Bloomfield Colliery - Life of Mine Extension, Modification 4

Bloomfield Collieries Pty Limited

15-Jun-2018

Response to Submissions

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Client: Bloomfield Collieries Pty Limited

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Reviewed by Catherine Brady

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			Name/Position	Signature
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Table of Contents

List of Tables

1.0 Introduction

1.1 Project Overview

Bloomfield Colliery's Pty Ltd (Bloomfield) is seeking a modification to the Project Approval MP 07_0087 to extend the life of mining at the Bloomfield Colliery Open Cut Mine (the Colliery) until 31 December 2030.

Existing mining methods would continue to be employed as part of the project to extract up to 1.3 Mtpa of ROM coal from within the existing approved extraction area. Changes to the mine fleet have allowed extraction of seams that were not previously considered to be a recoverable resource in the 2008 Environmental Assessment (EA). In addition, further exploration has identified other previously unrecoverable resources that the new fleet can now access. This modification therefore proposes a revised mine plan which includes extraction of deeper coal seams than originally approved.

The revised mine plan proposed as part of this Project would result in a modification of the previously approved final landform by moving the final void approximately 200m to the west.

1.2 Overview of Approval Process and Exhibition

The Colliery currently operates under Project Approval MP 07_0087, issued under Part 3A (repealed) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). As it was for the purpose of coal mining, the original development was classified as a Major Project under the *State Environmental Planning Policy (Major Projects) 2005* which triggered the former Part 3A approval pathway.

While Part 3A of the EP&A Act was repealed in 2011, transitional arrangements set out in Schedule 6A of the EP&A Act provide that, until recently, Part 3A continues to apply to approved Part 3A projects, and that section 75W of the EP&A Act continues to apply for the purpose of modifications to Project Approvals. The current project would therefore be undertaken as a modification to the existing Project Approval (MP 07_0087) under section 75W of the EP&A Act. The approval authority is the Minister for Planning.

Exhibition of the EA commenced on 2 February 2018 and was completed on 2 March 2018. The EA was made available on the Department of Planning and Environment (DP&E) web site (http://majorprojects.planning.nsw.gov.au/). Soft and hardcopies of the EA were supplied to the following agencies for exhibition or review purposes:

- Cessnock City Council;
- Maitland City Council;
- Nature Conservation Council; and
- Department of Primary Industries – Division of Resources and Geosciences.

1.3 Purpose of this Report

Correspondence was received by Bloomfield from DP&E on 2 March 2018 providing copies of submissions received during the exhibition of the EA and requesting responses to the matters raised by the submission.

The purpose of this Response to Submissions (RTS) Report is to:

- Detail and provide responses to issues raised in the submissions received during the EA exhibition period; and
- Note any changes to the project or additional management measures that have been recommended as a result of those submissions.

To enable the Minister for Planning to determine the application.

1.4 Structure of this Report

This RTS Report addresses issues raised in the submissions and is structured as follows:

- **Section 1** provides an overview of the project, the EIS process and the RTS purpose and structure;
- **Section 2** provides a summary of the agency submissions received and responses;
- **Section 3** provides a summary of the non-government organisation and business submissions received and responses;
- **Section 4** presents a updated set of management and mitigation measures that have been reviewed following consideration of the submissions as detailed in this RTS Report; and
- **Section 5** Conclusion and next steps.

1.5 Summary of Submissions Received

The modification EA was placed on exhibition between 2 February and 2 March, 2018. Submissions were received from the following:

- Government agencies (refer **Section 2.0**):
  - Department of Planning and Environment;
  - Dam Safety Committee;
  - NSW Environment Protection Authority;
  - NSW Heritage Council;
  - Roads and Maritime Service;
  - Department of Planning and Environment - Division of Resources and Geoscience;
  - Office of Environment and Heritage;
  - NSW Department of Industry; and
  - Hunter New England Population Health.
- Non-Government organisations and business (refer **Section 3.0**):
  - Hunter Environment Lobby;
  - Youth Off The Streets Organisation; and
  - Kings Engineering Rutherford.
- Public submissions(refer **Section 3.4**):
  - 11 submissions from community members. All in support of the project.

