analysis.
- Minimise the mine discharge through the current discharge adit on completion of the mine sealing and completion of the surface passive water treatment system.

Specific criteria for the revegetation works down the Loch Catherine drift will be the establishment of a self-sustaining vegetation community of equivalent dominant species as the surrounding Mittagong Sandstone Woodland. Areas of agricultural land and surplus land not required for the water treatment and transfer project will be rehabilitated to a standard suitable for private sale as rural lifestyle blocks.

### **6.2 Completion Criteria**

Individual completion criteria for the identified domains are provided in Table 6.1.

**Table 6.1 - Completion Criteria**

Objective	Performance Indicator	Completion Criteria	Justification / Source	Link to TARP	Progress at Start of Stage 2 MOP	Progress at Completion of Stage 2 RMP
<b>Phase 1: Decommissioning</b>						
Domain 1 - Clean Catchment	Provision of pollution control dams Maintain clean runoff Stable drainage system	- All remaining debris removed and ensure runoff is clean.	Stage 2 MOP 2013 Berrima Colliery Water Management Plan	No	Completed	Completed
Domain 1 – AWTS	Maintain AWTS and irrigation area until land sold for rural residential	- Functioning system when site repurposed	Stage 2 MOP 2015 Environmental Site Assessment DLA Environmental	No	Commenced	Completed
Domain 1 - Office and Bathhouse	Buildings to remain for repurposing	- Undertake historic study in accordance with Heritage Study report. - Asbestos will be either removed or made safe in accordance with the Code of Practice for the Safe Removal of Asbestos (NOHSC:2002 (2005))	Stage 1 MOP  2015 Berrima Colliery Heritage Study – OzArk EHM	No	Commenced	Commenced
Domain 1 - Infrastructure	Removal of infrastructure Disconnection of services Footings made safe Contamination removed or bioremediated	- Decontaminate to acceptable levels for intended final land use (Residential A). - Remove remaining coal related infrastructure. - Construct water treatment facility - Compliance verified by Contamination Auditor	Stage 2 MOP 2015 Environmental Site Assessment DLA Environmental 2015 Final Closure MOP	No	Nil	Completed
Domain 2 - Drift Cutting and Bridge	Retention of bridge and stabilisation of drift cutting	- Ensure drift cutting is stable and minimises erosion and sedimentation - Install water pipeline to deliver underground water to water treatment plant	Stage 2 MOP	Yes	Nil	Completed
Domain 1 - Control Dams	Clean runoff within the dam on completion of rehabilitation works	- Decontaminate to acceptable levels for intended final land use. - Construct additional pondage to support water treatment process  - Dams to remain on completion of rehabilitation works.	Stage 2 MOP	No	Nil	Completed

Objective	Performance Indicator	Completion Criteria	Justification / Source	Link to TARP	Progress at Start of Stage 2 MOP	Progress at Completion of Stage 2 RMP
Domain 3 - Loch Catherine	No remaining coal stockpiles Surface prepared Growing media conducive to pasture growth.	<ul style="list-style-type: none"> <li>- Remove any remaining coal stocks.</li> <li>- Access road to remain.</li> <li>- Create suitable topdressing material to support pasture.</li> <li>- Dams and bunding to remain.</li> </ul> Determine what sale opportunities are available for this site.	Stage 1 MOP 2013 Berrima Colliery Water Management Plan 2012 Rehabilitation and Final Closure Plan	No	Complete  Nil  Nil	Completed
Domain 5 - Mine Entries	Signoff under the Resources Regulator guidelines	<ul style="list-style-type: none"> <li>- Removal all plant and equipment which may pose a risk to groundwater contamination.</li> <li>- Removal of dewatering equipment and flooding of the mine</li> <li>- Design of seals to be approved by Resources Regulator</li> <li>- Bolting and refurbishing underground roadways to access seal sites</li> <li>- Install two Bowmans Creek seals</li> <li>- Install main drain adit seal and installation of permanent drainage provisions</li> <li>- Removal of main conveyor belting</li> <li>Removal of disused but economically recyclable materials</li> <li>- Seal ventilation fan entry in accordance with Resources Regulator requirements and standards.</li> <li>- Install bulkheads around pit bottom at seam level</li> <li>- Seal main drift and install pumping equipment</li> </ul>	Final Closure MOP 2012 Rehabilitation and Final Closure Plan	No	Complete  Complete  Complete  Complete  Complete  Nil  Nil  Nil	Complete  Complete
Domain 4 Loch Catherine Mine Entries	Sign off from Resources Regulator	<ul style="list-style-type: none"> <li>- Establish access down existing drift</li> <li>- Assess condition of bench and entries and develop sealing methodology</li> <li>- Install barriers as described in Section 5.1.10 as approved by the Resources Regulator</li> </ul>	Stage 1 MOP Stage 1 MOP  Stage 1 MOP		Commenced  Commenced  Nil	Complete  Complete
Domain 6 - Underground Mining Area	Land owner agreements for sign off	<ul style="list-style-type: none"> <li>- Remove vibratory wire piezometers.</li> <li>- Continue subsidence monitoring and land surface inspections until Resources Regulator or Subsidence Advisory NSW are satisfied that monitoring is no longer required.</li> </ul>	Stage 1 MOP 2012 Rehabilitation and Final Closure Plan	No	Commenced	Complete

Objective	Performance Indicator	Completion Criteria	Justification / Source	Link to TARP	Progress at Start of Stage 2 MOP	Progress at Completion of Stage 2 RMP
Domain 7a	Minimise weed growth	Less than 10% weed cover by random sample	Stage 1 MOP	No	Commenced	Ongoing
Domain 7b	Incorporation into Berrima Cement Plant operation	Transfer of rehabilitation obligations to Berrima Cement Plant	Stage 1 MOP	No	Nil	Complete

**Phase 2: Landform Establishment (all Domains excluding 6 underground mining area)**

Establish landform	Minimise erosive water flow	- Slopes less than 1 in 4 - Surface stabilized and topdressed with 100mm of material suitable for pasture	Stage 1 MOP 2012 Rehabilitation and Final Closure Plan	No	Commenced	Complete
Effective drainage controls	Contain surface drainage	- Maintain free board no less than 600 mm - Re-establish previous drainage system - No of gullies or rills greater than 0.3 m in depth or width - Install final erosion and sedimentation controls as detailed in Plans 4d to 4g	Stage 1 MOP 2012 Rehabilitation and Final Closure Plan	No	Commenced	Complete
Maintain drainage line stability	Evidence of erosion	- Drainage lines carrying greater than 2.5 m/s peak flow to be protected - Drainage embankments no higher than 500 mm and established every 10 m down drift	Stage 1 MOP 2012 Rehabilitation and Final Closure Plan	No	Commenced	Complete
	Dam walls to be permanently stable	Geotechnical consultant verification	Stage 1 MOP 2012 Rehabilitation and Final Closure Plan	No	Commenced	Complete
Create final land form that is stable and non polluting	Surfaces to be free draining but without elevated erosion risk	Final landforms to be less than 18 degrees	Stage 1 MOP 2012 Rehabilitation and Final Closure Plan	No	Commenced	Complete
Minimise Dust	Maintain water truck on site and used as required to minimise dust	No greater than 2 g/m <sup>2</sup> /month	Stage 1 MOP	No	Commenced	Complete

**Phase 3: Growth Media Development (Domains 1 to 8, 9b)**

Site preparation to achieve adequate growing media	Root depth	- Achieve 100mm of root penetration depth suitable for pasture growth (as reasonably possible)	Stage 1 MOP 2015 Final Closure MOP	No	Nil	Complete
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Objective	Performance Indicator	Completion Criteria	Justification / Source	Link to TARP	Progress at Start of Stage 2 MOP	Progress at Completion of Stage 2 RMP
Soils capable of supporting sustainable vegetation growth	Soil physical and chemical properties and amelioration	<ul style="list-style-type: none"> <li>- pH between 5 and 7.5</li> <li>- Electrical conductivity within the range of general agricultural soils</li> <li>- Organic Carbon levels no less than found in surrounding sandstone derived soils</li> <li>- Phosphorus levels no less than found in surrounding sandstone derived soils</li> <li>- Nitrogen levels no less than found in surrounding sandstone derived soils</li> <li>- Soil depth greater than 100 mm</li> <li>- Soils not sodic or saline</li> </ul>	Stage 1 MOP 2015 Final Closure MOP	No	Nil	Complete
<b>Phase 4: Ecosystem Establishment (Domains 1 to 8, 9b)</b>						
Establish vegetation compatible with Mittagong Sandstone Woodland	Pasture	Southern Highlands Grazing mix (Perennial)	Stage 1 MOP 2015 Final Closure MOP	No	Nil	Complete
<b>Phase 5: Ecosystem Development (Domains 1 to 8, 9b)</b>						
Revegetation is sustainable for the long term	Vegetation self sustaining	Perennial grasses older than 6 months	Stage 1 MOP 2015 Final Closure MOP	No	Nil	Ongoing until land sold
	Weed infestation	Weeds account for less than 10% of total cover or otherwise comparable with surrounding vegetation community	Stage 1 MOP 2015 Final Closure MOP	No	Commenced	Ongoing until land sold
	Stability	Little evidence of erosion or bare patches where pasture has failed.	Stage 1 MOP 2015 Final Closure MOP	No	Nil	Ongoing until land sold
<b>Phase 6: Final Land Use Sustainability (Domains 1 to 8, 9b, 11a)</b>						
Soil structure and fertility capable of sustaining vegetation	Determine appropriate soil conditions, structure and fertility	Soil condition in revegetation areas comparable with reference sites.	Stage 1 MOP 2015 Final Closure MOP	No	Nil	Ongoing until land sold
Revegetation is sustainable for the long term	Vegetation self sustaining	Little evidence of erosion or bare patches where pasture has failed. Completion of preparatory work for sale.	Stage 1 MOP 2015 Final Closure MOP	No	Nil	Ongoing until land sold
<b>Phase 7: Lease Relinquishment</b>						

<b>Objective</b>	<b>Performance Indicator</b>	<b>Completion Criteria</b>	<b>Justification / Source</b>	<b>Link to TARP</b>	<b>Progress at Start of Stage 2 MOP</b>	<b>Progress at Completion of Stage 2 RMP</b>
Rehabilitation	Commissioning of water treatment and transfer project Private sale confirmed for any surplus land	Rehabilitation Monitoring demonstrates that vegetation community is self sustaining and long term viable Satisfy any specific conditions imposed by Council and that land is suitable for sale	Stage 2 MOP	No	Nil	Ongoing until land sold
Satisfy lease conditions	Audit compliance	Satisfactorily demonstrate to government stakeholders that the rehabilitation work has been completed in accordance with this RMP	Stage 2 MOP	No	Nil	Ongoing until land sold

## 7. Rehabilitation Implementation

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This RMP covers all remaining rehabilitation activities leading to partial lease relinquishment.

### 7.1 Rehabilitation Phase - Decommissioning

At the commencement of this RMP, the colliery is at an advanced stage of decommissioning and preparation is underway for the proposed reuse of the site as a passive treatment process for the underground water. The following activities or items have been completed or at an advanced stage of completion:

- Removal of economically recoverable underground equipment.
- Removal of dewatering equipment and flooding of the mine.
- Bolting and refurbishing underground roadways within the old workings in order to access the seal sites.
- Completion of the two Bowmans Creek seals.
- Completion of the main drain adit seal and installation of permanent drainage provisions.
- Removal of the main conveyor belting.
- Removal of potentially contaminating materials underground.
- Removal of disused but economically recyclable materials.
- Removal of coal stockpile at Loch Catherine.
- Removal of the product coal bin and associated overhead conveyors.
- Completed the first stage of the Loch Catherine entry sealing and the finalisation of the proposed final sealing methods.
- Installation of an underground passive water treatment system.
- Installation of seven underground bulkheads to obtain further information on the potentially to fully seal the workings.
- Development of an alternative final land use which will resolve the problem of an ongoing mine discharge and ultimately lead to the recovery and beneficial reuse of the water resource.

### 7.2 Rehabilitation Phase – Land Use Establishment

This RMP covers the following key activities leading to final lease relinquishment:

- Continue monitoring of the additional ambient water quality sites until such time as the Environment Protection Licence is modified to reflect the water transfer operation;
- Repurpose existing buildings and sheds to cater for the water transfer project and remove any remaining coal handling infrastructure;
- Rehabilitate the Loch Catherine Coal Stockpile area as outlined in this RMP;

- 
- 
- ❑ Installation of the additional internal bulk heads around the pit bottom area and install pumping equipment;
  - ❑ Complete the Loch Catherine Mine Entry seals or approved barriers;
  - ❑ Rehabilitate the Loch Catherine Drift cutting on completion of the barrier construction following a staged approval as outlined in this RMP; and
  - ❑ Remove ventilation equipment and install a permanent seal on the fan entry.

Given the reuse of the site for either passive water treatment or simple sale of excess land, there are no other phases of rehabilitation.

### **7.3 Relinquishment Phase Achieved During RMP Period**

This RMP covers the continuation of final rehabilitation work and implementation of the passive water treatment process at the Berrima Colliery Pit Top. Boral considers the completion of the passive water treatment system as being part of the final mine closure activities as it satisfies the outstanding issues associated with dealing with the groundwater discharge from the mine. It is recognised that this aspect of the mine closure has yet to be approved by the Resources Regulator.

Boral considers the passive treatment system as being a long term sustainable reuse of the mine site however this RMP does not propose to relinquish CCL748 over the underground mining or pit top surface infrastructure domains. There may be opportunities to reduce the extent of CCL748 but these will be discussed in more detail with the Resources Regulator.

## 8. Rehabilitation Monitoring and Research

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### 8.1 Rehabilitation Monitoring

Given that Berrima Colliery is an underground mine with an established but very small surface footprint, progressive rehabilitation does not occur and revegetation trials are not warranted.

The establishment of the final land use, that is, ongoing passive water treatment, will be completed during the term of this RMP. The main area of rehabilitation will be at the Loch Catherine entries and drift. The main pit top and railway easement to the cement plant will be repurposed for water treatment while the final use of the surrounding Boral owned land will be rural residential and/or lifestyle blocks with a mixture of existing native forest and agricultural land. Privately owned land within the previous underground extraction area will continue as is once the lease is relinquished.

The following monitoring activities will be undertaken during this RMP term:

- Continuation of the Performance Monitoring Program or its equivalent under the Environment Protection Licence. This work will continue until advised by the EPA and Resources Regulator.
- Disturbance and rehabilitation activities resulting from the removal of the subsidence and groundwater monitoring instrumentation within the extraction area will be inspected on an annual basis for a period of 2 years or until the Resources Regulator is satisfied that the work is stable and of equivalent condition as surrounding agricultural land.
- Final rehabilitation work undertaken on the Loch Catherine mine drift will be inspected on a 6 monthly basis for a period of 2 years. Maintenance work will be undertaken as required.
- Continue to monitor groundwater within the previous mining area on a quarterly until 30 September 2021.

### 8.2 Monitoring Methodology

The only domains requiring rehabilitation is the Loch Catherine drift and a portion of the Loch Catherine coal storage area. These domains have a combined area of approximately 4.7 ha. There are several potential building sites however there will also be peripheral areas requiring rehabilitation. The rehabilitation activities will need to ensure the land is stable and non-polluting with a self-sustaining vegetation cover suitable for private sale.

As it is not proposed to regenerate a native vegetation community, specific monitoring methodologies such as Ecological Function Analysis will not be undertaken. The inspections will be visual only but will include:

- Vegetation cover, health and vigour.
- Evidence of erosion or sediment movement on or off site.
- Weed growth.

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### **8.3 Research and Rehabilitation Trials and Use of Analogue Sites**

No rehabilitation trials are proposed during this RMP. The rehabilitation activities will be designed to maximise the sale value of the land. This will include a combination of works including removal of mining infrastructure, decontamination activities, development of building sites and rehabilitation of external areas. Rehabilitation will be designed to be permanently stable and self-sustaining and include a mixture of improved pasture over the building sites and curtilage.

## 9. Intervention and Adaptive Management

### 9.1 Trigger Action Response Plan

Berrima Colliery previously operated under a series of Trigger Action Response Plans (TARPs) developed in June 2010. These triggers required actions to be undertaken in the event the triggers are breached however given that the operation has now moved into a closure path, these triggers are no longer valid.

As the colliery moves towards final closure, the triggers are based around specific closure issues.

The following Trigger Action Response Plan (TARP) covers the activities of the Stage 1 Closure MOP.

Criteria	Trigger	Action
Dust emissions	Visible fugitive dust leaving property boundaries.	Stabilise areas causing wind erosion
Surface Erosion	Bank or bed cutting, sediment movement and build-up	Widen channel to achieve less than 2.5 m/s peak flow Install channel protection such as rock rubble Reduce slope
Nil discharge from Pollution Control Dams	Overtopping of dams during storm events	Pump water to larger dams on site Test water to ensure standard discharge criteria would be met in the event of discharge occurring
Contamination	Contamination auditor confirms criteria not met	Identify source of contamination and remove or bioremediate further
Foundations made safe	Confirmation by Resource Regulator	Rectify as instructed
Growing Media Depth	Confirmation by site Environmental Officer	Rectify as instructed
Growing Media Quality	Comparable with surrounding soil quality	Apply fertiliser and soil conditioners until optimal media quality is achieved
Vegetation dieback	Greater than 10% death rate	Establish soil chemistry Apply soil ameliorants Retest soil to confirm suitability
Sustained growth	Lack of self-seeding	Monitor growth stages to determine limitations Improve soil structure and fertility, reduce physical limitations

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## 9.2 Threats to Rehabilitation

Issues associated with water quality and the potential short and long term impacts on the Wingecarribee River have been assessed through the Performance Monitoring Program attached to the Environment Protection Licence. This assessment has found that the section of river most impacted by the mine is the first 500 m below the discharge point. The impact is reducing over time however the long term closure may also see a reduction in discharge volume and a change in the location of the discharge point. The reduction will arise as a result of a proportion of the water being transferred to the cement plant. The final assessed impacts of the mine closure forms part of the ongoing monitoring and assessment program and it is anticipated that the long term impacts would be acceptable.

The decision to pump the majority of water from the mine workings to the pit top for treatment prior to either being discharged back to the Wingecarribee River near the mine bridge or transferred to the Berrima Cement Plant removes the main risk to the closure process, being the ongoing discharge of water from the mine adit. Water delivered to the cement plant becomes the responsibility of a separate licence holder.

Achieving the final vegetation community at Loch Catherine drift will take time and will be subject to ongoing maintenance work. It is anticipated that the vegetation community will be established and progressing to self-sustainability within 5 years, however Boral may seek relinquishment of the lease prior to final land sale.

As all excess land not required for the water treatment and transfer project is destined for sale for private use, there are few direct threats to the rehabilitation activities. The quality of revegetation work may influence the attractiveness of the property for sale and ultimate sale value however this is not considered a specific threat.

The relinquishment of the mining titles over the land would be predicated on a commercial agreement to the satisfaction of the Resources Regulator. Given the location of the property and vistas available, it is considered unlikely that private sale would not be possible.

# 10. Reporting

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## 10.1 Reporting Requirements

Berrima Colliery will continue the current reporting regime covering the operation, as listed below.

- Annual Rehabilitation Reports.
- EPA Licence returns.

The primary reporting document will continue to be the Annual Rehabilitation Report which will be lodged each year with the Resources Regulator through its on line portal and then provided to relevant government departments as required. The Annual Rehabilitation Report is an important tool for measuring and documenting the success and implementation of the commitments and planning made in this RMP.

In the event that a pollution incident occurs at the site, the relevant government departments will be advised as soon as possible.