Copies of all submissions received are attached at **Appendix A.**

1.6 Schedule of Lands

In reviewing the previously supplied schedule of land to which project approval MP 07_0087 applies as previously provided to DP&E by Bloomfield, a transcription error was noted in that schedule. This has now been revised and an updated schedule is provided at **Appendix B.**

2.0 Agency Submissions

2.1 Department of Planning and Environment

Responses to questions raised by the Department of Planning and Environment are addressed below.

Groundwater

Question

The Department notes that groundwater is referred to as close to neutral in the EA. Please provide accurate pH values.

Response

The statement in the EA has been taken from the 2008 surface water assessment as approved at the time by the Department. Given the time elapsed since the preparation of the original EA and to provide DP&E with actual pH values, recent monitoring events have been reviewed which confirm that there is not a significant change in pH levels since the preparation of the original EA. Reference is made to the attached pH values data in **Appendix C.**

Air Quality

Comment

The Department notes that the air quality modelling conducted as part of the EA showed there is potential for cumulative 24-hour average PM10 levels to exceed the NSW EPA impact assessment criteria. Please elaborate on the routine day-to-day reactive and predictive systems at Bloomfield Colliery that would prevent exceedances occurring.

Response

Modelling results conducted for the assessment indicate that there is potential for marginal cumulative 24-hour average PM10 impacts to occur without the use of reactive or predictive management systems to control short term dust levels. Given the conservatism in the assessment these effects may not actually occur, however the small reductions needed could easily be achieved through predictive and reactive dust control strategies, which would be operated at the site to mitigate such potential impacts.

Bloomfield Mine currently utilises meteorological monitoring to plan short term mining operations (several days in advance) to give early indications of favourable blasting days and the likelihood of abnormally high wind and temperate events. The results of this monitoring are used to organise additional dust reduction works, in advance of forecasted potentially adverse weather conditions. These works include additional dust suppression water being applied during the nights preceding the forecast high impact days. Dust suppression water is typically applied to mining bench dig faces, machine hard stand areas and blast hole drill patterns in advance of forecasted adverse or dust generating weather conditions.

On a routine day-to-day basis these dust suppression strategies begin with a review of predictive meteorological modelling software which incorporates regional weather station data and forecasts to predict daily weather events which may exacerbate dust impacts from planned operations. This information is reviewed in daily morning meetings by mine management when planning each day's operations and assists in determining the location of various mining activities.

Throughout the day various practices are used to monitor operations to assist in implementing and/or altering planning decisions. These include:

- Monitoring meteorological conditions throughout the day with the use of real-time on-site weather station data;
- Reviewing data from a network of portable real-time dust monitors nominally positioned upwind and downwind of mining activity that provide an indication of the potential amount of dust generated from the operations which can signal if excessive dust is being generated, and

- Visual inspections of dust plumes that are used to identify those activities which require controls to be applied.

In times of adverse dust generating weather conditions, or where further dust control is deemed required, temporary operational changes are made to the mining operations including:

- A review of current dust controls and check standard mitigation measures are in place;
- Postpone any planned blasting to another day;
- Review the elevation of mining activities and, where possible, relocate equipment to lower elevations until more suitable conditions return;
- Increase haul road watering rates by mobilising additional water carts;
- Selectively shutting down mobile equipment until more suitable conditions return;
- Temporarily pause and modify any activity generating excessive visible dust plumes; and
- Ceasing operations until more suitable conditions return.

Final Landform

Comment

The Department notes that in the event Abel Underground Mine remains in care and maintenance the final northern void will be 'slightly larger'. Please provide as estimate of the difference in size of the final northern void between scenario one and two.

Response

The proposed final void sizes under each scenario are shown in **Table 1.**

Table 1 Final Void Sizes

Scenario	Final Void Size (Ha)
1. Abel Mine resumes operation	45
2. Abel Mine remains in care and maintenance	52
Difference	7

2.2 Dam Safety Committee

The Dam Safety Committee (DSC) noted that the project does not impact any prescribed dams or dam notification areas therefore the DSC does not have any concerns with the project. In consultation, DSC noted that Bloomfield is considering an option to build embankments within the open cut between the area of tailings emplacement and the open cut extraction area.

As requested by the DSC, if Bloomfield proposes to proceed with this option, details would be provided to the DSC for comment prior to undertaking any works to allow the DSC to determine whether to prescribe the dam.