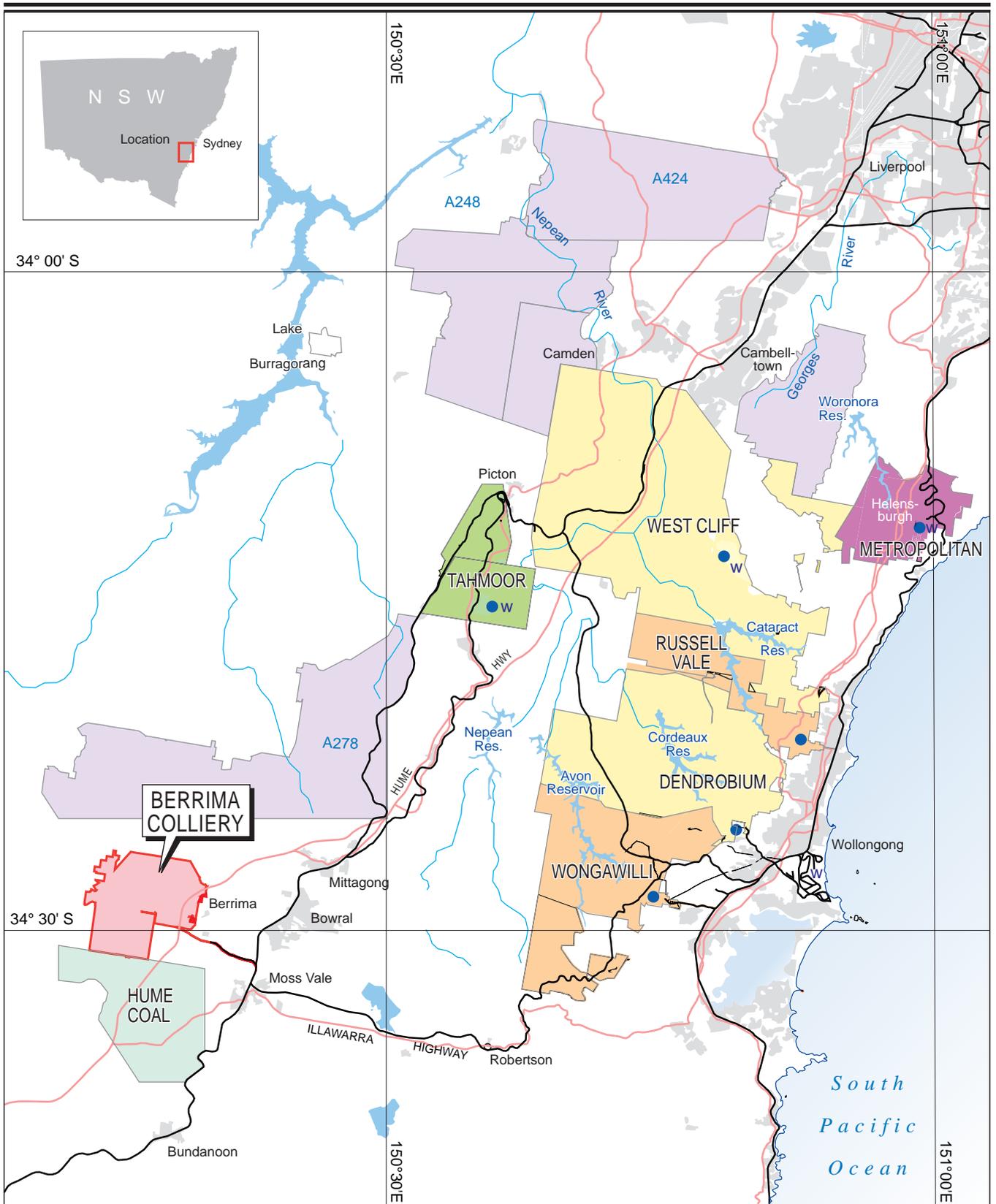
The Annual Rehabilitation Report will be provided to the following agencies:

- NSW Department of Planning and Environment - Resources Regulator;
- DPI-Water;
- Water NSW;
- Wingecarribee Shire Council;
- Office of Environment and Heritage; and
- NSW Environment Protection Authority.

The Closure Working Group, which includes the above agencies will also receive a copy of all environmental reports including this RMP and subsequent annual reports.

# Appendix A - Plans

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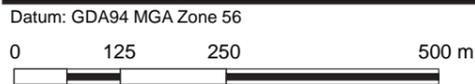


- |               |                    |                  |             |
|---------------|--------------------|------------------|-------------|
| Boral Limited | Hume Coal          | Underground mine | Urban areas |
| BHP Billiton  | Wollongong Coal    | Washery          | Railway     |
| Peabody Coal  | Coal Authorisation |                  | Main Road   |
| SIMEC Coal    |                    |                  | Reservoir   |

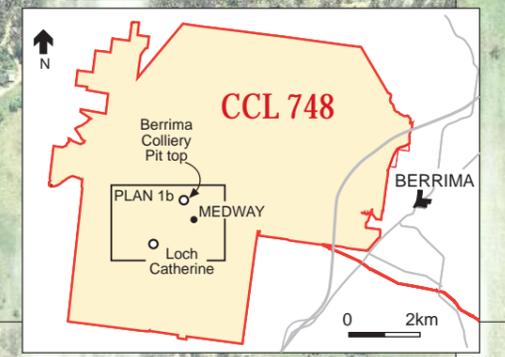
Jan 2019

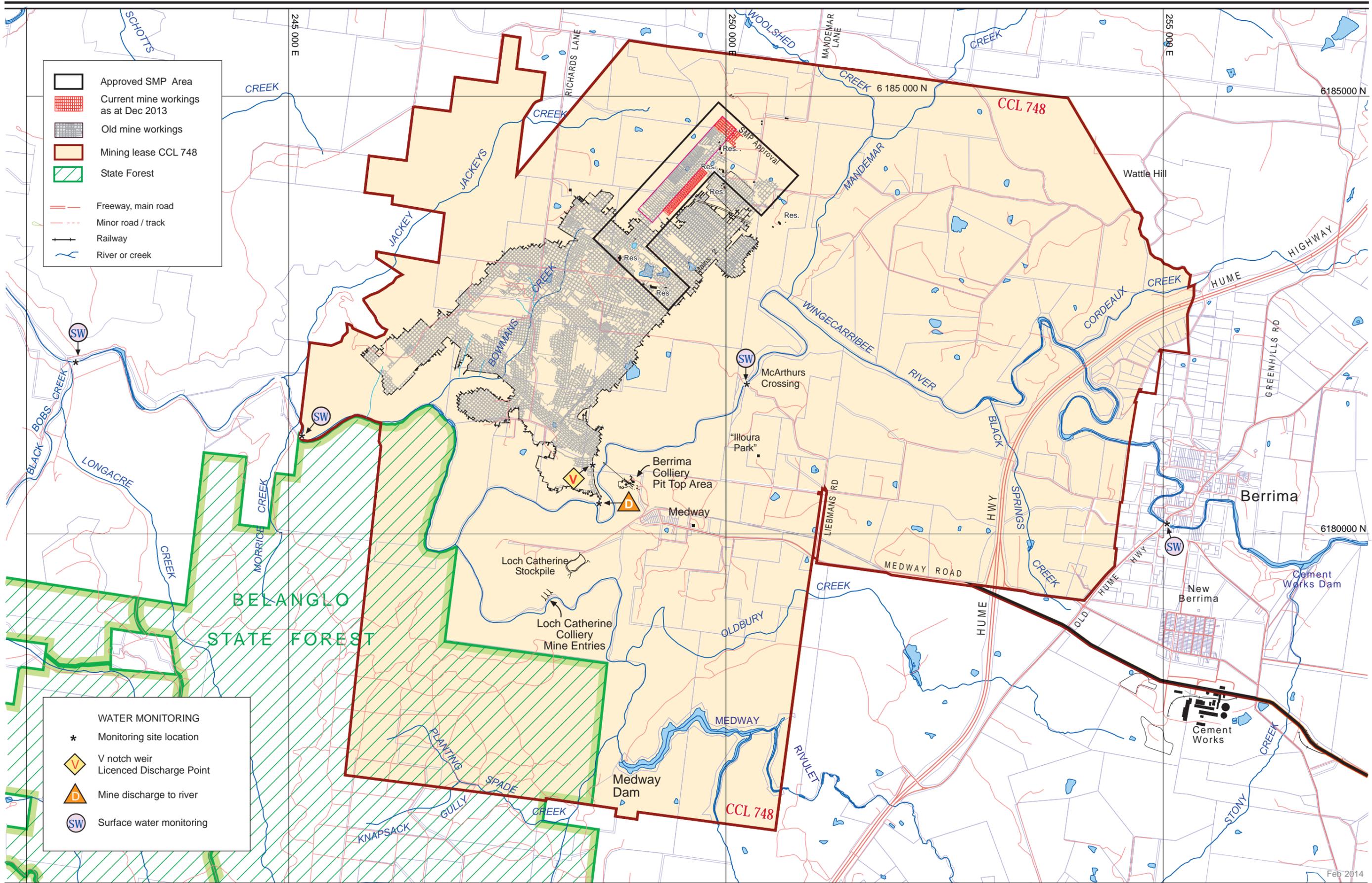


PLAN 1a  
 Berrima Colliery - Regional Location  
 Southern Coalfield, NSW



Cadastral lots (© NSW Lands Department)

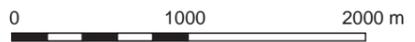




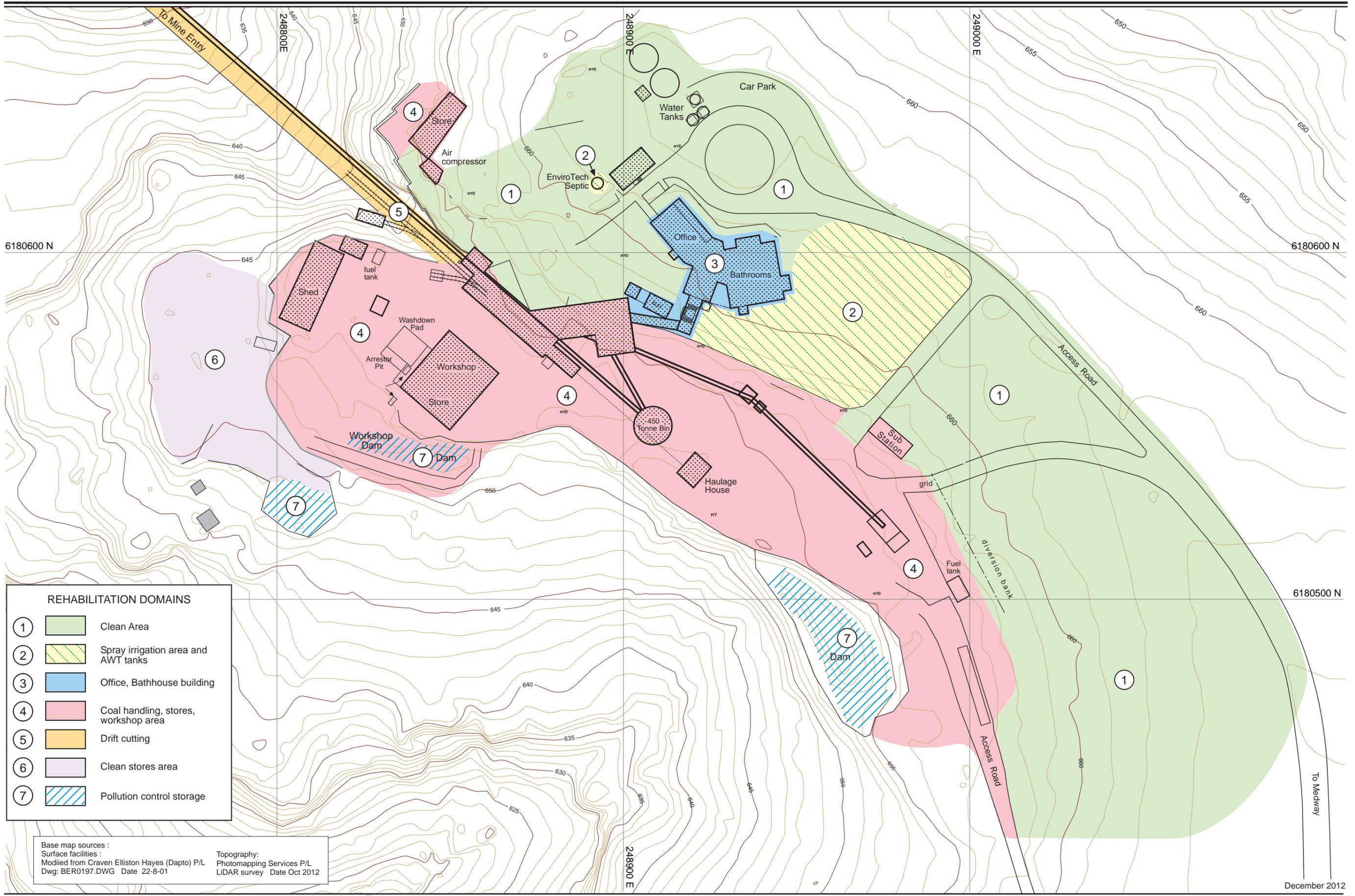
- Approved SMP Area
- Current mine workings as at Dec 2013
- Old mine workings
- Mining lease CCL 748
- State Forest
- Freeway, main road
- Minor road / track
- Railway
- River or creek

- WATER MONITORING**
- Monitoring site location
  - V notch weir  
Licenced Discharge Point
  - Mine discharge to river
  - Surface water monitoring

Map source: © NSW LPMI 2011



Feb 2014



**REHABILITATION DOMAINS**

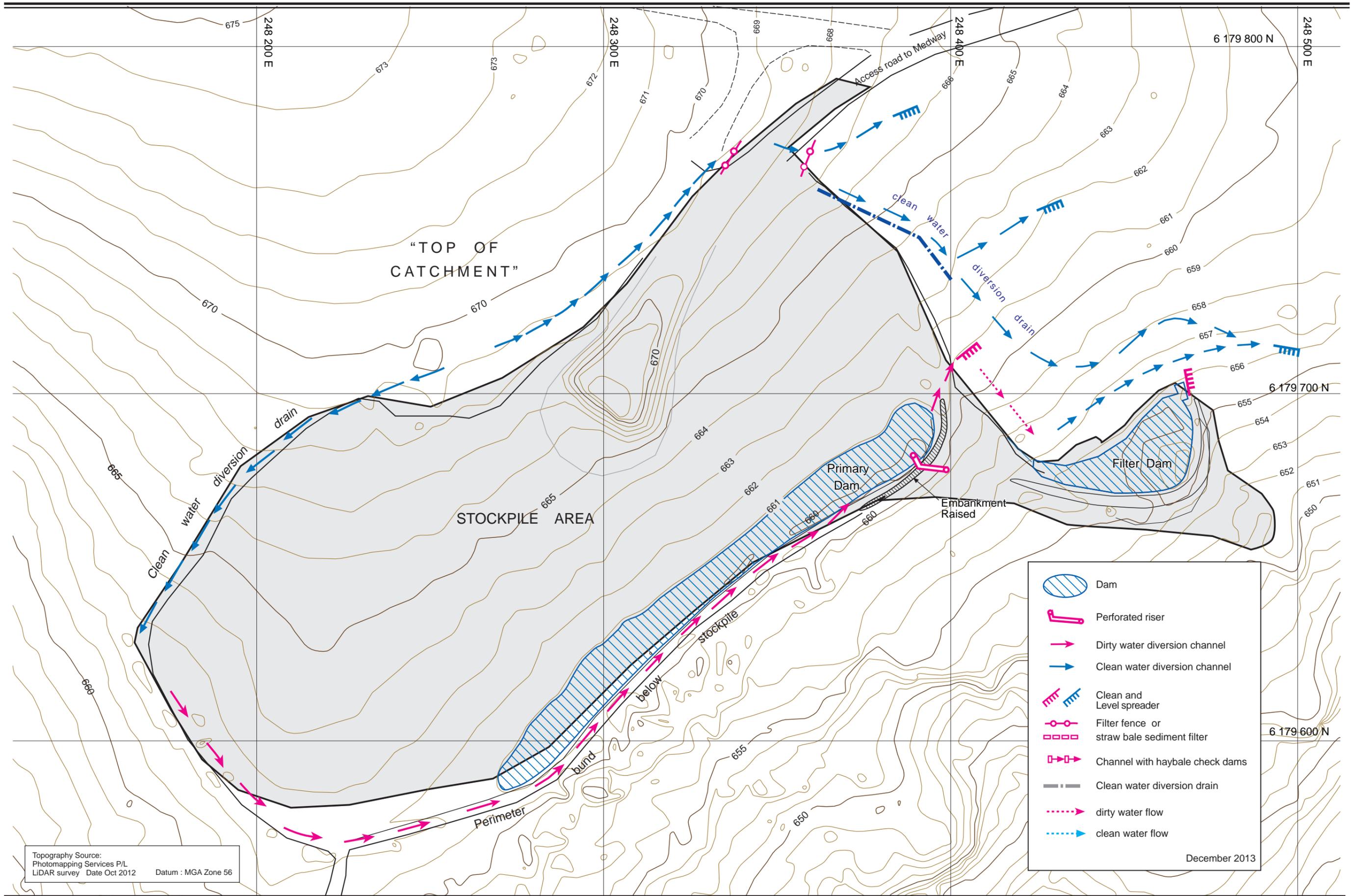
- ①  Clean Area
- ②  Spray irrigation area and AWT tanks
- ③  Office, Bathhouse building
- ④  Coal handling, stores, workshop area
- ⑤  Drift cutting
- ⑥  Clean stores area
- ⑦  Pollution control storage

Base map sources :  
 Surface facilities :  
 Modified from Craven Elliston Hayes (Dapto) P/L  
 Dwg: BER0197.DWG Date 22-8-01

Topography:  
 Photomapping Services P/L  
 LIDAR survey Date Oct 2012



December 2012

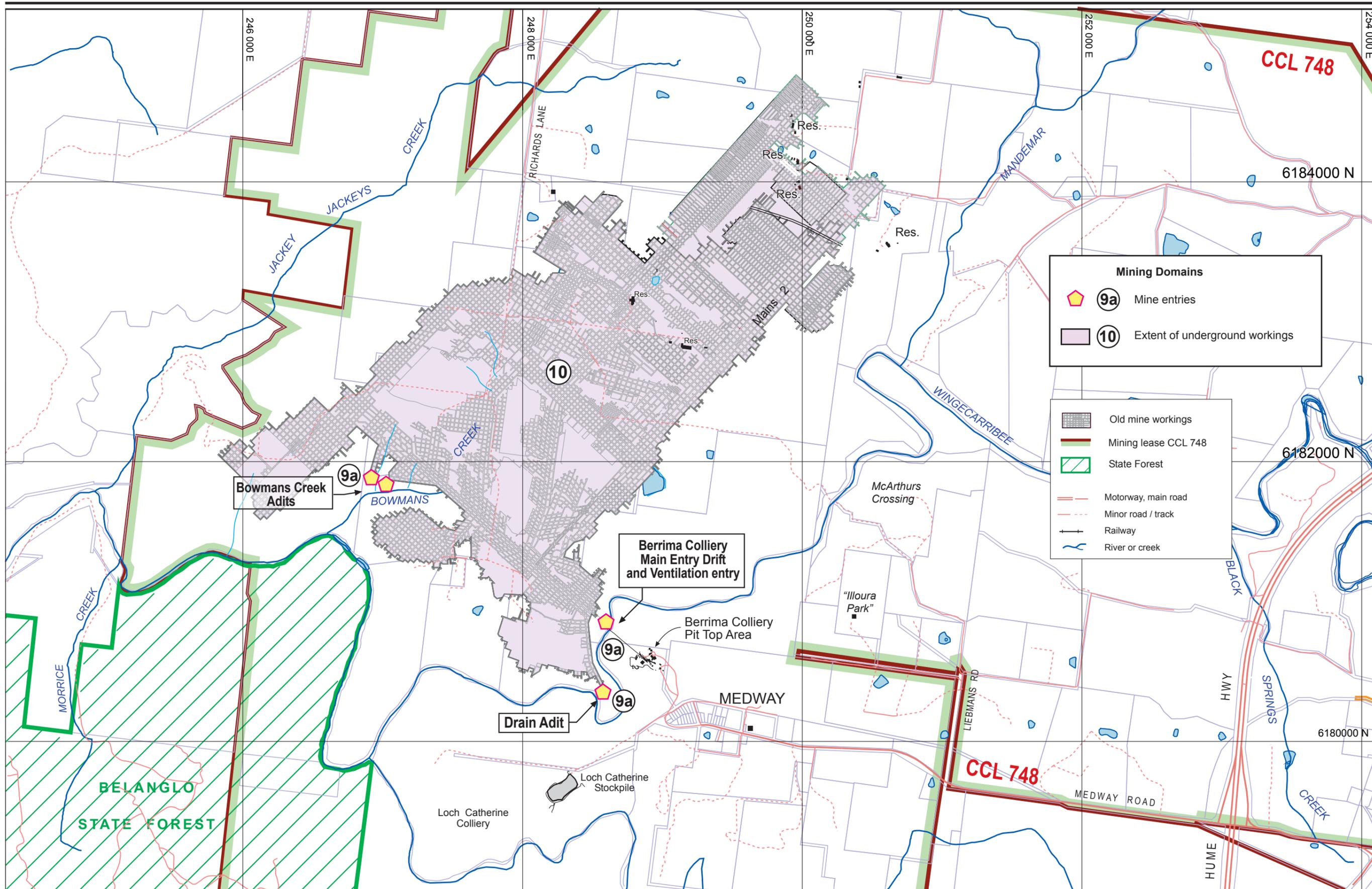


Topography Source:  
 Photomapping Services P/L  
 LiDAR survey Date Oct 2012 Datum : MGA Zone 56



	Dam
	Perforated riser
	Dirty water diversion channel
	Clean water diversion channel
	Clean and Level spreader
	Filter fence or straw bale sediment filter
	Channel with haybale check dams
	Clean water diversion drain
	dirty water flow
	clean water flow

December 2013

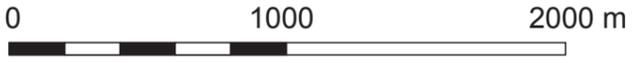


**Mining Domains**

- 9a** Mine entries
- 10** Extent of underground workings

- Old mine workings
- Mining lease CCL 748
- State Forest
- Motorway, main road
- Minor road / track
- Railway
- River or creek

Map source: © NSW LPMI 2011 Datum: GDA94 MGA Zone 56





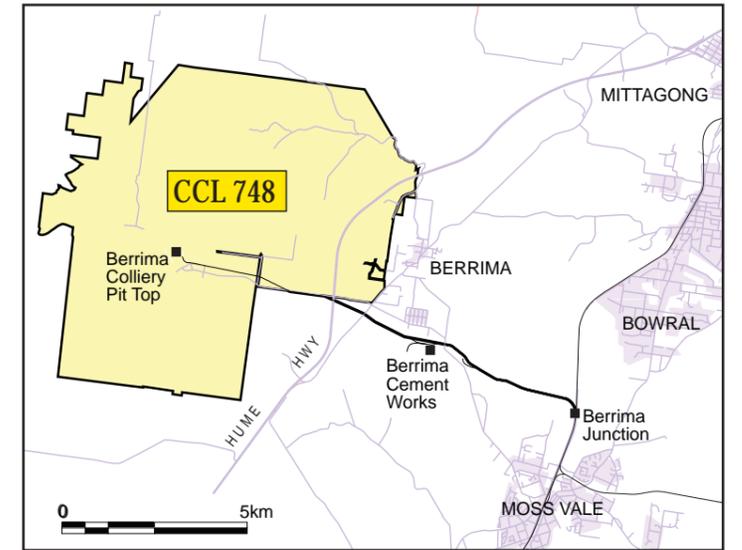
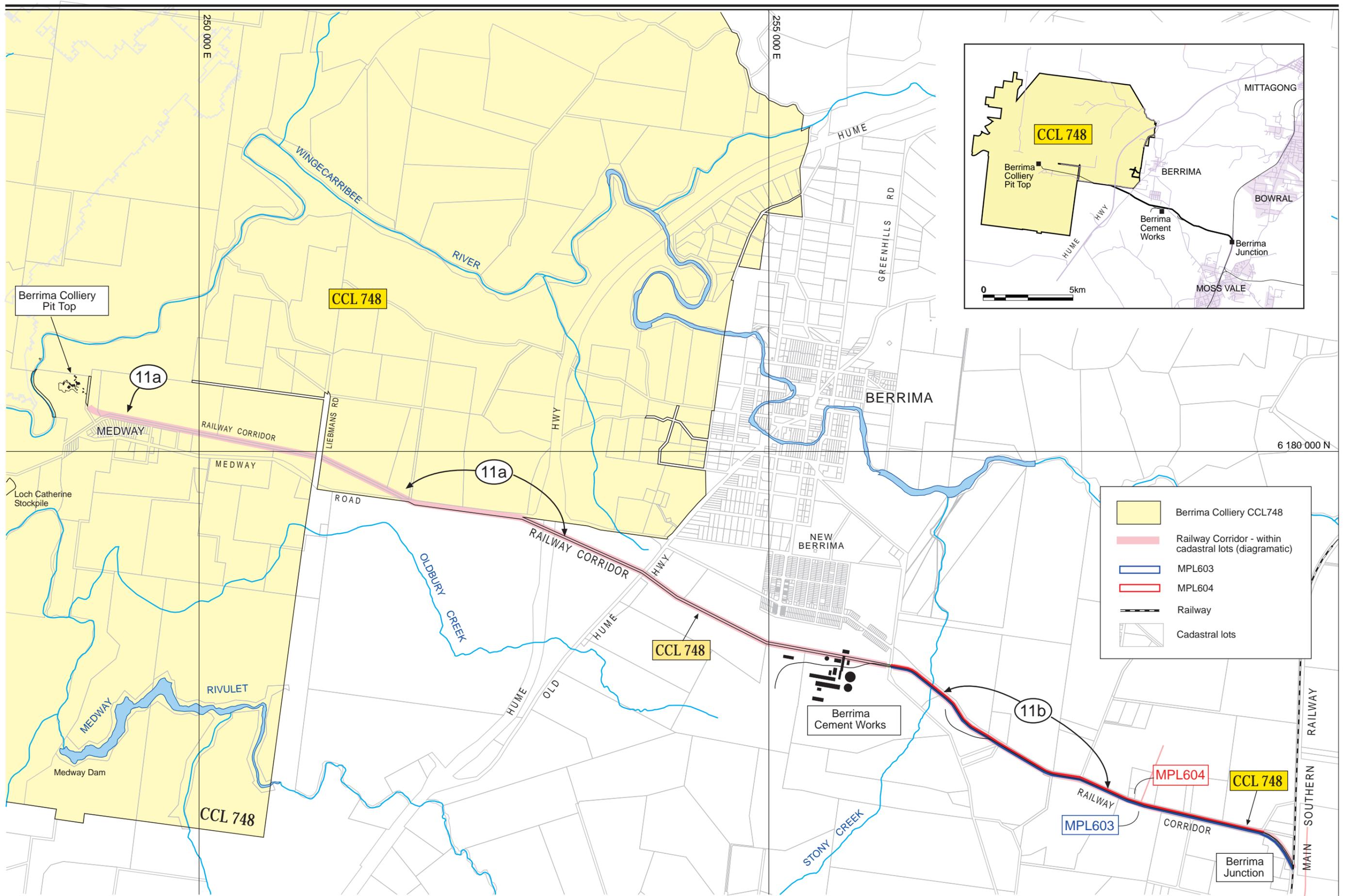
Datum: GDA94 MGA Zone 56 Contour interval: 5m

  Domain 9b - Loch Catherine Mine

0 25 50 100 m

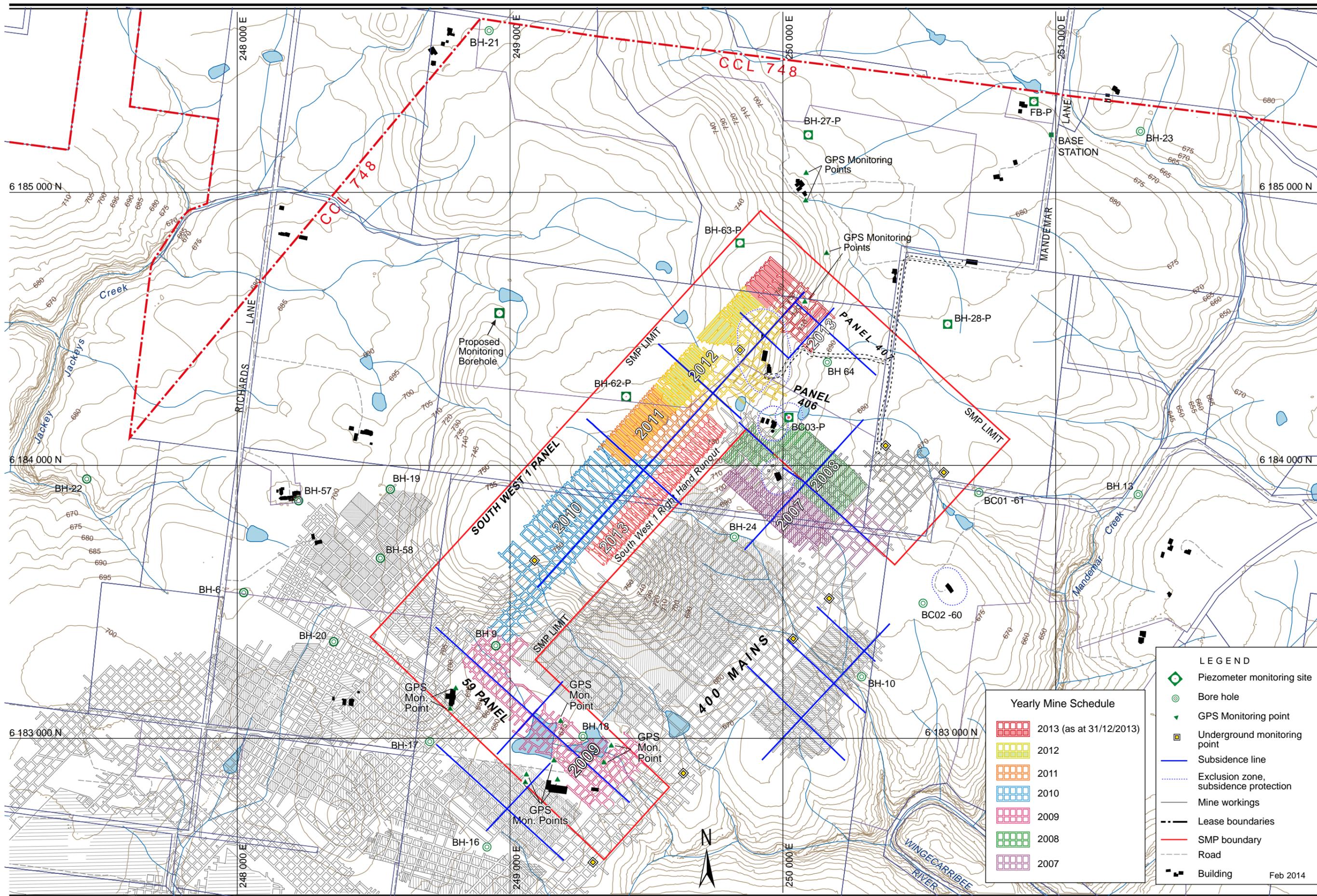


PLAN 2d  
Loch Catherine Colliery  
Mine Domains



Map source: © NSW LPMI 2011  
 0 1 2 kilometres



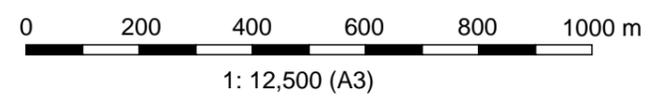


**Yearly Mine Schedule**

	2013 (as at 31/12/2013)
	2012
	2011
	2010
	2009
	2008
	2007

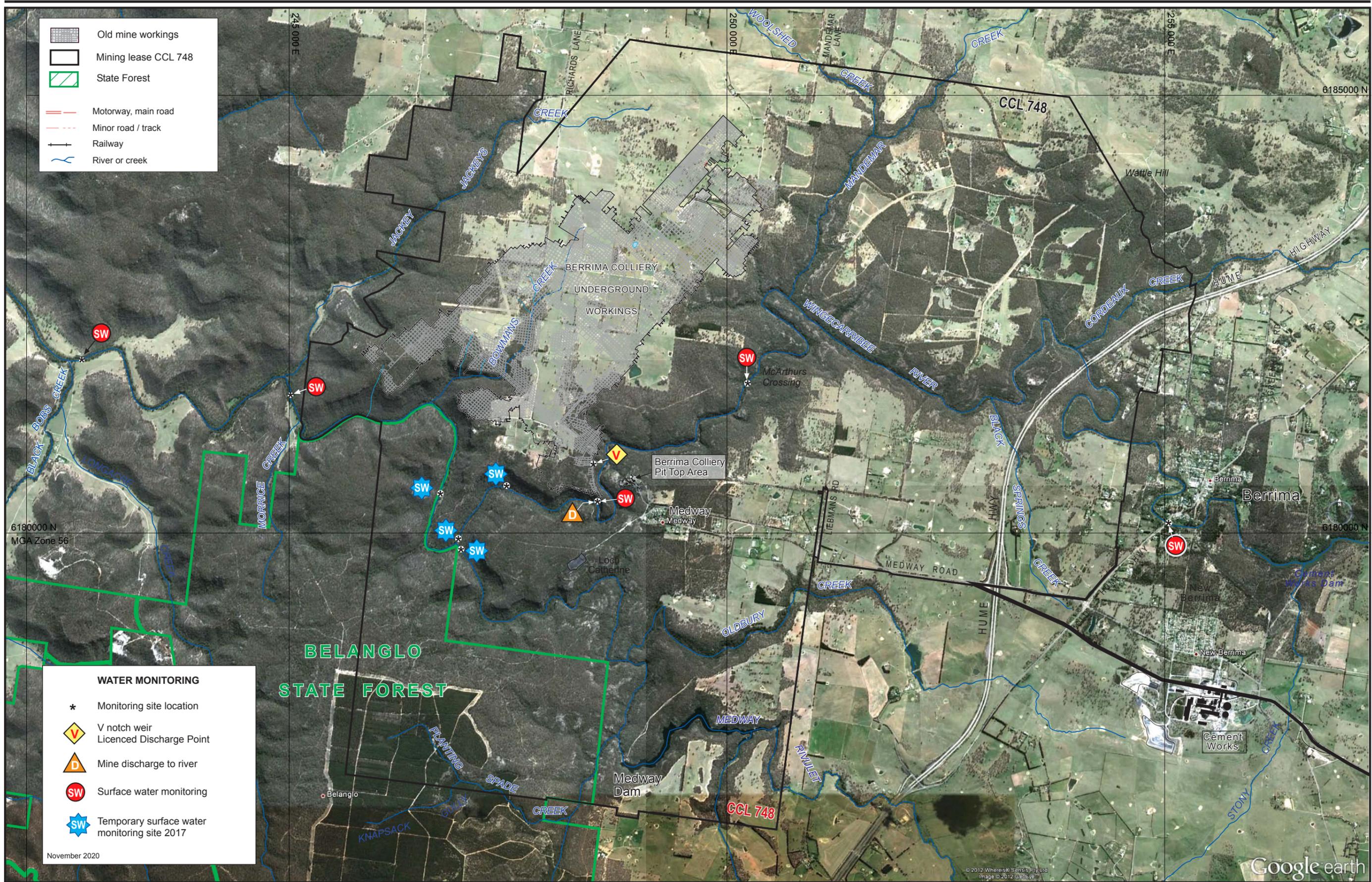
**LEGEND**

- Piezometer monitoring site
- Bore hole
- GPS Monitoring point
- Underground monitoring point
- Subsidence line
- Exclusion zone, subsidence protection
- Mine workings
- Lease boundaries
- SMP boundary
- Road
- Building



Base Map : Craven, Elliston & Hayes BE515. dxf February 2013  
 Datum : GDA94 MGA Zone 56

Feb 2014



	Old mine workings
	Mining lease CCL 748
	State Forest
	Motorway, main road
	Minor road / track
	Railway
	River or creek

**WATER MONITORING**

- \* Monitoring site location
- V notch weir
- Licenced Discharge Point
- Mine discharge to river
- Surface water monitoring
- Temporary surface water monitoring site 2017

November 2020





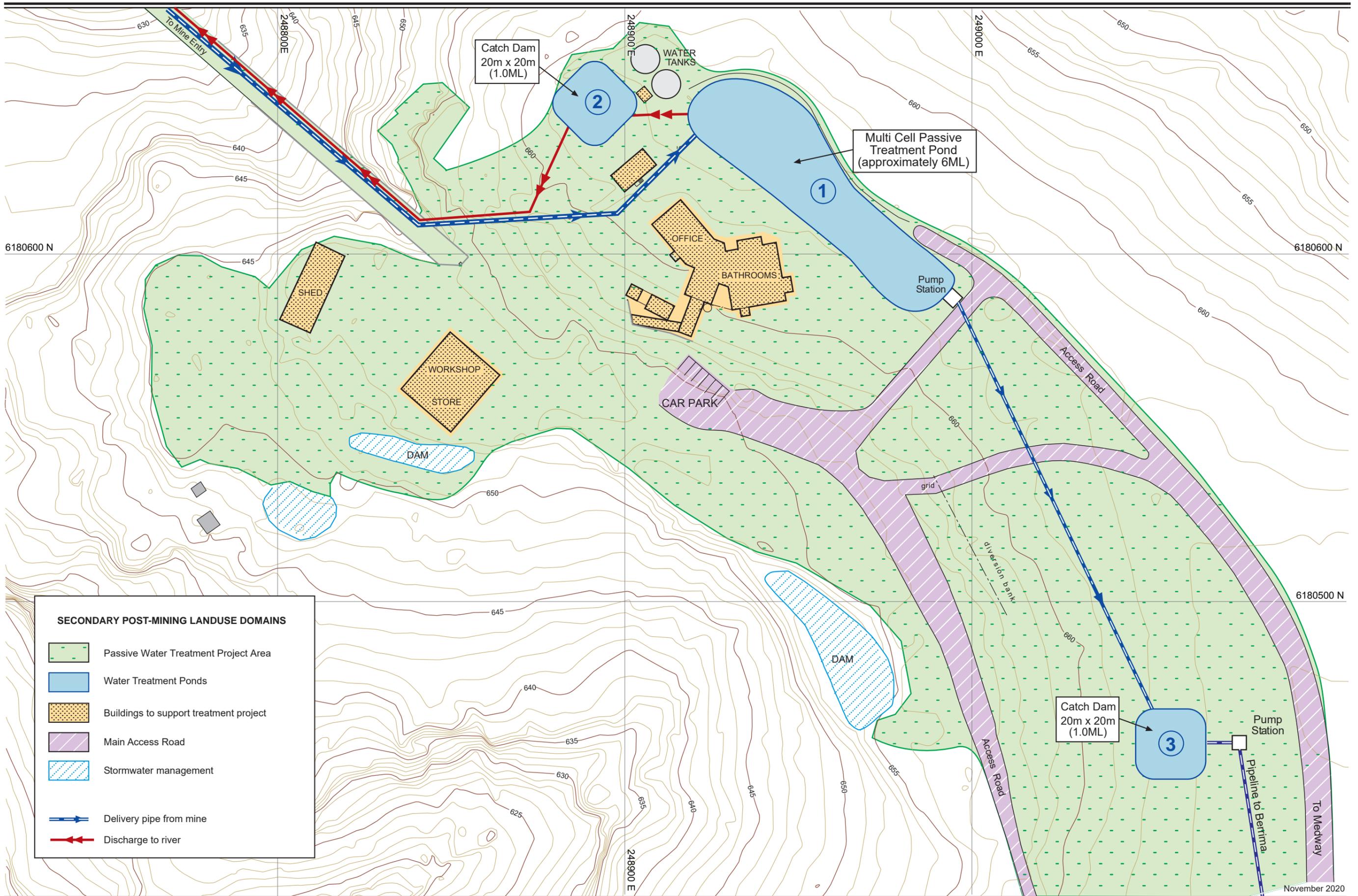
**WATER MONITORING**

- \* Monitoring site location
-  V notch weir  
Licenced Discharge Point
-  Mine discharge to river
-  Surface water monitoring
-  Temporary surface water monitoring site 2017

November 2020

Datum: GDA 94 MGA Zone 56  
 0 250 500 metres





November 2020

Projection: MGA Zone 56 (GDA94)



Signed : \_\_\_\_\_  
 (Mine Manager)

Date : \_\_\_\_\_



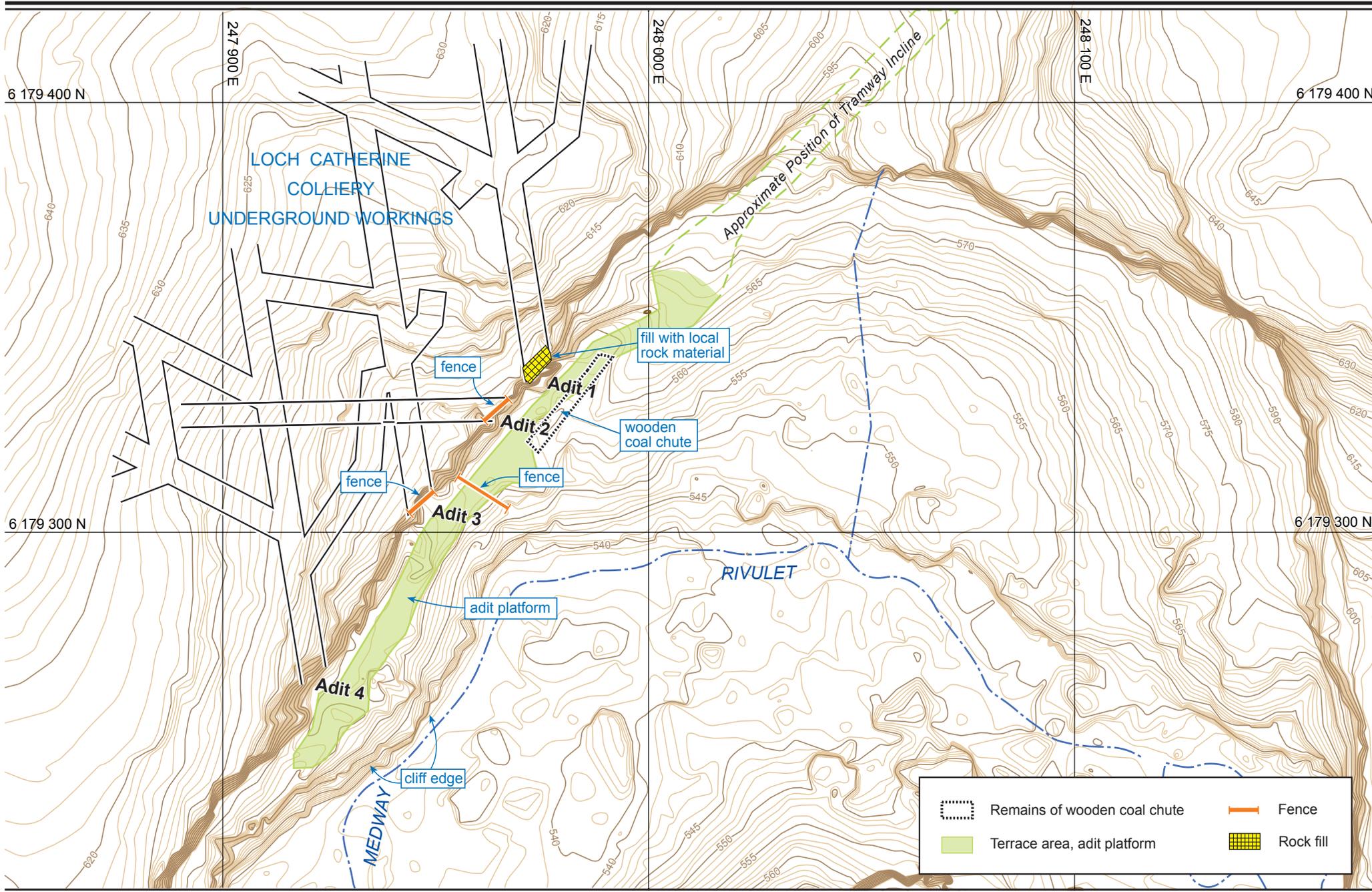
- Perforated riser
- Divergence channel
- Divergence channel
- Clean and Level spreader
- Filter fence or straw bale sediment filter
- Channel with haybale check dams
- Waterway
- Blue = clean water flow
- Red = dirty water flow
- Rehabilitation areas