2.3 NSW Environment Protection Authority

The Environmental Protection Authority (EPA) has reviewed the Environmental Assessment and does not have any issues or comments with the project. The EPA does not consider the project to result in any significant increase in the existing environmental impact.

2.4 Heritage Council

The Heritage Council notes that the Environmental Assessment did not identify any heritage items as being located with the project area. The Heritage Council does note however that there are three heritage items located within close proximity to the project area, being:

- The Buttai Cemetery (Wilfred Elliott Private Cemetery) is listed on the Cessnock Local Environmental Plan (CLEP) 2011;
- Buttai Reservoir No. 1 is on the Hunter Water Corporation section 170 register of heritage items. Reservoir No 1 is also of state significance as it is the oldest operating reservoir within the Hunter Water system; and
- Buttai Reservoir No. 2 is on the Hunter Water Corporation section 170 Heritage register and is of local significance.

Due to the changes in the proposed mining the heritage council considers that the following conditions should be placed on the project approval to manage the potential risk of impacts to the heritage items:

Proposed Conditions:

1. A condition survey is to be undertaken of the Buttai No. 1 reservoir and No. 2 reservoir within two months of any determination of Modification 4. The reservoirs' condition is to be monitored for the life of the mine. Any damage is to be carefully repaired following best conservation practice and as advised by Hunter Water's heritage specialist.
2. The condition of the Buttai Cemetery (Wilfred Elliott Private Cemetery) and its contents, any memorials headstones, graves, fences and trees should be surveyed within two months of any determination of Modification 4. Any damage should be mitigated. A conservation management plan should also be prepared for the cemetery in accordance with Heritage Council of NSW guidelines, refer www.environment.nsw.gov.au/Heritage/conservation/managementplan.htm

Bloomfield commits to undertaking the necessary conditions surveys as soon as practical for both the Buttai No. 1 and 2 reservoirs and the Buttai Cemetery. Additional management measures have been added to the list of project management measures provided in **Section 4.0.**

2.5 Roads and Maritime Service

Comment

Roads and Maritime has reviewed the information provided including the Environmental Impact Assessment ('EIA') written by AECOM dated 17 January 2018. While Roads and Maritime acknowledges that all coal extracted from the site is to be transported via the existing rail network and the proposal will not generate any additional workforce traffic, it is noted that additional construction traffic will be generated to upgrade new haulage routes. Details on the expected timeframe for construction, number of vehicles and access from the network has not been identified in the EIA. Accordingly, Roads and Maritime recommends that a traffic and transport study shall be prepared in accordance with Austroads Guide to Traffic Management Part 12 and the Roads and Maritime's Guide to Traffic Generating Developments 2002 and is to include (but not be limited to) the following:

- Assessment of all relevant vehicular traffic routes and intersections for access to / from the subject properties;
- Current traffic counts for all of the traffic routes and intersections;
- Identification of the anticipated additional vehicular traffic generated from both the construction and operational stages of the project;
- The distribution on the road network of the trips generated by the proposed development. It is requested that the predicted traffic flows are shown diagrammatically to a level of detail sufficient for easy interpretation;
- Consideration of the traffic impacts on existing and proposed intersections, in particular, the intersection of Four Mile Creek Road and the New England Highway, and the capacity of the local and classified road network to safely and efficiently cater for the additional vehicular traffic

generated by the proposed development during both the construction and operational stages. The traffic impact shall also include the cumulative traffic impact of other proposed developments in the area;

- Identification of the necessary road network infrastructure upgrades that are required to maintain existing levels of service on both the local and classified road network for the development. In this regard, preliminary concept drawings shall be submitted with the EIS for any identified road infrastructure upgrades. However, it should be noted that any identified road infrastructure upgrades will need to be to the satisfaction of Roads and Maritime and Council;
- Traffic analysis of any major / relevant intersections impacted, using SIDRA or similar traffic model, including:
  - Current traffic counts and 10 year traffic growth projections;
  - With and without development scenarios;
  - 95th percentile back of queue lengths;
  - Delays and level of service on all legs for the relevant intersections;
  - Electronic data for Roads and Maritime review;
- Any other impacts on the regional and state road network including consideration of pedestrian, cyclist and public transport facilities and provision for service vehicles.

Response

Roads and Maritime acknowledge that the project will not generate any significant change in operational traffic levels but has requested that a traffic and transport study be undertaken to assess the potential impacts of construction related traffic and transport related to haulage route upgrades and construction.