Base map source :  
 Craven Elliston Hayes (Dapto) P/L  
 Dwg: A3-LOCH0301 Date 31-3-01

2007



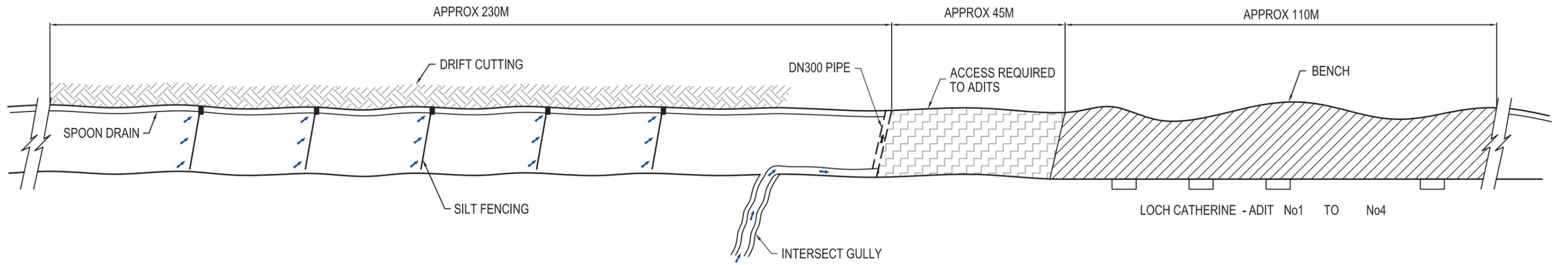
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**Berrima Colliery - Loch Catherine**  
**Final Rehabilitation**



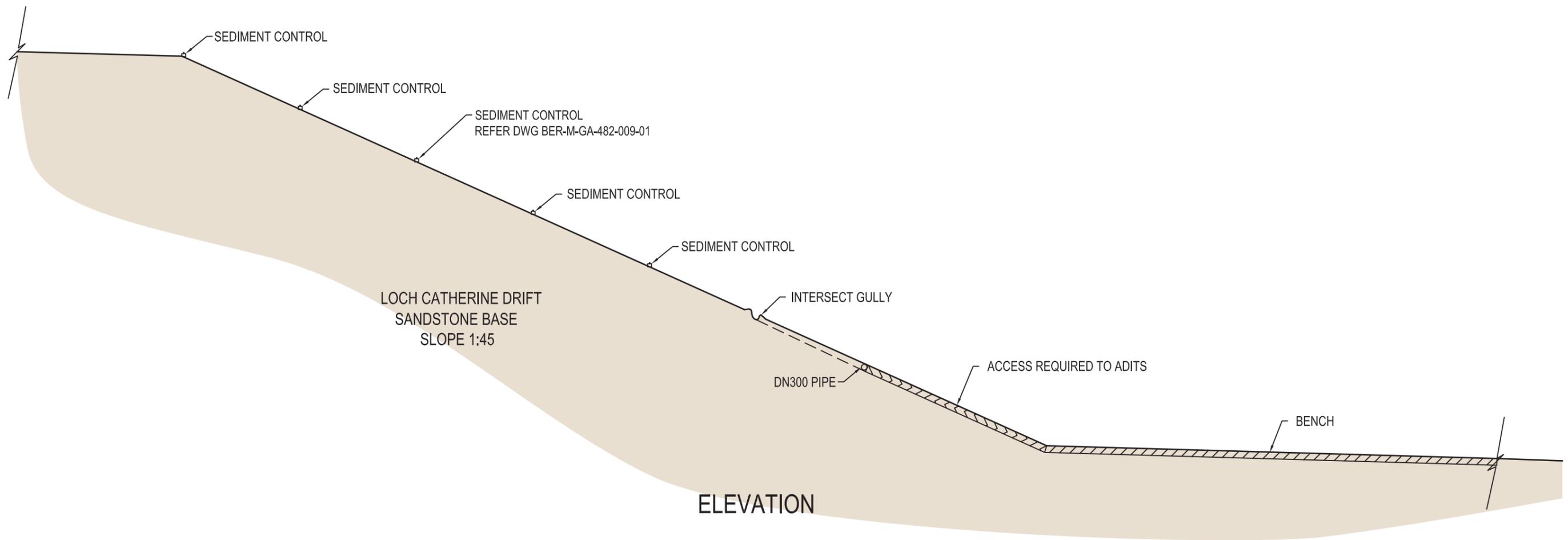
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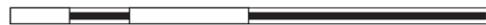
PLAN

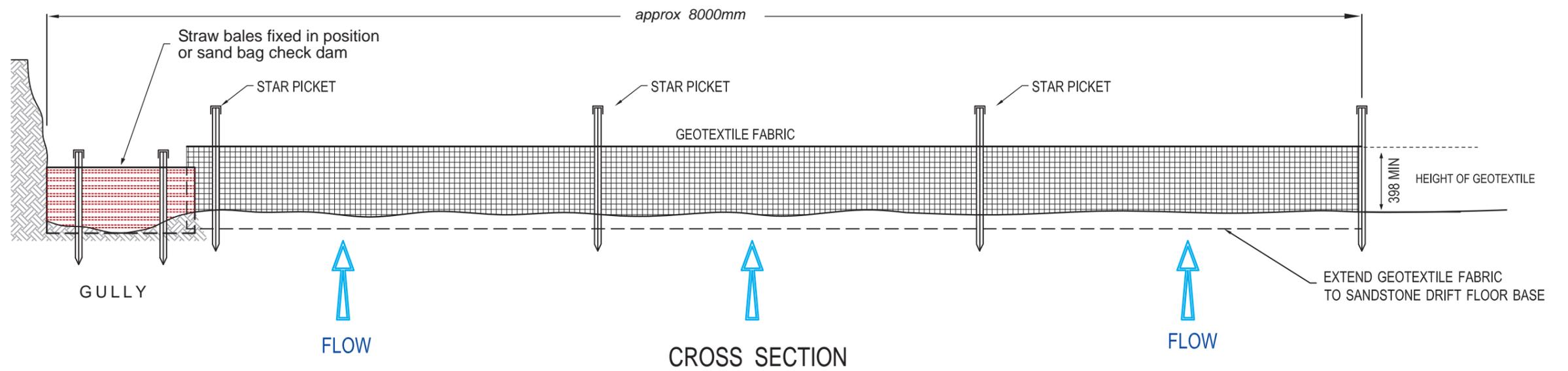
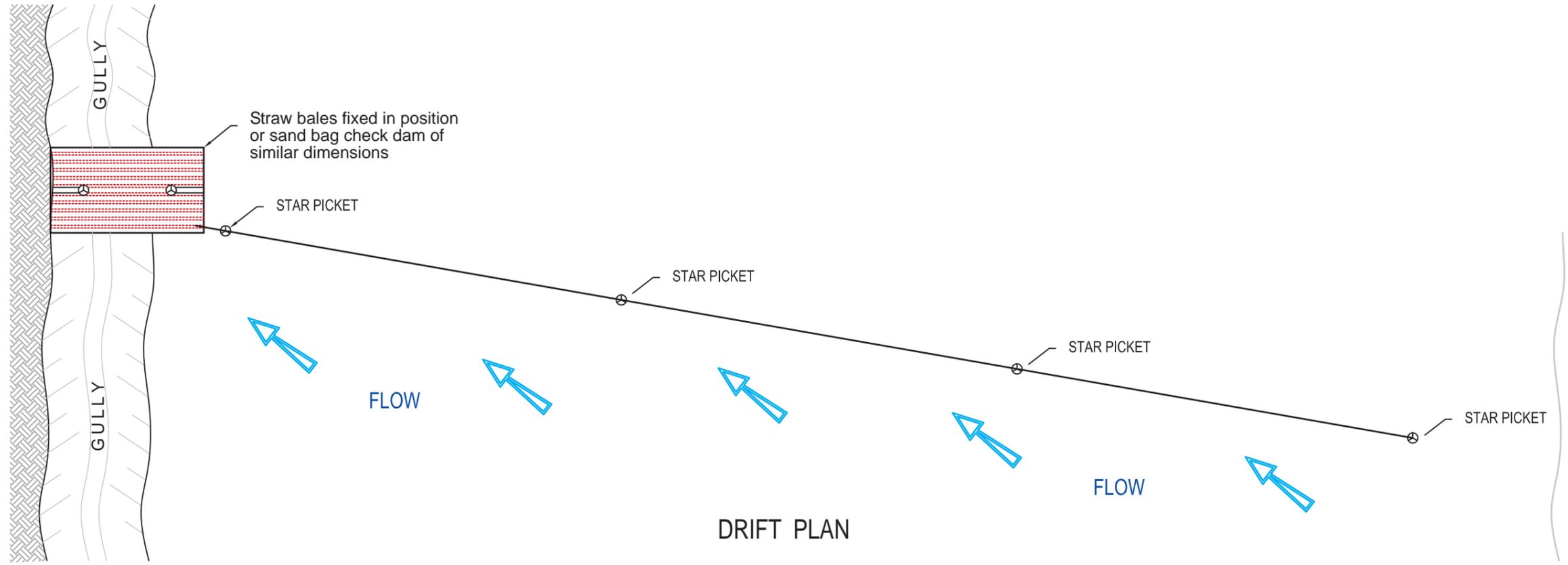


ELEVATION

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 21 June 2108

NOT TO SCALE

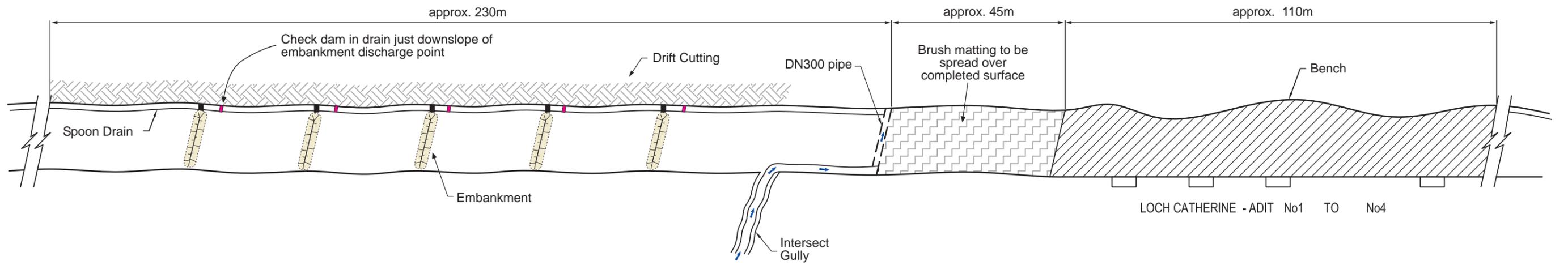




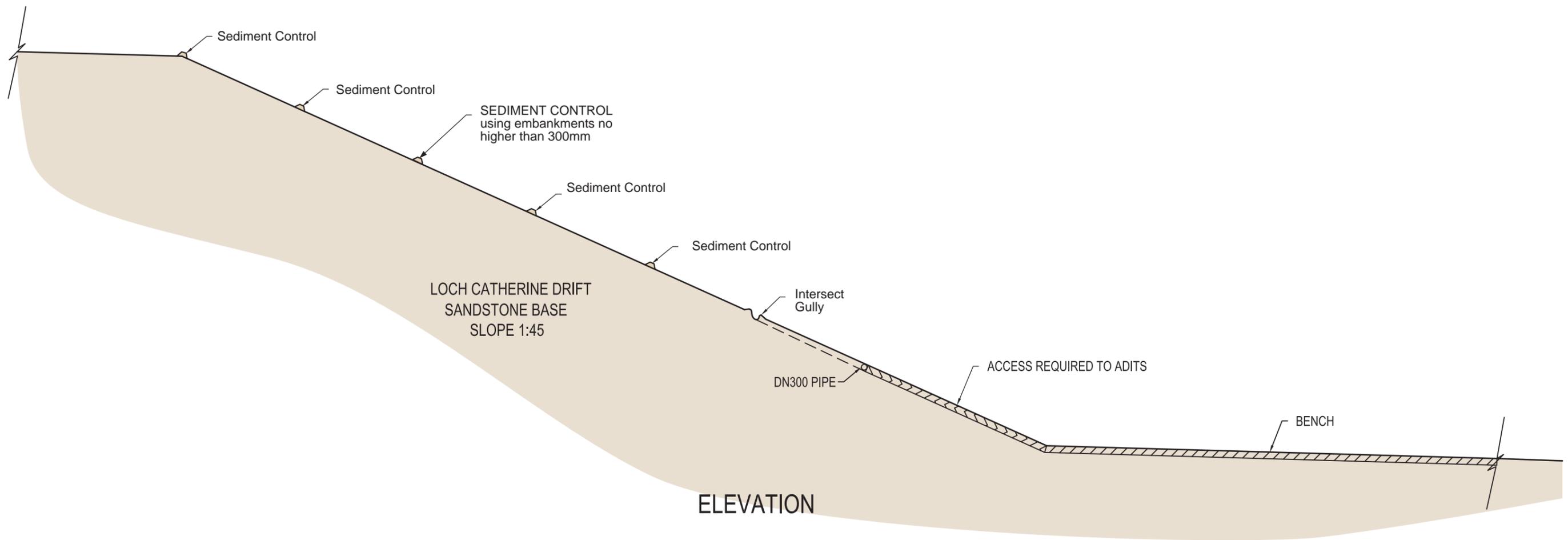
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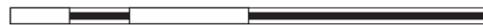
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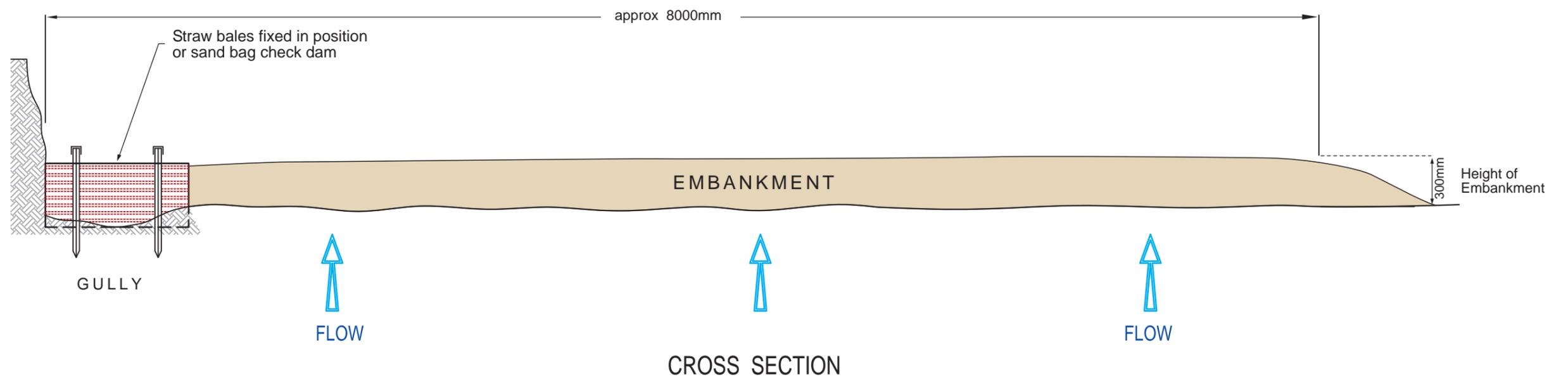
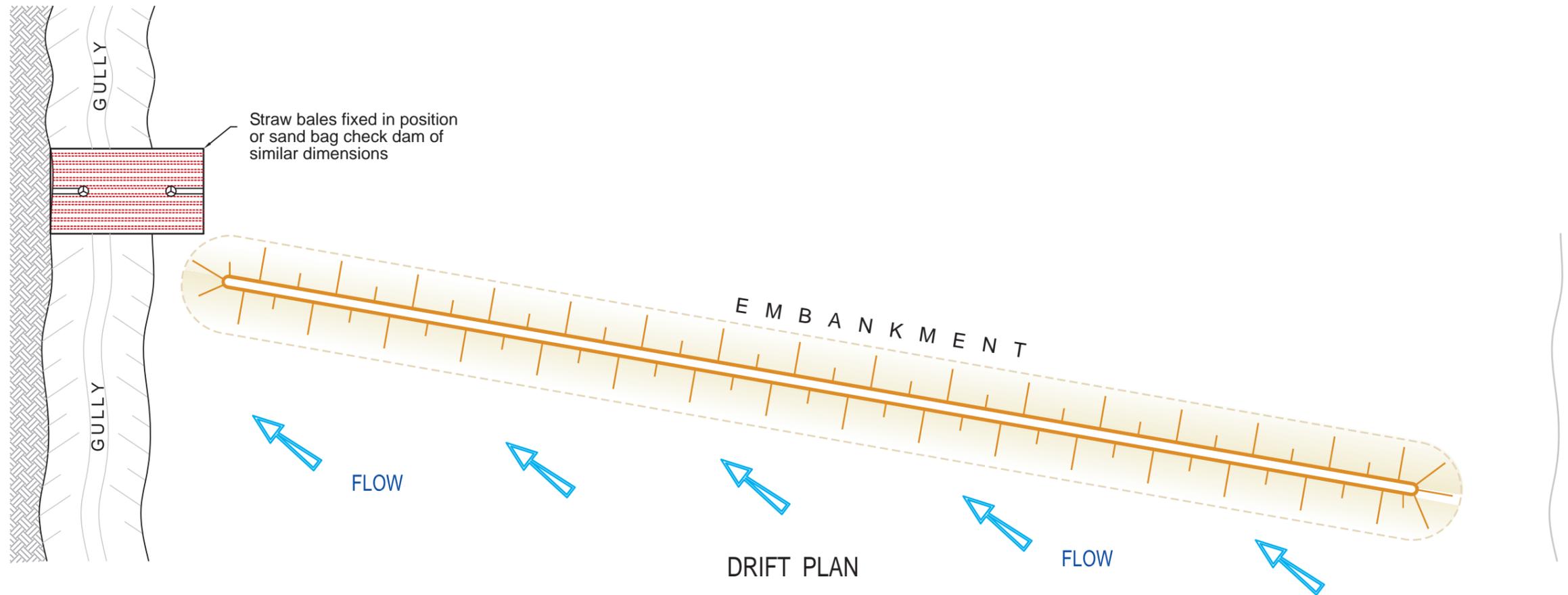


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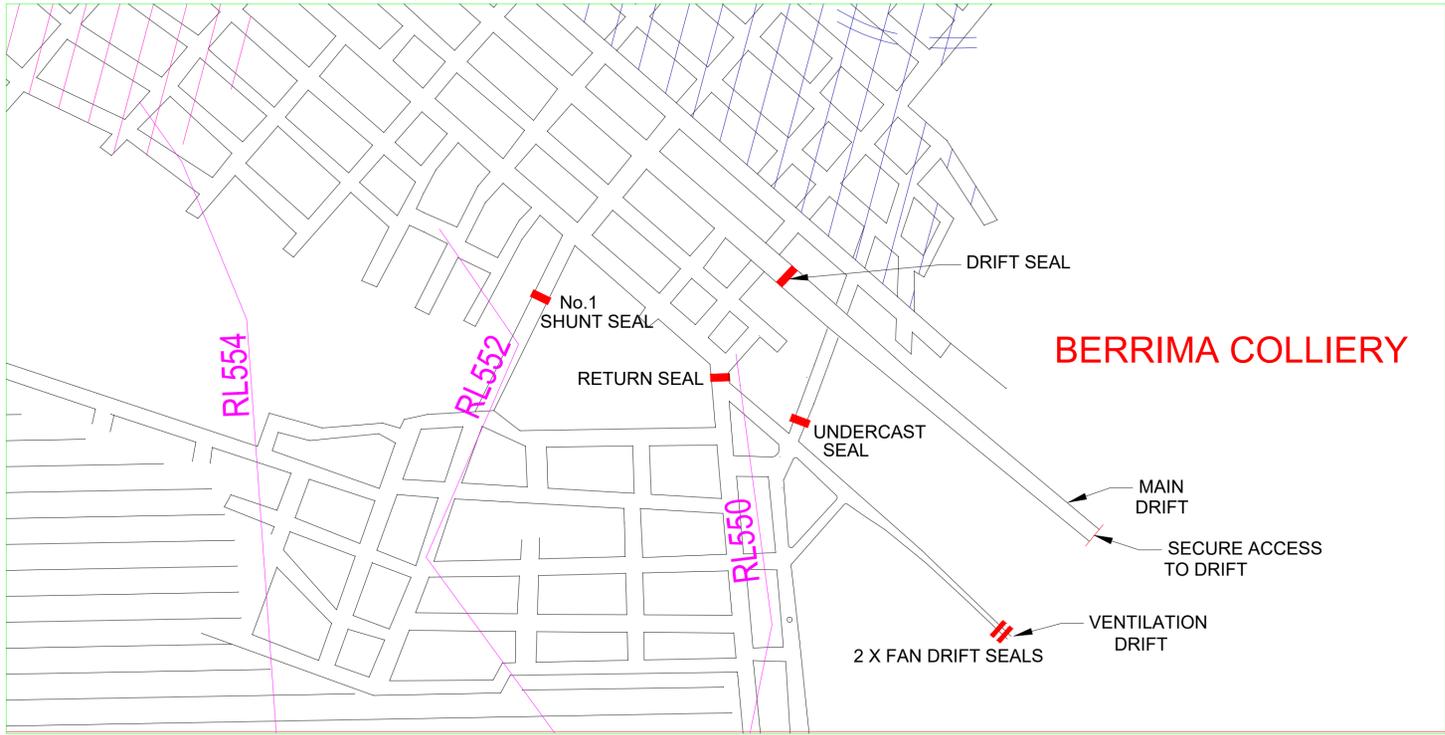
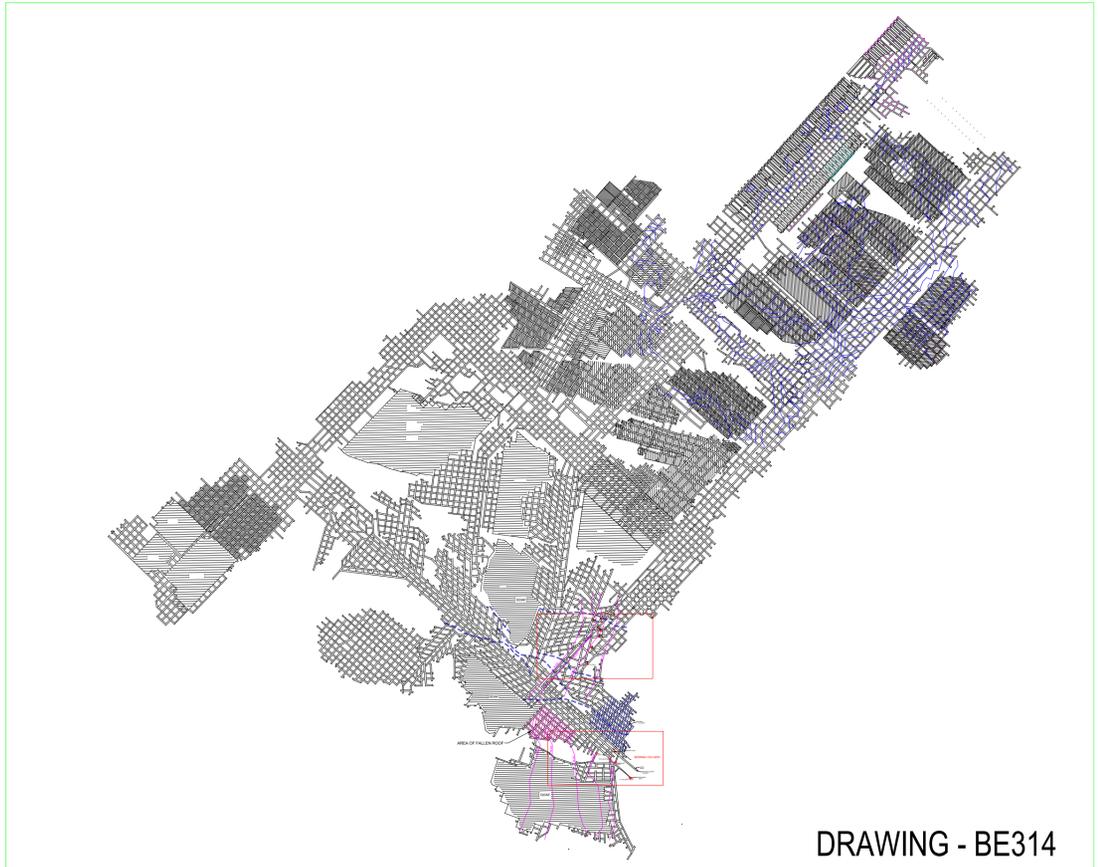
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21 June 2108

NOT TO SCALE



**LEGEND**

- PIT BOTTOM SEALS
- COAL SEAM CONTOURS
- TRANSFORMER
- PRESSURE GAUGE
- PRESSURE TRANSMITTER

**NO JOB IS SO IMPORTANT THAT IT CAN'T BE DONE SAFELY!**

REV.	DATE	REV-BY	APPROVED	REVISIONS	REVISION
A	28-04-20	L.P.McIntosh		DRAWING ISSUED FOR COMMENT.	

DRAWN:	L.P.McIntosh	DATE:	28-04-20
CHECKED:		DATE:	
ENGINEER:		DATE:	
APPROVED:		DATE:	

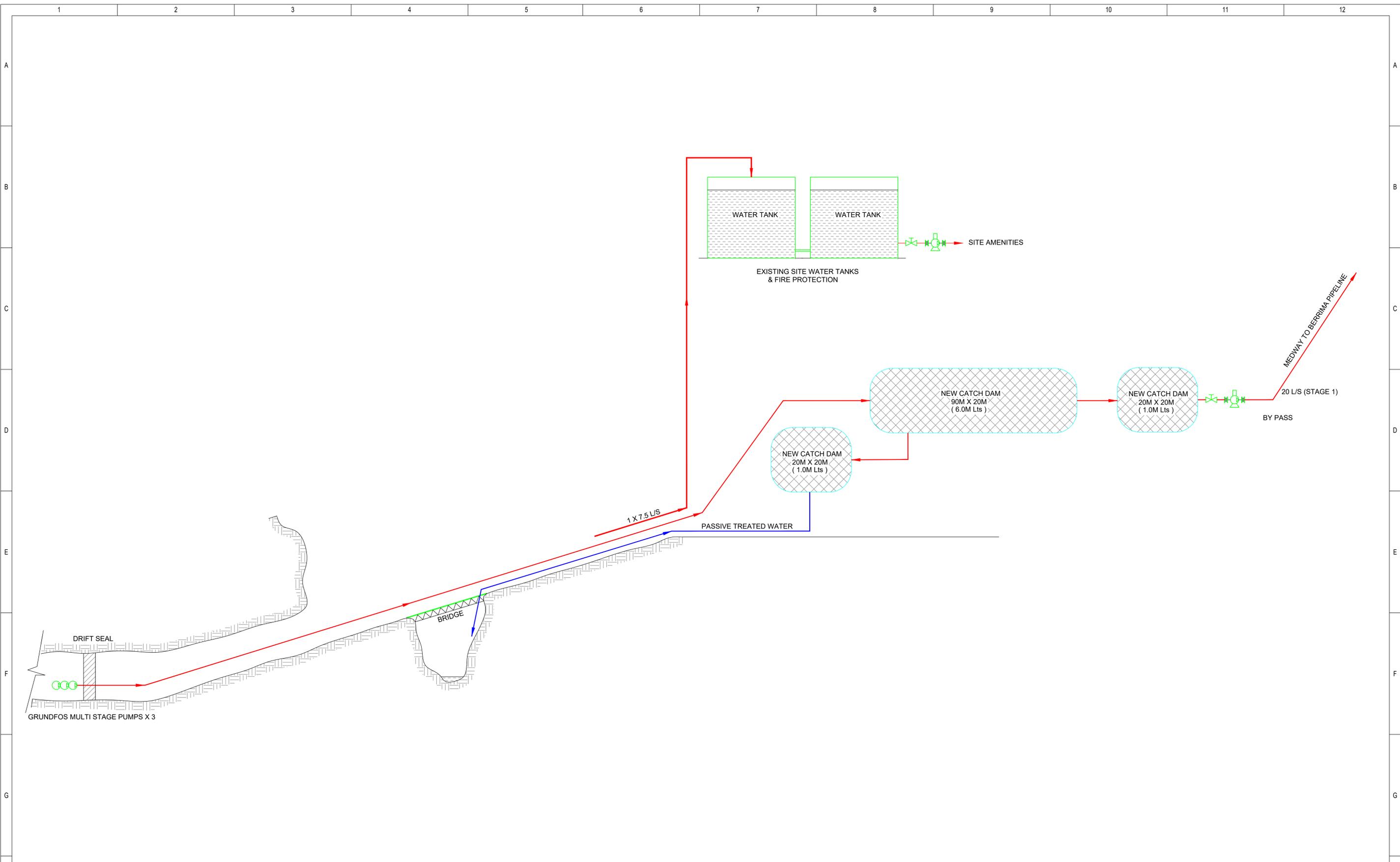
**BORAL Boral Cement**  
 ABN 62 008 528 523  
**Engineering Services**

Taylor Avenue New Berrima NSW 2577 Phone: +61 2 4860 2325  
 Locked Bag 4 New Berrima NSW 2577 Fax: +61 2 4860 2399  
 Email: drawing.office@boral.com.au

STATUS:	<b>PRELIMINARY</b>
ALPHA NUMERIC:	
BCSC-GES JOB No:	<b>GBM482</b>
SHEET:	<b>A1</b>
SCALE:	<b>NTS</b>
STOCK NUMBER:	

PLANT:	BERRIMA COLLIERY
PROJECT:	COLLIERY CLOSURE
SECTION:	MINE
SUB SECTION:	
TITLE:	<b>INTERNAL BULKHEADS</b>
CLASSIFICATION:	<b>GENERAL ARRANGEMENT</b>

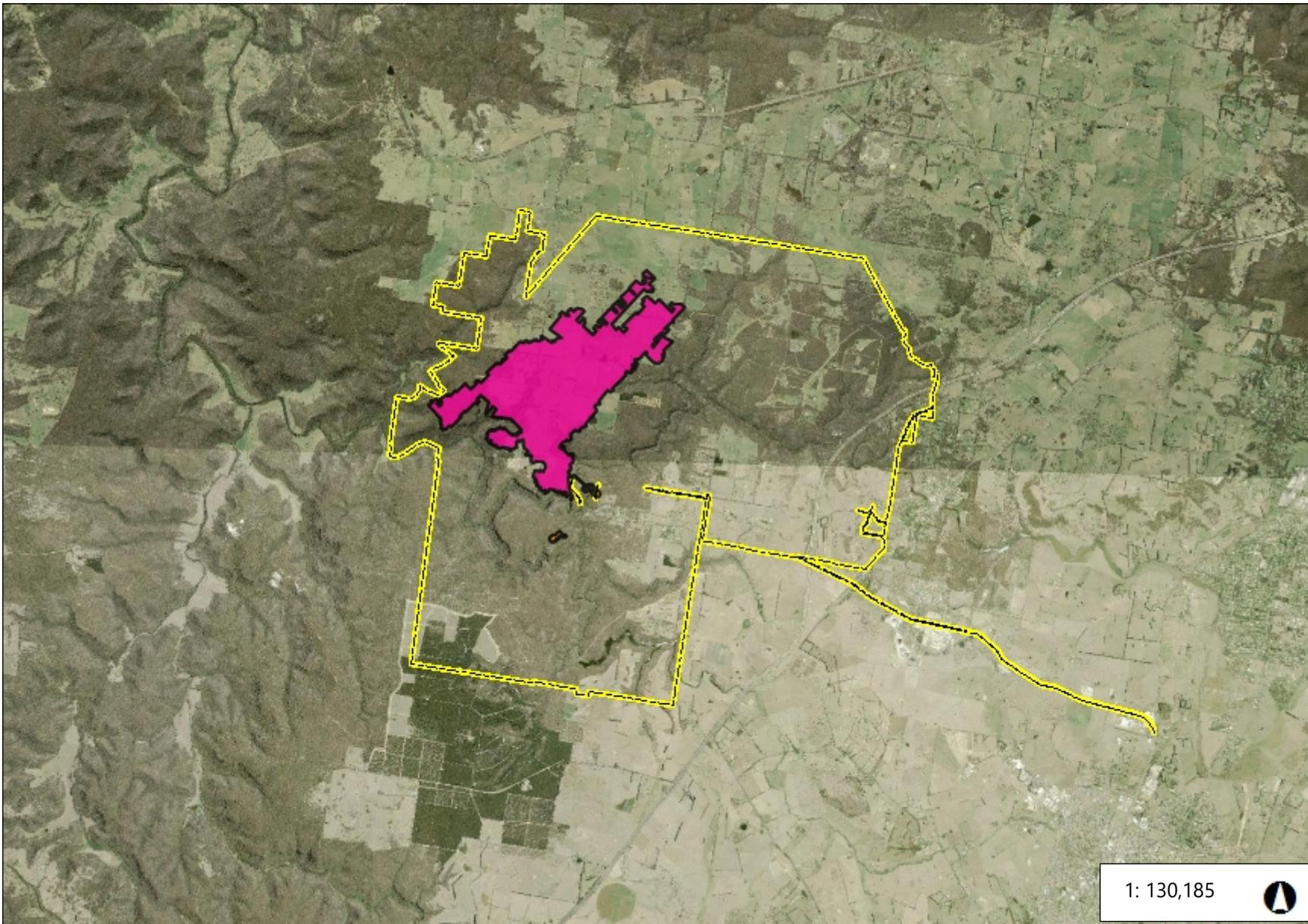
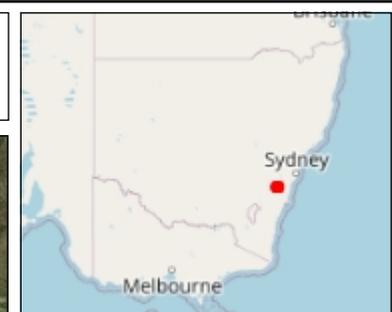
DRAWING No:	BER-M-GA-482-012-01
WORKS No:	<b>Plan 5A</b>
REV.	<b>A</b>



**NO JOB IS SO IMPORTANT THAT IT CAN'T BE DONE SAFELY!**

DRAWING No		DESCRIPTION		REV. A	DATE 05-11-20	REV-BY L.P.McIntosh	APPROVED	REVISION	DRAWN: L.P.McIntosh	DATE: 05-11-20	<b>Boral Cement</b> ABN 62 008 528 523 <b>Engineering Services</b> Taylor Avenue New Berrima NSW 2577 Phone: +61 2 4860 2325 Locked Bag 4 New Berrima NSW 2577 Fax: +61 2 4860 2399 Email: drawing.office@boral.com.au	STATUS: <b>PRELIMINARY</b>	PLANT: MEDWAY	DRAWING No: BER-M-PFD-482-05-01
REFERENCE DRAWINGS		REVISIONS		DRAWING ISSUED FOR COMMENT		APPROVED:		DATE:	ALPHA NUMERIC:	BCES JOB No: <b>GBM482</b>		PROJECT: BERRIMA COLLIERY CLOSURE	SECTION: MINE	
								DATE:	STOCK NUMBER:	SHEET: <b>B1</b>		SUB SECTION: PIT TOP WATER TREATMENT	TITLE: GENERAL ARRANGEMENT	WORKS No: <b>Plan 5b</b>
								DATE:	SCALE: <b>NTS</b>	CLASSIFICATION:				REV. <b>A</b>

# Berrima Colliery Holdings



## Legend

- ### Disturbance Trace
- Beneficiation Facility
  - Infrastructure Area
  - Other
  - Overburden Emplacement Area
  - Tailings Storage Facility
  - Underground Mining Area (SMP)
  - Active Mining Area (Open cut void)
  - Water Management Area

- ### Rehabilitation
- Decommissioning
  - Landform Establishment
  - Growth Media Development
  - Ecosystem and Land Use Establish
  - Ecosystem and Land Use Developr
  - Relinquishment (Rehabilitated)
  - Rehabilitation Completion

- ### Disturbance
- Beneficiation Facility
  - Infrastructure Area
  - Other
  - Overburden Emplacement Area
  - Tailings Storage Facility
  - Underground Mining Area (SMP)
  - Active Mining Area (Open cut void)
  - Water Management Area

Mine Operations Area

1: 130,185



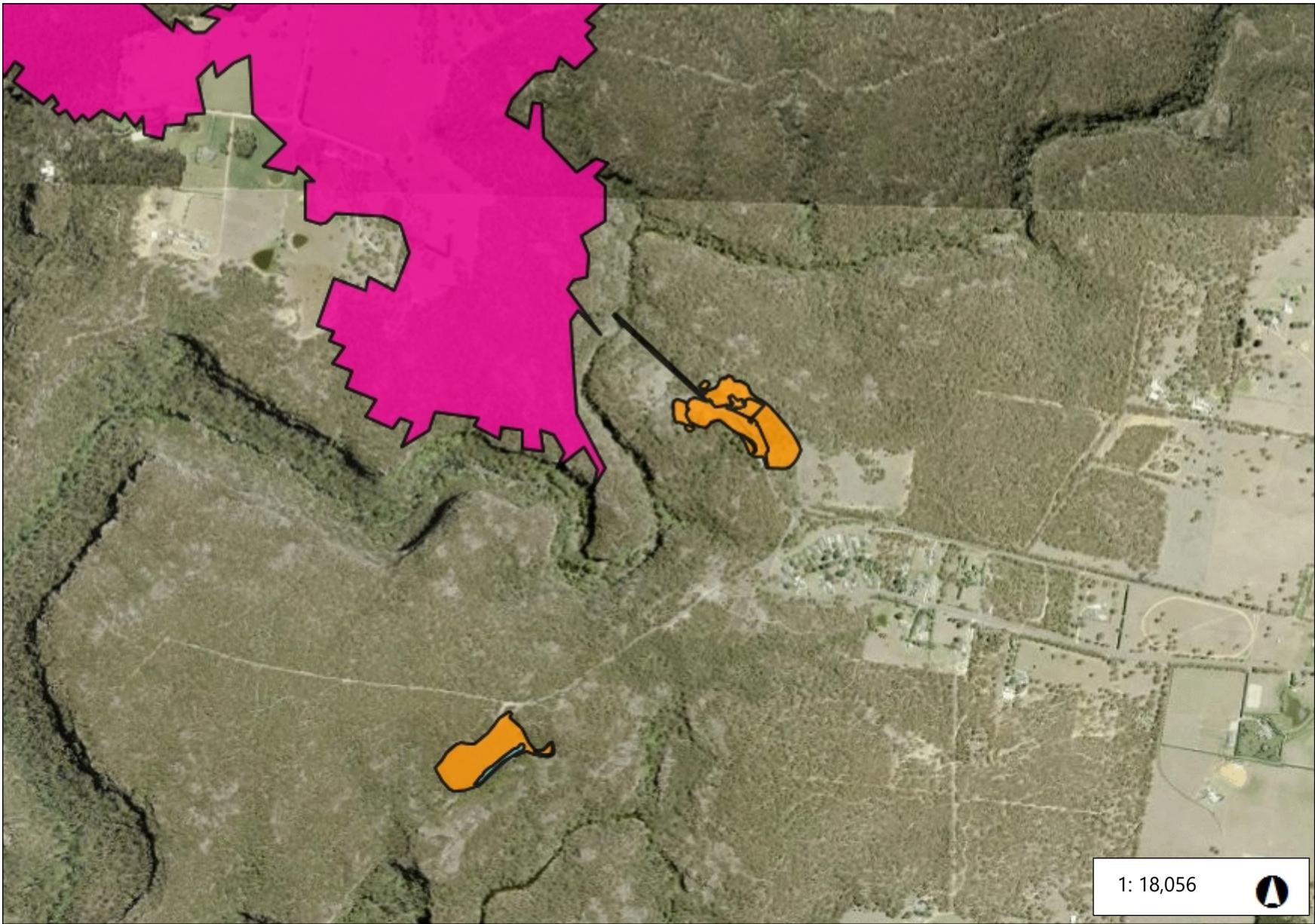
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## Notes

# Berrima Colliery Disturbance



## Legend

- Disturbance Trace**
- Beneficiation Facility
  - Infrastructure Area
  - Other
  - Overburden Emplacement Area
  - Tailings Storage Facility
  - Underground Mining Area (SMP)
  - Active Mining Area (Open cut void)
  - Water Management Area

- Rehabilitation**
- Decommissioning
  - Landform Establishment
  - Growth Media Development
  - Ecosystem and Land Use Establish
  - Ecosystem and Land Use Developr
  - Relinquishment (Rehabilitated)
  - Rehabilitation Completion

- Disturbance**
- Beneficiation Facility
  - Infrastructure Area
  - Other
  - Overburden Emplacement Area
  - Tailings Storage Facility
  - Underground Mining Area (SMP)
  - Active Mining Area (Open cut void)
  - Water Management Area

1: 18,056



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## Notes

# Berrima Colliery Pit Top Final Land Use



1: 4,514 

## Legend

### Final Landuse Trace

-  Agricultural – Cropping
-  Agricultural – Cropping
-  Agricultural – Grazing
-  Agricultural – Grazing
-  Rehabilitation Biodiversity Offset Ar
-  Final Void
-  Heritage Area
-  Industrial
-  Infrastructure
-  Native Ecosystem
-  Water Management Areas
-  Water Storage (Excluding Final Voi
-  Other

### Final Landform Features Trace

#### Rehabilitation

-  Decommissioning
-  Landform Establishment
-  Growth Media Development
-  Ecosystem and Land Use Establish
-  Ecosystem and Land Use Developr
-  Relinquishment (Rehabilitated)
-  Rehabilitation Completion

#### Disturbance

-  Beneficiation Facility
-  Infrastructure Area
-  Other
-  Overburden Emplacement Area
-  Tailings Storage Facility

## Notes

Passive Water Treatment Facility

229.3 0 114.66 229.3 Meters

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# Loch Catherine Storage Facility



## Legend

### Final Landuse Trace

- Agricultural – Cropping
- Agricultural – Cropping
- Agricultural – Grazing
- Agricultural – Grazing
- Rehabilitation Biodiversity Offset Ar
- Final Void
- Heritage Area
- Industrial
- Infrastructure
- Native Ecosystem
- Water Management Areas
- Water Storage (Excluding Final Voi
- Other

### Final Landform Features Trace

#### Rehabilitation

- Decommissioning
- Landform Establishment
- Growth Media Development
- Ecosystem and Land Use Establish
- Ecosystem and Land Use Developr
- Relinquishment (Rehabilitated)
- Rehabilitation Completion

#### Disturbance

- Beneficiation Facility
- Infrastructure Area
- Other
- Overburden Emplacement Area
- Tailings Storage Facility

1: 4,514

229.3 0 114.66 229.3 Meters

WGS\_1984\_Web\_Mercator\_Auxiliary\_Sphere  
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## Notes

Preparation for private sale

## **Appendix B – Groundwater Model Update**

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Senior Project Manager  
Boral Cement  
Berrima, 2575 NSW

Katarina David  
6 Lawrence street  
Blackheath, NSW 2785  
mob 0412 080 360

Sydney, 20<sup>th</sup> May 2021

**RE: Addendum to groundwater modelling report and mine operation plan for Berrima Colliery**

Dear David and Robert,

This letter has been provided to support the closure of Berrima colliery and provide additional information related to current groundwater conditions and future predictions. The report is an update on the previously prepared groundwater modelling assessment for the closure of Berrima Colliery in 2016.