Following review of their submissions Roads and Maritime was contacted and the project, including construction related elements was described as detailed below. For clarity the upgrade of haul roads and associated haul road construction does not represent a separate construction activity beyond the current routine operation of the mine. Haul roads are constructed sequentially as the open cut pit mining progresses. As detailed in Section 4.2 of the EA, Bloomfield Colliery utilises a multi-seam bench open cut mining method. The development of progressively deeper benches within the open cut allows seams and overburden to be progressively removed with depth. It also results in benches which can then be used as haul roads to provide access into the open cut pit.

The equipment used to create the benches and haul roads is limited to the mining fleet which at Bloomfield consists of a range of plant including excavators, shovels, haul and dump trucks, dozers and graders. The current mine fleet is made up of the following plant:

- Hitachi Excavator 5500;
- Caterpillar Rear Dump Trucks 789;
- Caterpillar 777 Watercart;
- Caterpillar Rear Dump Trucks 793;
- Caterpillar Front End Loader 992;
- Caterpillar Dozer D11;
- Caterpillar Dozer D10;
- Caterpillar Grader 24G;
- SK75 Drill;
- SK50 Drill; and
- P&H 5700 Shovel.

All this equipment is retained onsite by Bloomfield for current and future mining operations. No plant, equipment or dedicated construction staff are bought to the mine for these activities, therefore there is no offsite heavy or light vehicle traffic generation on the road network associated with these activities.

As indicated Section 8.8.4 of the EA, the project would not result in an increase in traffic movements or transportation of materials. The project would utilise the existing workforce and there would be no increase in traffic movements associated with site personnel. Transport of materials within the project area would remain consistent with existing approved operations. Accordingly it is considered that undertaking a detailed traffic and transport study is not considered necessary. Existing traffic and transport management measures would continue to be in force for the duration of the project.

2.6 Division of Resources and Geoscience

The Division of Resources and Geoscience (DRG) undertook a resource assessment which was included in its submission confirming the viability to the resource. DGR also made two comments requiring further information to aid its assessment

Comment

Further specific detail regarding the post mining land use and domains, should no future residential/mixed use/industrial land uses as described within the Environmental Assessment be approved by future development applications.

Response

Should there be no future residential, mixed use or industrial land uses proposed for the site following the completion of mining any remaining hardstand, mine infrastructure areas, or areas not previously identified as being rehabilitated would be returned to either pasture or trees over pasture. This is consistent with the proposed final land use and rehabilitation strategy over the remainder of the site. Updated final land use plans are provided in **Appendix D** for both the ‘Abel Mine Resumes Operation’ and the ‘Abel Mine in Care and Maintenance’ scenarios provided in the EA.

Comment

Rehabilitation objectives and completion criteria that clearly define the outcomes required to achieve the post mining land use for each domain identified in [the previous comment].

Response

Reference is made to **Table 2** which details the proposed rehabilitation objectives and completion criteria for the pasture and trees over pasture rehabilitation areas.

Table 2 Rehabilitation Areas Domain, Pasture and Trees Over Pasture, Objectives and Completion Criteria

Objective	Performance Indicator	Completion Criteria
These areas require maintenance and monitoring only. Maintenance may include periodic fertiliser application, weed management and soil conservation works.	Stable water management structures such as diversion drains and stock dams	Water management structures functioning as designed
	Ground cover %	>70%, or combined live and litter cover of 70% in tree areas
	Litter cover %	Present at 75% of sites with 20% litter cover
	Presence of rill erosion	Monitoring indicates rills remaining stable in number and size <30cm wide and deep
	Presence of weeds	No significant infestations of declared weeds. Weeds controlled in accordance with relevant legislation Weeds account for <15% of total herbage mass
	Soil pH	pH 4.5 - 9
	Soil EC	EC <0.6 dS/m
	Soil EAT Class	Class 3-8
	Tree species displaying successful recruitment	Monitoring results show evidence of successful recruitment
	Tree species assemblages and health characteristic of species found within region	Tree species composition and health is comparable to analogue site
	LFA monitoring results	Stability index >50 Infiltration index >25 Nutrient cycling index >20
	Pasture herbage mass	> 800 kg DM/ha
	Pasture % dead matter	<50%
	Crude protein of pasture	>2%
	Digestibility of pasture dry matter	>40%
	Metabolisable energy of pasture	>6MJ/kg DM
	Potential stocking rates	2-4 DSE/Ha
	Soil substrate and pasture cover	Comparable with non-mined grazing reference site