Boral provided the Stage 2 Mining Operation Plan for Berrima Colliery to the Resources Regulator and the EPA in late 2020. The Resources Regulator and the EPA requested the clarification on a number of groundwater requirements in their letter dated 18<sup>th</sup> December 2020 and email dated 5<sup>th</sup> March 2021.

**Required information**

The following were the Resources Regulator requirements (letter refence MAAG0009122):

- a) Model a no pump scenario with projected water discharge volumes and quality e.g. what happens if Boral can no longer maintain a pump to dewater the mine/long term full closure;
- b) Quantify the effectiveness of the bulkhead at retaining groundwater e.g. what % of water bypasses through the strata; and
- c) Under the no pump scenario consider the effectiveness of additional bulkhead installations to further reduce the impact on the environment from discharge water e.g. Scenario 1 - fully sealed option with installation of the 14 underground bulkheads

The following are the additional EPA requirements as specified in their email date 5<sup>th</sup> March 2021:

1. Provide a confidence -level classification for the re-calibrated model;
2. Revised model conceptualisation using data collected since 2015;
3. Model verification – comparing the predictions of the calibrated model to a set of measurements that were not used to calibrate the model; and
4. Present the volumetric flow rate numerically and graphically at the Adit and the exchange with the Wingecarribee River with an estimate of the uncertainty.

The scope of works undertaken to address the requirements is as follows:

- Check and adjust the coal seam floor levels with RL of the bulkheads B1 to B7 included in the model layer;
- Include the water level monitoring data since 2016 in the model;
- Remove existing bulkheads in the model – 2016 groundwater model had bulkheads at different locations to the ones installed in 2019;
- Include the flow data for the period since the installation of the bulkheads;
- Recalibrate the model and run 5 model scenarios;
- Add 7 plus 5 new bulkheads to the model as per Berrima Colliery Rehabilitation and Closure Plan; and
- Use most recent quarterly monitoring data for model verification.

### **Methodology**

The proposed methodology included the use of existing datasets prepared for the 2016 Berrima groundwater model and monitoring data collected up to December 2020 to set up an updated conceptual and numerical groundwater model using Groundwater Vista. This work addresses Point 2 of the EPA requirements. Once the model was updated, it was re-calibrated to the current conditions. Model was then verified using the most recent monitoring data from last quarter of 2020 - this addresses Point 3 of the EPA requirements.

Modelling scenarios to address the required information (letter reference MAAG0009122) were:

- Point a - Run model for a period of 10 years with pumping. Pumping would occur from a point behind the Drift Seal. Stop pumping for a period of 10 years. Run model for another 90 years;
- Point b was addressed based on the observed data and predicted model scenarios that address Point a; and
- Point c - Add additional 10 bulkheads from Scenario 1 (original model 2016 please see below) to the model including the Adit and run model for 10 years using end of 2020 as starting point. Run model for 100 years.

The responses to the EPA questions raised in the email of 5<sup>th</sup> March 2021 are given in the following report sections:

- Point 1 - Model recalibration;
- Point 2 - Conceptual model;
- Point 3 - Model verification; and
- Point 4 - Predictive model runs and Figures 11 to 16

The terminology used in this letter report for groundwater levels and head has the following meaning: hydraulic head is the height to which water will rise in a bore. For example, it should be taken as measure of the potential of the water fluid at the measurement point.

## Results

### Conceptual model update

Over the past 5 years Berrima Colliery collected the monitoring data from the production and monitoring bores (3 bores and one vibrating wire piezometer) and outflow volumes at the Mine Adit. Below is the summary of monitoring results which added information to improve the conceptual model (**Figure 1**):

- Higher rainfall events prevailed in the period from late 2014 to 2017, followed by drier period to 2020 and wetter during 2020.
- The monitoring data for Belbin bore (**Figure 2**) was not available after mid 2016 until mid-2020 (**Figure 3**). The results indicate that the overall groundwater level has increased slightly (2 m) over that time. Recently, the piezometric head has been decreasing since September 2020. However, the bore has been pumping daily and the drawdown during pumping ranged around 30-35 m. At that time, the was pumped twice per day for a short period of time, however since early October 2020 it was pumping 8 hours a day resulting in 40 m drawdown.
- Culpepper production bore historically showed a decrease in water level in 2012-2013 however wet weather period from 2014 to 2017 assisted the recovery of water levels to 22 m BGL (**Figure 4**). By 2020 the water level had decreased to 27 m BGL. No data was available after mid-2017 and during late 2020 groundwater level in Culpepper bore remained at its lowest level since the start of monitoring in 2008. The bore was pumped on a daily basis with a drawdown of around 3 m on each pumping cycle. It is not clear if the decline in water level in the period from 2017 to 2020 was due to the weather conditions or other causes.
- Francis production bore recorded stable conditions until late 2017 (**Figure 5**). Since that time the groundwater level has started decreasing (about 2-3m). Recent wetter conditions in early 2020 have resulted in groundwater level rise by around 1 m. The drawdown resulting from pumping was steady at around 13 m for each pumping period prior to late 2017. However, since that time the drawdown induced in the bore has increased to around 17m. This indicates that there is less available drawdown and the bore is emptying faster than during the mine operation. Over the last 2020 quarter groundwater level has increased reflecting higher rainfall conditions despite continued daily pumping (**Figure 5**).
- Vibrating wire piezometer B63 monitors three units; upper and lower Hawkesbury sandstone and zone above the coal seam at around 177m below ground level (**Figure 6**). The deepest sensor at 177 m depth indicates that the strata is dry at this elevation and has remained dry since late 2012. The sensor installed at the lower Hawkesbury sandstone at 133m depth, has always had around 4-5 m of head, however since late 2016 the water level has started rising and now fluctuates between 8-9 m above the sensor. This change follows the rainfall trend, as can be seen from Figure 6 and the rainfall residual mass. The upper most sensor in the Upper Hawkesbury sandstone indicates mainly unsaturated conditions however since May 2020 the water level has risen by 1 m.
- Mine discharge via the Adit remained within the 2-3 ML/day range over the period from 2016 to 2018 (**Figure 7**). The exception were the periods where water was diverted for water quality trial. Following the installation of the bulkheads mid 2019 the drainage and outflow at the Adit was variable due to water being allowed to backup behind the

bulkheads and then being pumped out. After the reestablishment of water levels behind the bulk heads, the outflow at the Adit varied mainly in the range from 1.5 to 2 ML/day.

The saturation in the Lower and Upper Hawkesbury sandstone is likely the result of rainfall recharge. The most recent rise in water level in both the Lower and the Upper Hawkesbury sandstone is showing the trend of recovery resulting from increase in rainfall residual mass (RRM) since the start of 2020. Rainfall residual mass represents a long term trend in rainfall data. It is calculated as the cumulative difference between actual monthly and long term monthly rainfall. Positive trend represents above average rainfall and negative declining trend represents below average rainfall.

In April 2019 Boral has installed seven bulkheads in 400 Panel following the dewatering of this area in 2018 to enable the installation of the bulkheads. Boral was monitoring the water level prior to and post installation at each bulkhead site with a pressure gauge and a pressure transducer. Before the installation the roof and floor at each of the bulkheads were mainly dry. In the period to April 2020, the water level at some bulkheads (B7 and B1) has risen such that water treatment and pumping system had to be turned on. An inspection of the bulkheads in May and September 2020 indicated that at all bulkheads the floor and roof were wet with pumps operating to manage the groundwater flow. The inspection found that the groundwater was leaking around the bulkheads at 0.1 ML/day and reporting to the Adit.

The conceptual model was updated following the review of the bulkhead installation and the monitoring data from the boreholes:

- Recharge to the groundwater system occurs by infiltration of rainfall through the outcropping strata.
- Analysis of groundwater hydrographs indicates that there is vertical recharge and flow through the upper and lower sandstone, and that there is strong lateral flow in the coal seam. This is supported by:
  - the hydrographs indicating recharge in the Upper and Lower Hawkesbury Sandstone following rainfall events, and
  - records of relatively quick rise of water level behind the bulkheads and seepage of water through the coal.
- In some areas, Wingecarribee River may 'lose' to the groundwater system and provide a recharge source, depending on the relative level of the groundwater compared with the river.
- Groundwater discharge occurs through flow via the open mine drives and discharge at the Adit, evaporation, baseflow, seepage along the cliffs where the groundwater levels intersect the ground surface.
- Installed bulkheads have resulted in temporary reduction in outflow via the Mine Adit, and flooding of the northeastern part of the workings. Since mid 2020 the outflow at the Adit varied from 1.5 ML/day to 2 ML/day with an average of 1.7 ML/day.
- While the bulkheads have performed satisfactory following the installation, the strata surrounding the bulkheads has become wet and water treatment pump system has been used to manage groundwater which was rising behind the bulkheads.

### Model recalibration

The available monitoring data to September 2020 (as discussed above) were used in the existing model with the aim of calibration. The coal seam floor level was adjusted based on the recent additional data obtained from the historical drillholes and the bulkhead installment. The location of the bulkheads was corrected so that it coincides with actual installed locations.

The updated groundwater model remains classed as Class 1 in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al, 2012). This is based on the few existing wells distributed at the northern section of the mine footprint, uncertainty in the coal seam levels in the areas of the mine due to the availability of historical accuracy of mapping, lack of drillholes to provide the information of layer thickness and calibration based on the spatially limited dataset. However, the model is calibrated to piezometric heads and outflows with 6% Scaled Root Mean Squares (SRMS) (**Figure 8**) and the cumulative model mass balance error below 1 %. The SRMS of less than 10% is considered an acceptable level of error. The model has also previously been peer reviewed (2016). It is considered that this provides sufficient support for the prediction scenarios.

### Seepage around the bulkheads

The change in natural seepage from the mine workings and around the bulkheads was assessed based on the observed data and then forward prediction was estimated. Over the past 6 months around 100,000 L/day seeped around the bulkheads. It needs to be noted that the pressure behind the bulkheads was artificially maintained by pumping. Using the long term modelling assumptions, the effectiveness of bulkheads is predicted to be 7% based on the long term predicted outflow at the Adit and the long term historical outflow rate.

### Model verification

Model verification was undertaken using the dataset collected in the last quarter of 2020. The model was recalibrated as indicated in the previous section. The results of the prediction of the calibrated model were compared to groundwater level and mine outflow measurements collected during December 2020.

The results of model verification are provided in **Figure 9**. The results show that the model is correctly predicting heads when compared to the December 2020 dataset. Most monitoring points fall on the 1:1 line with the exception of the Culpepper production bore for which the model underestimates the water levels.

The verification against the mine inflow indicate good model prediction for December with observed mine inflow average of 1.79 ML/day for the period from 1<sup>st</sup> to 26<sup>th</sup> December 2020 and model predicted 1.8 ML/day.

### Predictive model run - pumping from behind the Drift Seal

A predictive model run was undertaken following the calibration of the model to 2020 observed data. This predictive run was undertaken considering the presence of seven bulkheads installed in 2019 and pumping from a point behind the drift seal. Figures 10a and 10b show the location of

seven installed bulkheads and four bulkheads around pit bottom. Predicted inflow rates are slightly higher than long term outflow via Adit, however, please note that the model is classified as Class 1 therefore there is uncertainty in the predicted output.

The locations of the bulkheads are given in **Figure 10a** and the location of pumping is given in **Figure 10b** along with 4 additional bulkheads at pit bottom and ventilation shaft located above the seam level. The predicted water level contours at the coal seam level are given in **Figure 11**. The outflow volumes at the Adit are given in Table 1.

**Table 1** Predicted inflow rates at the Drift Seal during pumping

Time	Predicted inflow rates (ML/day)
Year 1	2.9
Year 5	3.0
Year 10	3.0

Exchange of water between the river and groundwater was calculated for three segments:

- Section 1 upstream to the confluence of Mandemar Creek and Wingecarribee River;
- Section 2 confluence of Mandemar Creek and Wingecarribee River and downstream to the confluence of Medway Rivulet and Wingecarribee River; and
- Section 3 downstream of Section 2.

The change in flow in these three sections is presented in **Table 2**. The flux in (ML/day) represents the inflow into the groundwater system from the River (river losing) and flux out (ML/day) is the baseflow contribution to the River (river gaining). The flux between the groundwater and the River considers the exchange with all aquifers through which the River flows. The flow in and out of the River and groundwater contribution is a natural process which occurs as a result of difference in water levels between the River and the groundwater **Figure 12**. Table 2 shows that there is negligible difference between the River outflow and groundwater contribution to the River as a result of installation of the bulkheads.

**Table 2** Groundwater flux relative to the Wingecarribee River with seven bulkheads installed at Year 10.

River section	River outflow (ML/day)	Baseflow contribution (ML/day)
1	1.36	1.815
2	0.57	0.42
3	0.0004	0.0006

Predictive model run - no pumping following 10 year of pump operation

This predictive model run provides the projected discharge volumes in the case that the pumps behind the Drift Seal fail and are out of operation. This scenario addresses the Point A from the MAAG0009122 letter from Resource regulator.

In this scenario the water flows down to the Adit and the inflow rates at the Adit are given in **Table 3**. The groundwater flux relative to Wingecarribee River is shown in **Table 4** and indicates a small difference between the River outflow and groundwater contribution to the River. This table also

points to minimal exchange of waters downstream of the mine past the Medway Rivulet. The water level contours after 10 years of no pumping are provided in **Figure 13**.

**Table 3** Predicted discharge at the Adit 10 years after no pumping

Time	Predicted discharge volumes at the Adit (ML/day)
Year 1 no pumping	2.59
Year 5 no pumping	2.6
Year 10 no pumping	2.6

**Table 4** Groundwater flux relative to the Wingecarribee River with bulkheads installed 10 years following no pumping (Figure 10a and 10b)

River section	River outflow (ML/day)	Baseflow contribution (ML/day)
1	1.8	2.19
2	0.46	0.5
3	0.00009	0.0007

Predictive model run – no pumping for the next 90 years

The model scenario from the previous run was run for another 90 years to understand the impact of no pumping for a long time period. The predicted mine inflow for Year 20 and Year 100 are provided in Table 4 and the water level contour at the coal seam level are given in **Figure 14**.

**Table 5** Predicted long term mine inflow with no pumping and 7 bulkheads installed

Time	Discharge at the Adit (ML/day)
Year 20	2.6
Year 100	2.6

Predictive model run- additional 10 bulkheads with no pumping for 10 years

This predictive model run includes the addition of ten bulkheads as shown on **Figure 15**. These bulkheads are in addition to the seven already installed and the aim of the run was to understand the effectiveness of additional bulkhead installation to further reduce the impact on the environment.

The results of the model run are presented in **Figure 16**. **Figure 16** shows the predicted water level contours after ten years of no pumping. Under this no pumping scenario the outflow at the Adit was estimated at 2.6 ML/day. The water fluxes to and from the River are presented on **Table 6** and show negligible change from previous scenario and also between the River outflow and baseflow contribution.

**Table 5** Predicted long term mine inflow with no pumping and additional ten bulkheads installed

Time	Discharge at the Adit (ML/day)
Year 20	2.6
Year 100	2.6

**Table 6** Groundwater flux relative to the Wingecarribee River with seventeen bulkheads installed – Year 10

River section	River outflow (ML/day)	Baseflow contribution (ML/day)
1	1.73	2.08
2	0.49	0.50
3	0.000025	0.006

Predictive model run- no pumping for 100 years with all bulkheads installed.

Predictive model run with additional bulkheads was run for additional 100 years with no pumping. The model results are shown on **Figure 17** for long term period of 100 years. The results indicate minor change from 10 year period and the volume of outflow at the Adit has not changed. **Table 8** shows that after 100 years of no pumping, the exchange of water between the River and groundwater in River Section 2 remains stable and the river outflow is offset by baseflow contribution to the River.

**Table 7** Predicted long term mine inflow with no pumping and additional 10 bulkheads installed

Time	Discharge at the Adit (ML/day)
Year 20	2.6
Year 100	2.67

**Table 8** Groundwater flux relative to the Wingecarribee River with 17 bulkheads installed – Y100

River section	River outflow (ML/day)	Baseflow contribution (ML/day)
1	2.09	2.47
2	0.49	0.51
3	0.000007	0.00004

**Summary**

The following are the main points from the data analysis and additional modelling completed for Berrima Colliery:

- Additional groundwater monitoring data and measured discharge volumes confirm that the Upper and Lower Hawkesbury Sandstone are recharged by rainfall. The groundwater flow in the coal seam is mainly lateral with higher hydraulic permeability in the area of the mine footprint where coal was extracted and remaining coal is fractured.

- The installation of seven bulkheads in 2019 has reduced the total outflow at the drain Adit to between 1.5 and 2 ML/day.
- The observations made during the bulkhead trial indicate the bulkheads remain intact however the water level increasing behind the bulkheads results in seepage of water at the floor and the sides of the bulkhead, but in particular the roof.
- The conceptual model has been updated such that the previously assessed groundwater characterization was confirmed with recently observed data.
- Model verification indicated that model predicted the water levels and inflows match well the observed data with one data point being underestimated.

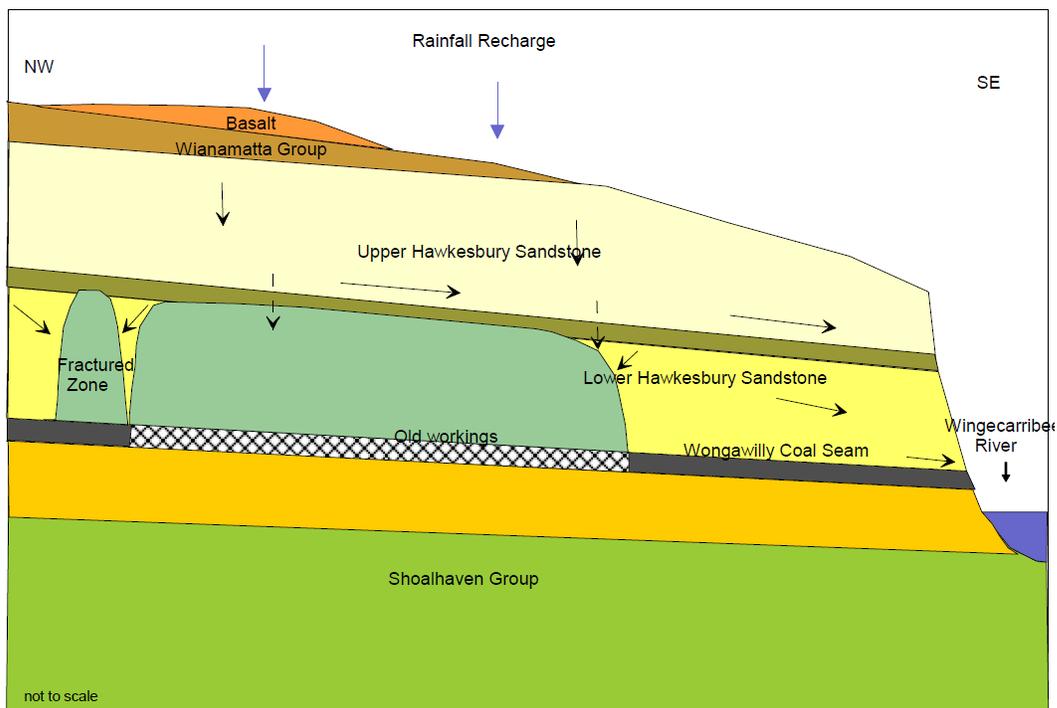
The particular questions are addressed as follows:

- **Point a-** Model scenario was run to simulate the projected discharge volumes and quality if Boral can no longer maintain the dewatering regime. This model run was undertaken following ten years of pumping behind the Drift Seal. The results indicate that in this case the outflow is predicted to be around 3 ML/day.
- **Point b-** The effectiveness of the bulkheads of retaining water was estimated by observed records and by model prediction. The observed records indicate that the bulkheads are efficient in keeping the water so long as water pressure is maintained behind the bulkheads by pumping. Without pumping the long term effectiveness of the bulkheads is predicted by the model at 7%.
- **Point c-** The installation of additional bulkheads as per fully sealed option indicates that long term there will be minor change in the outflow via the Adit compared to the predicted long term outflow with currently installed bulkheads.
- **Additional point 1** -Groundwater model is classified as Class 1 in accordance with the Australian Modelling Guidelines (Barnett et al, 2012) based on the available spatial information on water levels and geology information for individual model layers.
- **Additional Point 2-** The monitoring data since 2016 was used to update the conceptual model. The updated model confirms previous conceptualization.
- **Additional point 3-** Numerical model was verified with the most recently collected dataset from December 2020. The results indicate good match with observed data with the exception of one monitoring point.
- **Additional point 4-** The volumetric flow rate and water level information along with the hydrographs for selected monitoring points are shown numerically in Tables and as Figures in the Appendix. The flux (water exchange) between the groundwater and the Wingecarreebe River are presented in Tables 2,4,6, and 8. Data indicates that in all scenarios the River outflows are mainly offset by River gains. This process is a natural process which occurs in all systems where there is connectivity between the River and groundwater. There is up to 10% difference in River losses between the pumping and no pumping scenarios with seven new bulkheads. There is also a negligible difference in baseflow contribution between the scenario with currently installed bulkheads and scenario which assumes the installation of the additional bulkheads. Model uncertainty is relative to the model Class (Class 1) and is based on the available data in the area of interest.

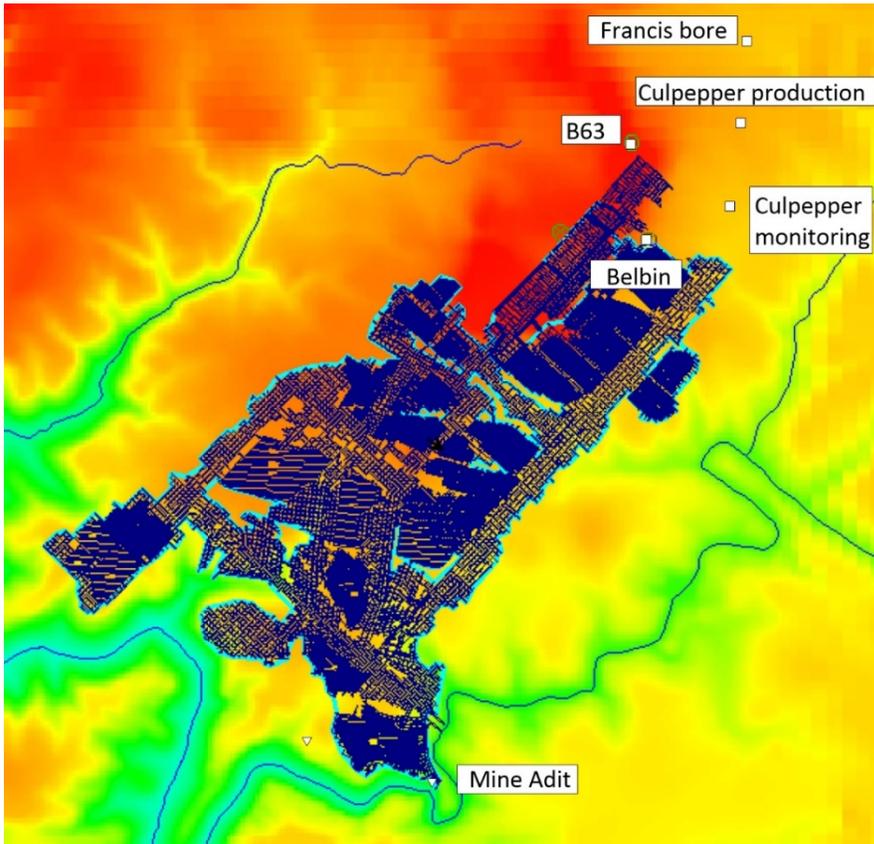
If you have any questions or comments regarding this memo, please contact me on 0412 080 360.

Regards,  
Katarina David, PhD  
Principal Hydrogeologist  
RPGeo (10060) Groundwater  
0412 080 360

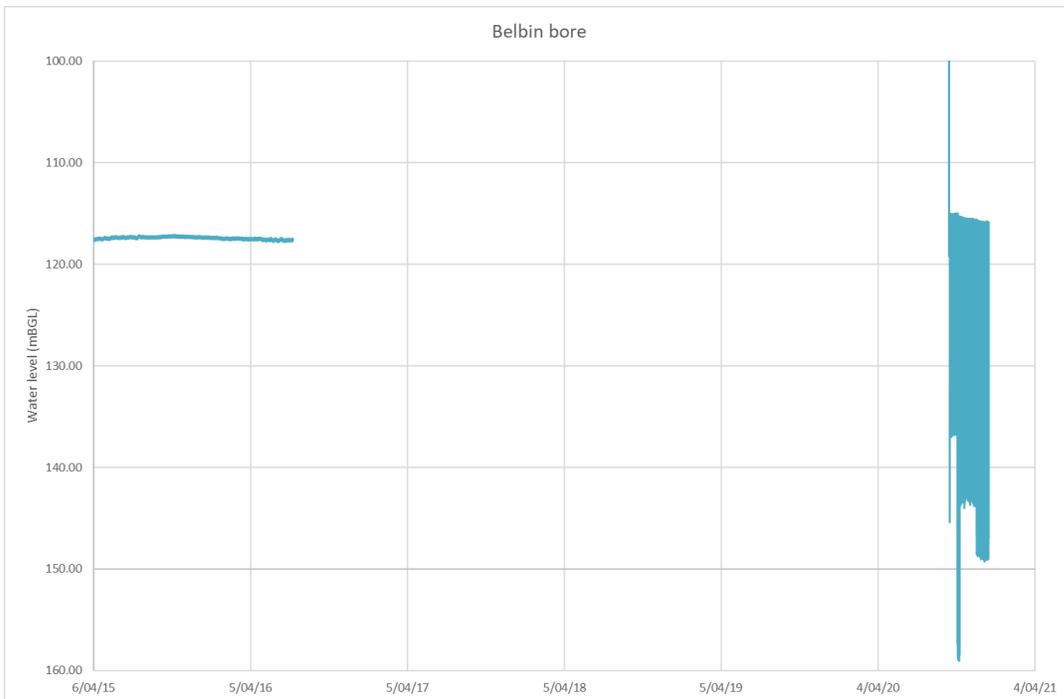
**Attachments :**  
**Figures 1 to 16**



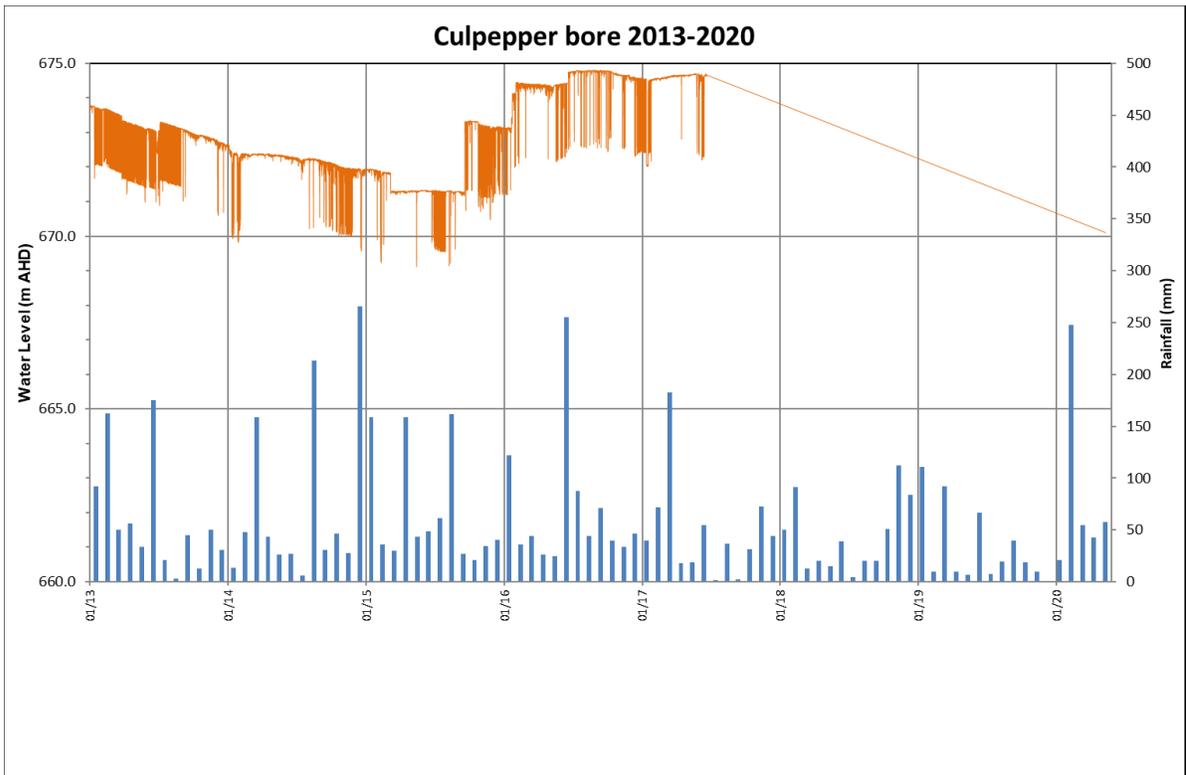
**Figure 1 Conceptual model for Berrima colliery**



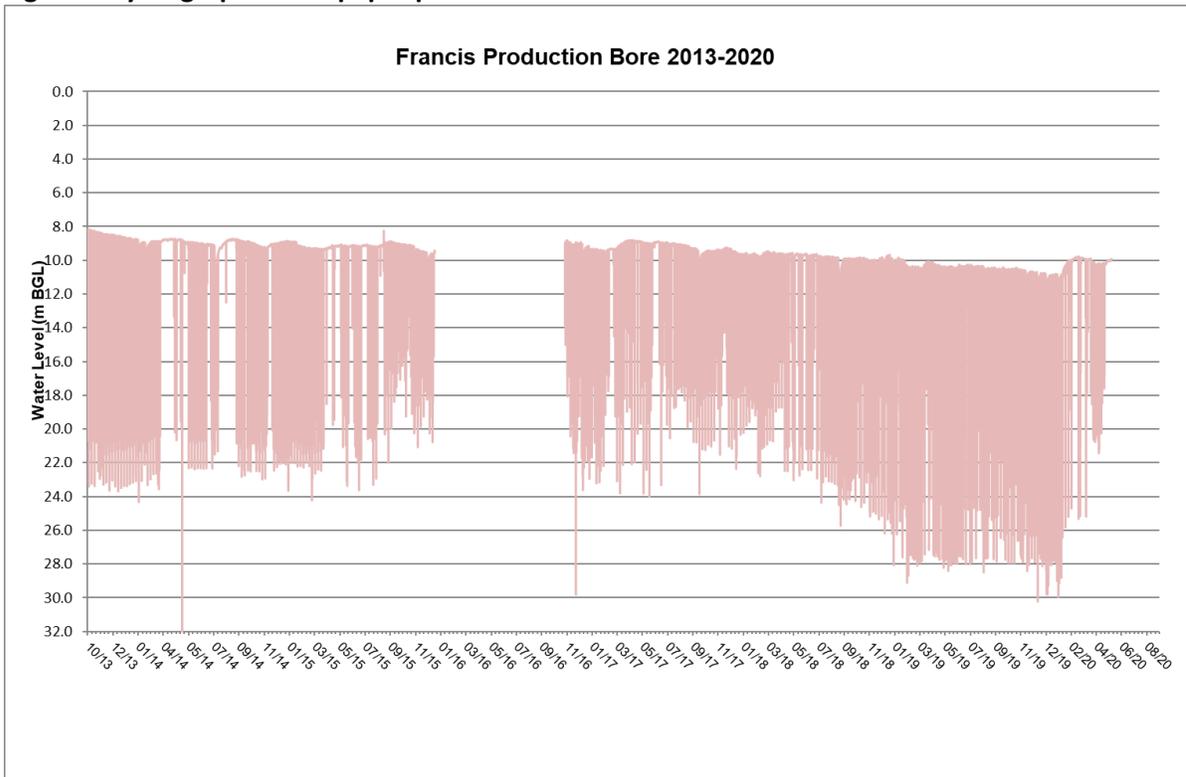
**Figure 2 Map with location of monitoring bores and mine Adit (colours represent the topography)**



**Figure 3 Hydrograph for Belbin bore (2015 to 2020)**



**Figure 4 Hydrograph for Culpeper production bore 2013-2020**



**Figure 5 Hydrograph for Francis production bore 2014-2020**

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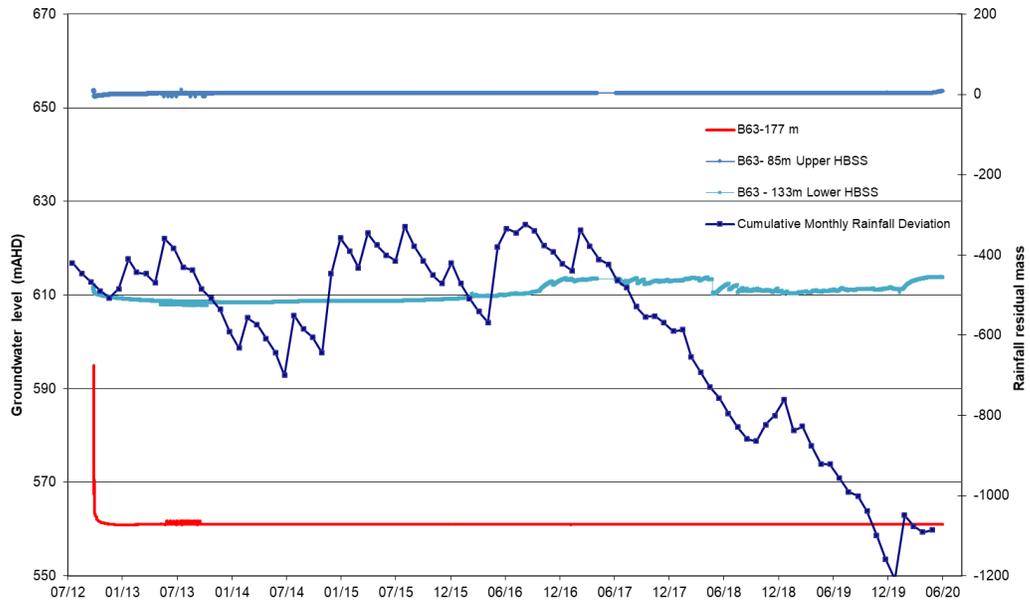


Figure 6 Hydrograph for VWP B63 2013-2020

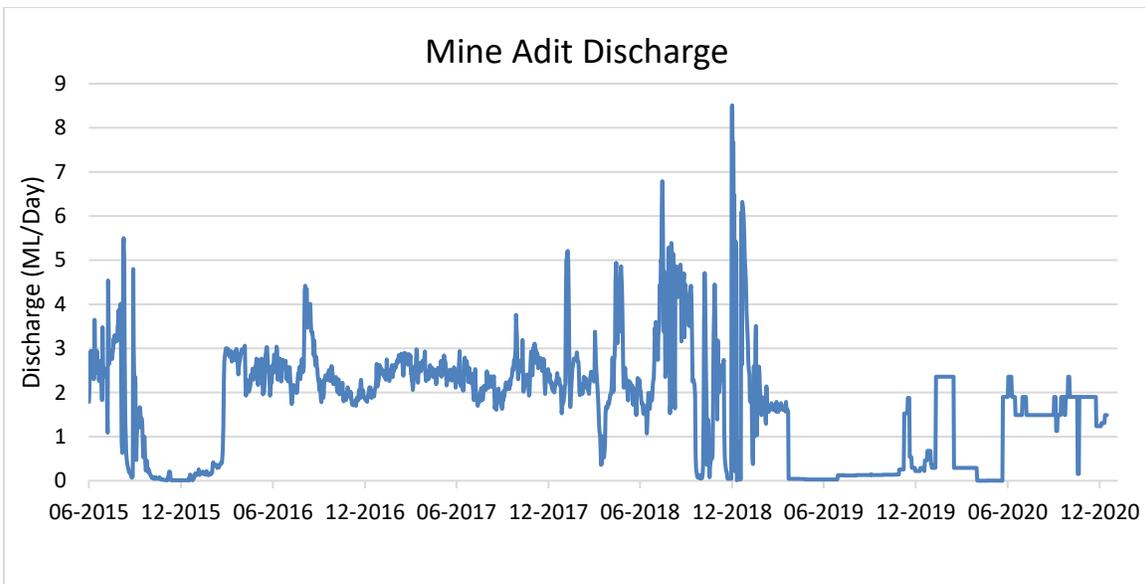
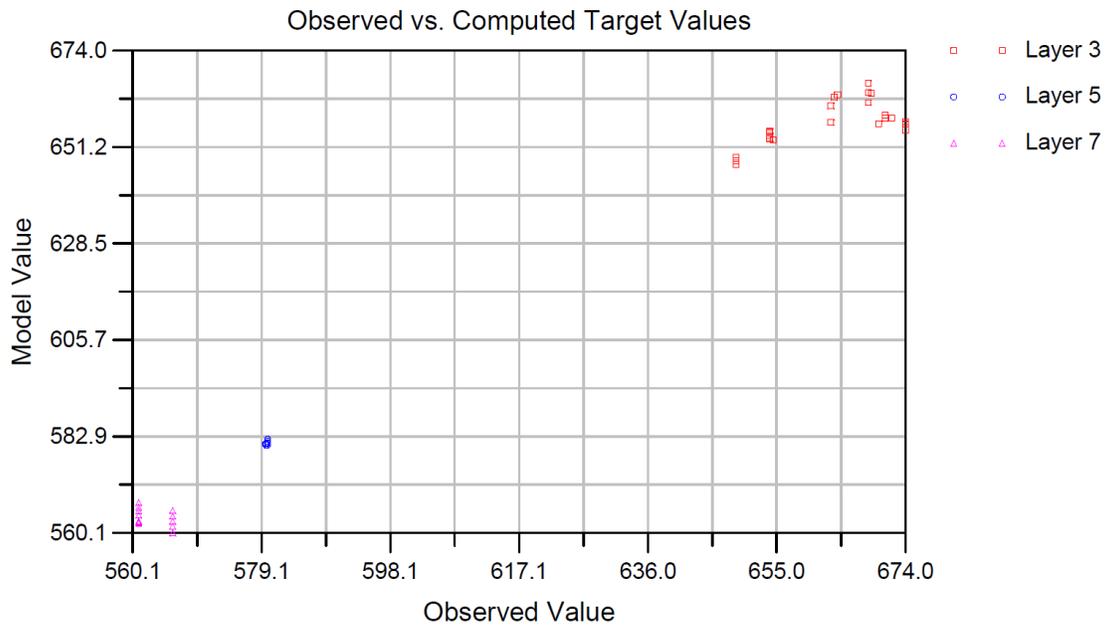
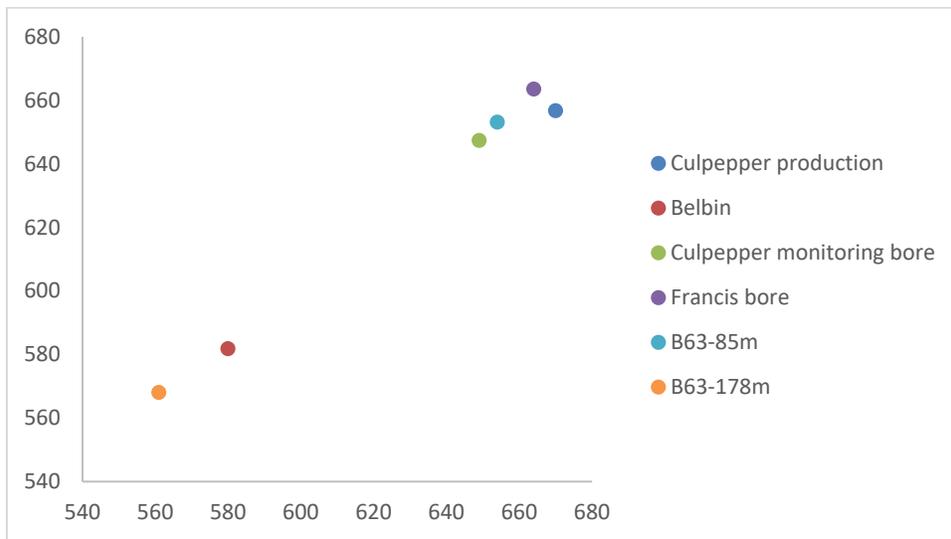