Bloomfield also notes the draft recommended conditions of consent that are attached to DRGs submission. Bloomfield does not have any objections to the recommended conditions although has made the following edits to the draft condition relating to the Rehabilitation Management Plan to align to the proposed operations:

- Removed reference to periodic trials and replaced with periodic monitoring – The Colliery has a well-established and functioning rehabilitation approach. Ongoing monitoring, as is already undertaken is more appropriate than specifying more trials; and
- Removed reference to target vegetation community and replaced with rehabilitation targets – The rehabilitation is seeking to return the mine to a mixture of trees and trees over pasture not a specific vegetation community type.

Reference is made to the updated list of proposed management measures detailed in **Section 4.0.**

2.7 Office of Environment and Heritage

The Office of Environment and Heritage (OEH) provided comment on the project with regard to biodiversity, Aboriginal cultural heritage and flooding.

Biodiversity

OEH indicated it is satisfied with the biodiversity assessment that accompanied the EA and that no further assessment is necessary. OEH provided recommended conditions for the project including that the proponent should retire the required number of biodiversity offset credits in accordance with Framework for Biodiversity Assessment (FBA). Bloomfield is in general agreement with the offsetting requirement and requests that any conditions of consent refer to the proposed offset strategy instead of a specific offset method (e.g. purchasing like-for-like credits), as a means for offsetting project impacts. The strategy approach is required as it would enable Bloomfield to utilise offsetting mechanism/s. This is necessary given the potential lack of available like-for-like credits available.

Aboriginal Cultural Heritage

OEH indicated it is satisfied with the Aboriginal cultural heritage assessment that accompanied the EA and that no further assessment is necessary. Bloomfield will update the existing Aboriginal Cultural Heritage Management Plan at the mine to incorporate the works covered by this modification.

Flooding

OEH has requested that a fit-for-purpose flood impact assessment be undertaken to quantify potential adverse off-site impacts. This assessment should identify potential off-site receivers by considering discharge points and distance to property boundaries. This specifically relates to the changes to the proposed final landform which when compared to the existing approved final landform would result in the following changes to catchment areas:

- Buttai Creek – An additional 41ha will be returned to the catchment under the proposed final landform; and
- Four Mile Creek – An additional 10ha will be returned to the catchment under the proposed final landform.

In response to this comment, Bloomfield engaged AECOM to undertake a review of the potential flooding impacts of the project. As noted in **Table 1** there are two final void scenarios. This assessment has reviewed the final void scenario with the potential worst case flooding impacts i.e. the scenario in which Abel resumes operation, which would result in a smaller final void (45 ha) and greater increase in the creek catchment areas for Buttai Creek (41ha) and Four Mile Creek (10ha).

Using the *Regional Flood Frequency Estimation Model* (RFFE), the peak flows for each catchment were estimated, and compared to the peak flow with the additional catchment area that is to be included as part of the project.

For both Buttai Creek and Four Mile Creek, the changes in peak flow are minor. The peak flow in Buttai Creek for the 1% AEP is increased by less than 2%, while for Four Mile Creek the increase is less than 1%. It should be noted that the changes in peak flow associated with the catchment reconfiguration proposed in the application are significantly less than the uncertainty associated with the flow estimates.

Using the Manning equation, the effect on the nearest downstream road crossings to benchmark the effect that the changes may have of flood risk. Flood levels are increased 0.02 m in Buttai Creek at Buchanan Road, and 0.01 m in Four Mile Creek at the New England Highway. These increases in flood level are small, and are likely to only have a very minor impact on flood risk. When considering the project impacts to catchment areas it should also be noted that while the areas of the Four Mile Creek and Buttai Creek catchment will increase, they will still remain smaller than the original catchment size had no mining ever been undertaken.

Reference is made to the flood assessment provided in **Appendix E.**

2.8 NSW Department of Industry

The Department of Industry's submission made comment in relation to Groundwater and Surface water matters.

Comment

The proponent should undertake an assessment of impacts to High Priority Groundwater Dependent Ecosystems (GDEs) as listed under the:

- Water Sharing Plan for the North Coast fractured and Porous Rock 2016; and
- Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources, 2009.