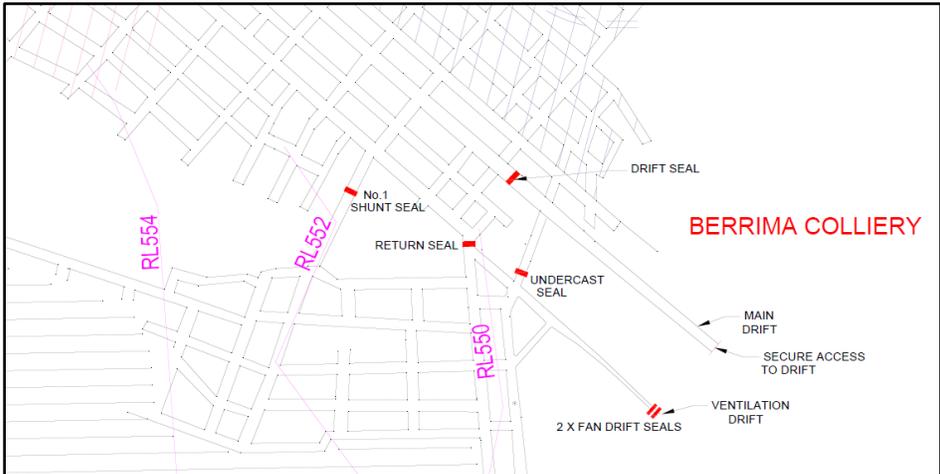
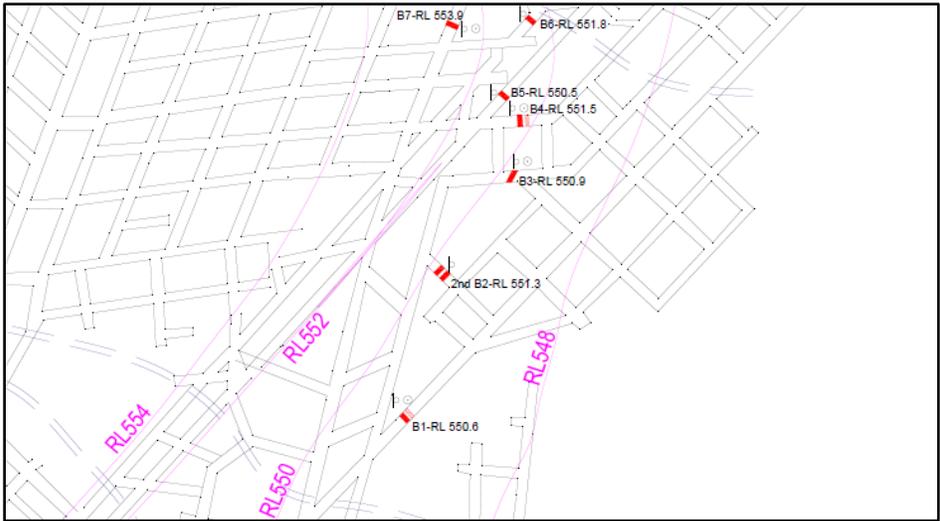
Figure 7 Outflow at the V-notch weir at Mine Adit 2015-2020



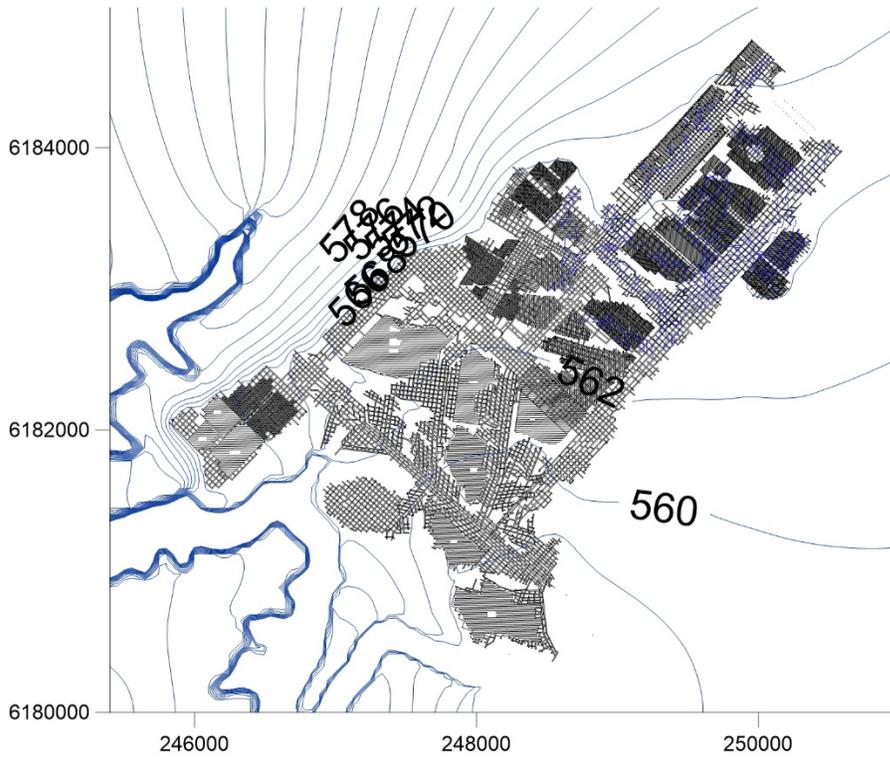
**Figure 8 Observed versus modelled heads**



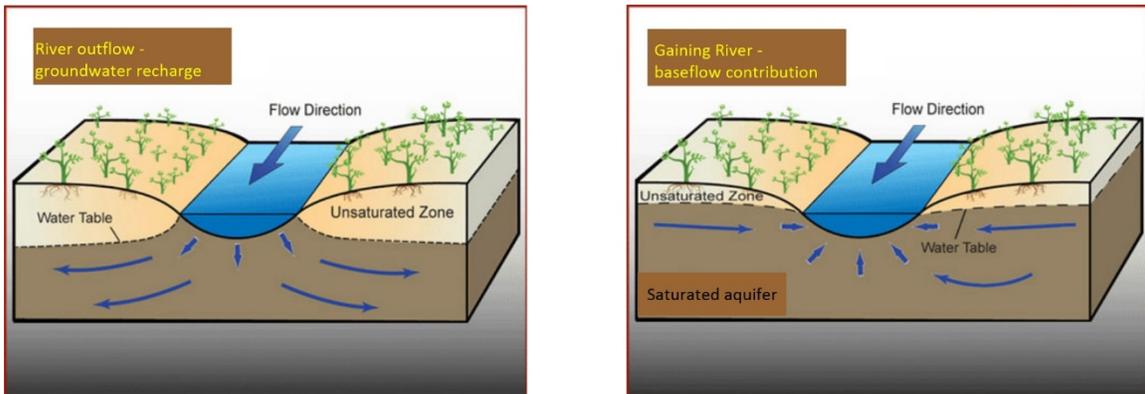
**Figure 9 Results of model verification – observed versus predicted heads for December 2020**



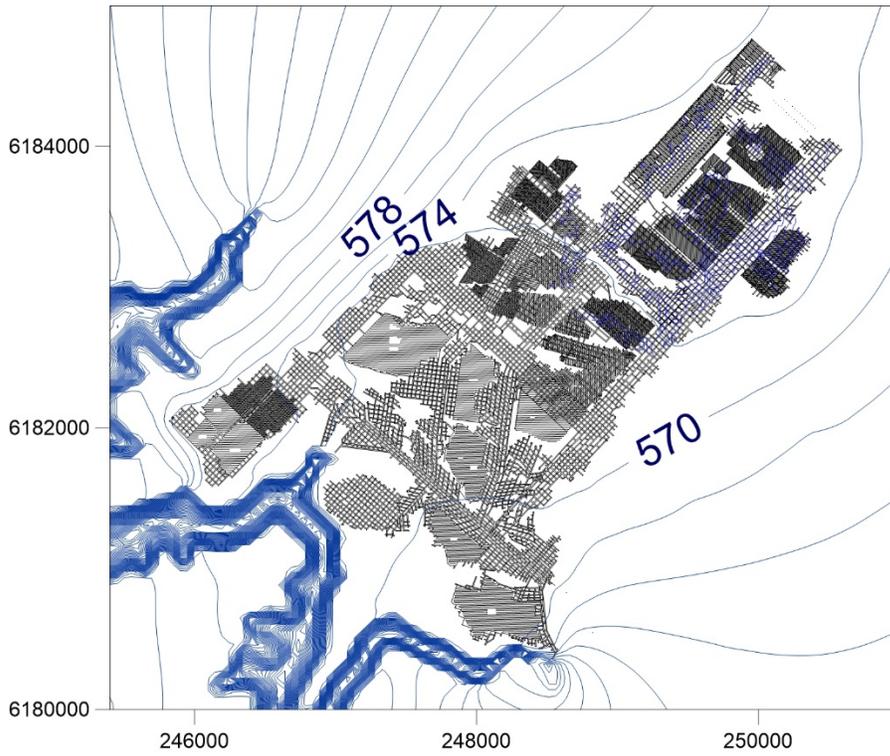
**Figure 10a and 10b Location of installed bulkheads (8a) and pumping location behind the Drift Seal (8b)**



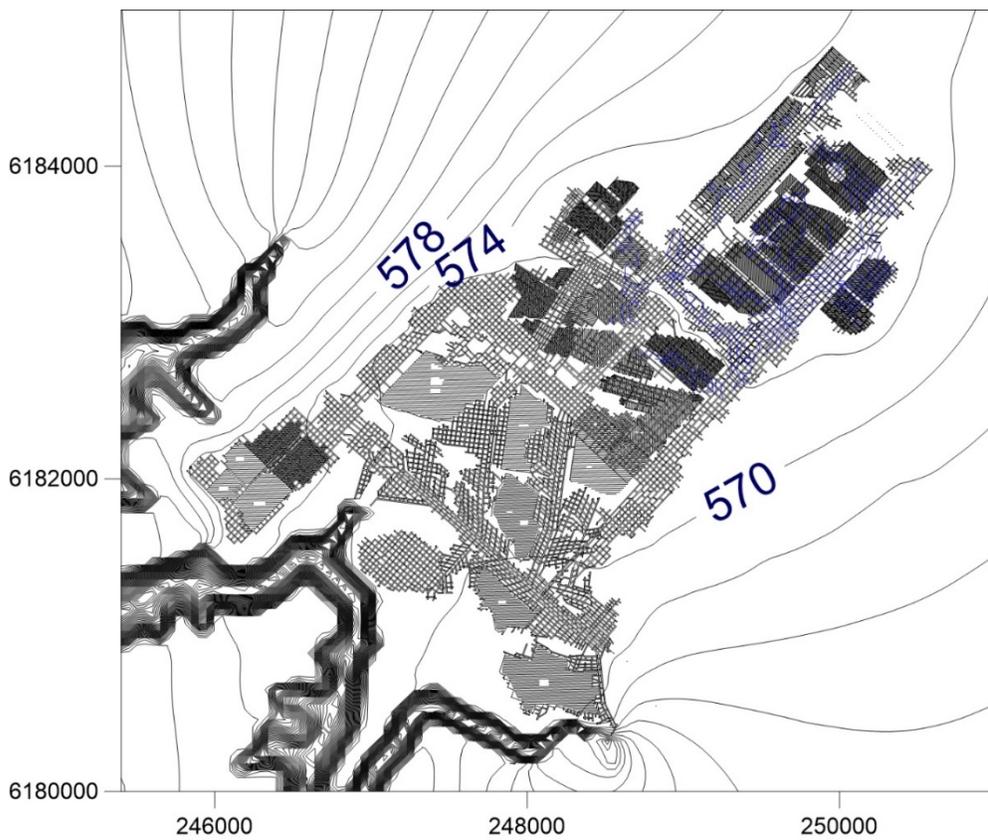
**Figure 11** Predicted water levels at Year 10 from 2020 and the locations of the installed bulkheads



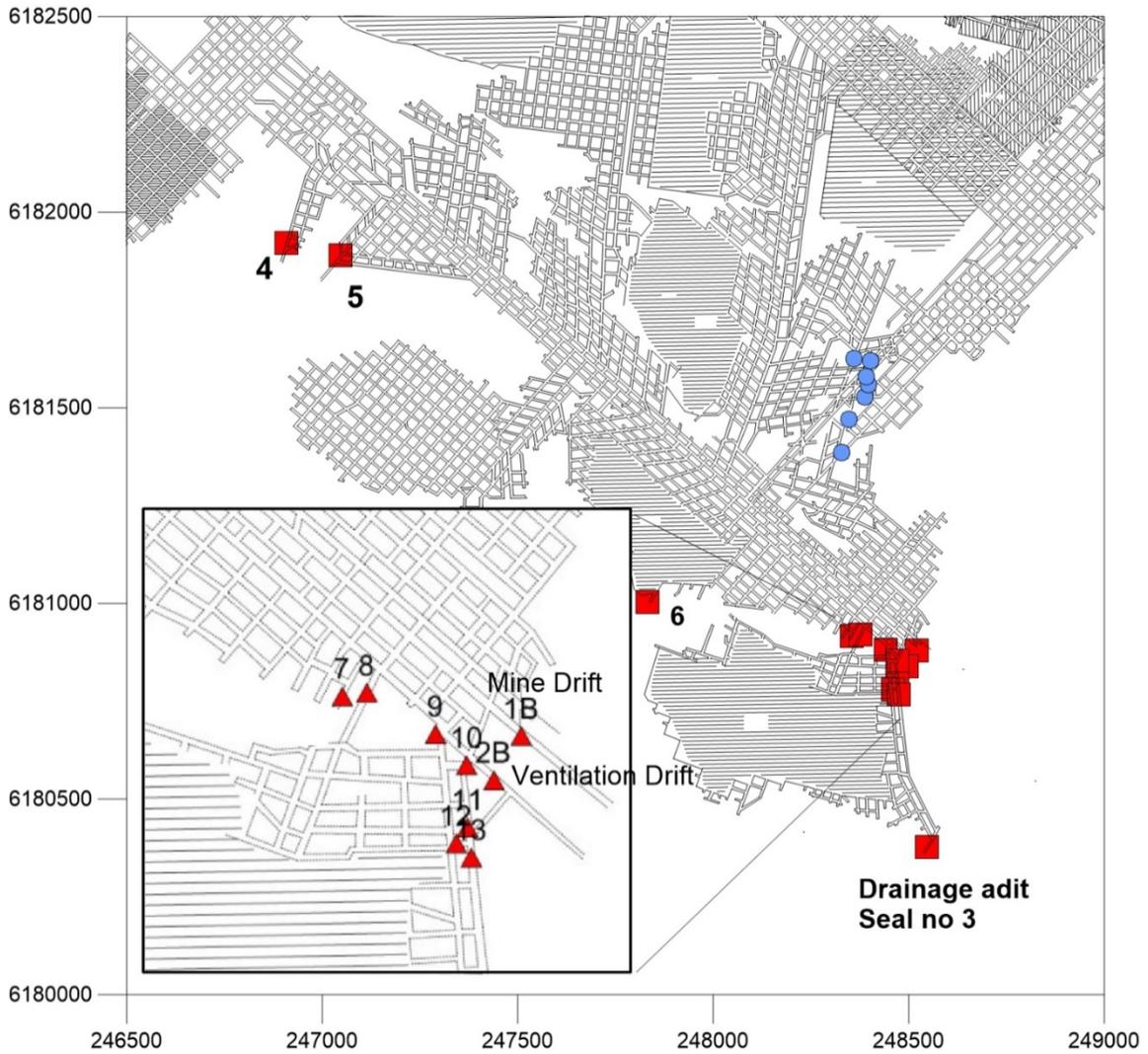
**Figure 12** Groundwater-surface water connectivity (adapted from Geoscience Australia, 2021)



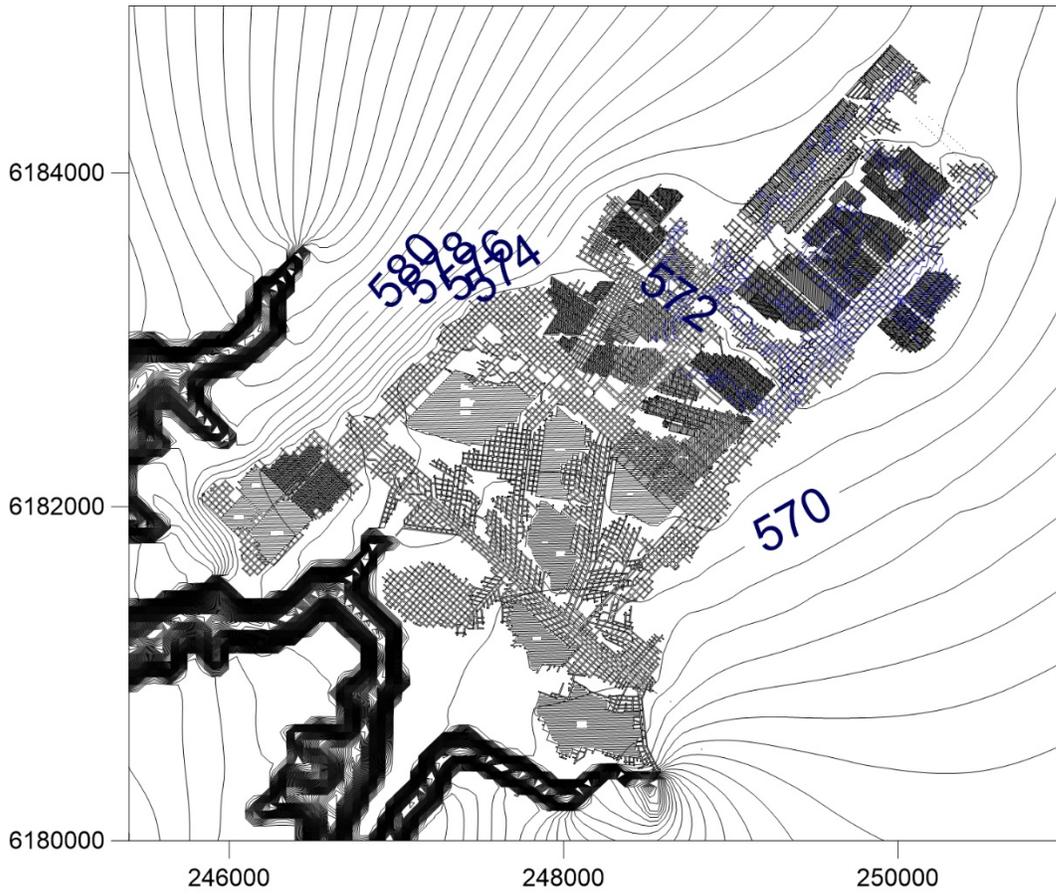
**Figure 13 Predicted water levels after 10 years of pumps not operating with 7 installed bulkheads**



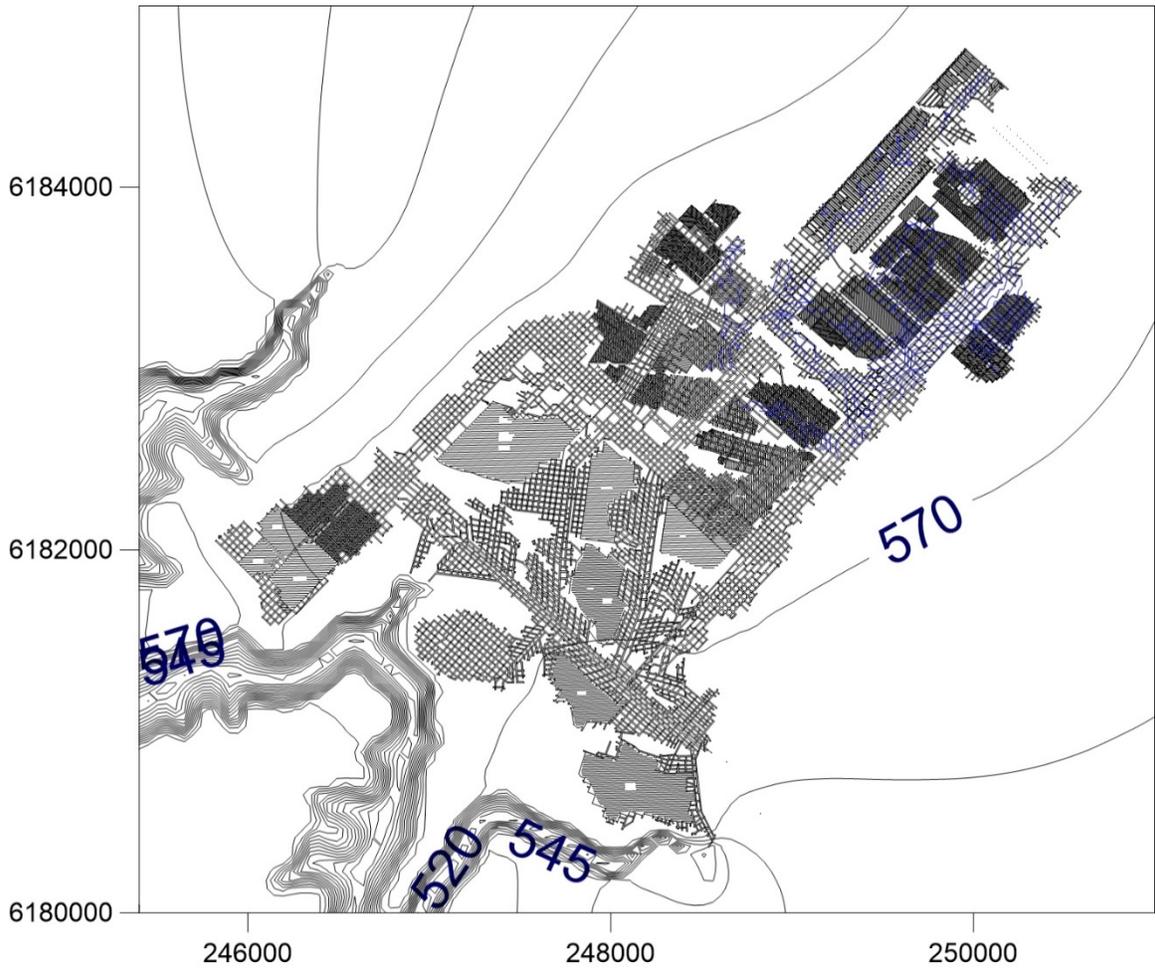
**Figure 14 Predicted water levels after 100 years of pumps not operating with 7 installed bulkheads**



**Figure 15 Location of all bulkheads for Scenario 4 and 5 (blue dots show the installed bulkheads)**



**Figure 16 Predicted water levels with 17 bulkheads installed and no pumping for a period of 10 years**



**Figure 17 Predicted water levels with 17 bulkheads installed and no pumping for a period of 100 years.**