As they occur in proximity to the site.

Response

Section 4.7 of the Groundwater Impact Assessment (AECOM, 2018) indicated that the relevant water sharing plans had been reviewed to determine the location of GDEs in proximity to the site. That assessment concluded that there are no GDEs in close proximity. In order to confirm the proximity of GDEs to the project both water sharing plans have been reviewed again, specifically the following GDE maps of relevance:

- North_Coast_Fractured_GDE_Map_GDE002_Version_1, 1 July 2016; and
- Hunter_Unregulated_Alluvial_GDE_Map_GDE012_version_1, 1 July 2016.

The nearest GDEs to the project are associated with Pambalong Swamp (approximately 6.5km to the south), Hexham Swamp (approximately 6km to the south-east) and Woodberry Swamp (approximately 8.5km to the east). The project does not directly drain to or from any of these areas. Impacts to these GDEs as a result of the project are therefore considered negligible.

Comment

The proponent should submit an independent review of the groundwater model as required under the Aquifer Interference Policy (2009).

Response

Bloomfield has engaged Peter Dundon from Dundon Consulting Pty Ltd to undertake an independent peer review of the groundwater modelling. The independent peer review identified a number of minor changes to the Groundwater Impact Assessment and accompanying modelling report however concluded that the Groundwater Impact Assessment was satisfactory. A copy of correspondence from Dundon Consulting Pty Ltd confirming this is attached at **Appendix F** along with a copy of the Groundwater Impact Assessment which has been updated to address those comments raised during the independent review.

Comment

The proponent should confirm licencing arrangements for the projected 26ML/yr from the Wallis Creek water sources and 8ML/yr from the Newcastle Water Source. Given that the Newcastle Water Source does not form part of a water sharing plan, this entitlement would need to be obtained under the *Water Act 1929.*

Response

Section 5.1.2 of the Groundwater Assessment (AECOM, 2018) for the project indicated that the alluvial take from the Wallis Creek and Newcastle water sources would be 26ML/yr and 8ML/yr respectively. It should be noted however that these quantities are included within the total 500ML/ yr take. This is reinforced in the conclusion to the Groundwater Assessment which indicates that mine inflows are within the licence conditions of 500ML/a. No additional licencing requirements are necessary.

2.9 Hunter New England Population Health

Hunter New England Population Health reviewed the Environmental Assessment for the project with particular attention to air quality, noise, water or other issues which may impact upon public health. The submission does not raise any issues or concerns with the project that require further addressing.

Hunter New England Population Health's comments regarding air quality and there being no evidence of safe particulate matter exposure are noted. Bloomfield is committed to undertaking all reasonable and feasible management measures to address issues such as air quality, noise and water as outlined in Section 8.3 of the Environmental Assessment (AECOM, 2018).

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3.0 Non-Government Organisations and Business

3.1 Hunter Environment Lobby

The Hunter Environment Lobby objects to the proposed modification for the following reasons:

- Biodiversity impacts;
- Loss and quality impacts to groundwater;
- Air quality impacts on communities;
- Noise impacts on communities; and
- Greenhouse gas emissions.

A comprehensive environmental assessment was undertaken as part of the modification EA to address a broad range of environmental aspects and considerations including all the matters listed by the Hunter Environment Lobby as discussed further below:

<u>Biodiversity</u>

A Biodiversity Assessment Report (BAR) was prepared to assess the potential impact of additional clearing proposed as part of the project and to undertake a gap analysis of previous ecological assessments undertaken within the Project Area. An additional 3.5 ha of previously rehabilitated landform (including 0.34 ha of native vegetation) would be cleared as part of the project for the proposed widening of a haul road and upgrade of a watercourse. The BAR included an assessment of likely biodiversity impacts of the project as a result of this additional clearing.

The 0.34 ha of native vegetation occurs as small patches. Two Plant Community Types (PCTs) were identified within the Haul Road Study Area, including PCT 1590 – *Spotted Gum – Broad leaved Mahogany – Red Ironbark shrubby open forest* (0.05 ha) and PCT 1592 – *Spotted Gum – Red Ironbark – Grey Gum – grass open forest of the Lower Hunter* (0.29 ha). These PCTs represent the Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion, which is an Endangered Ecological Community listed under the *Biodiversity Conservation Act 2016* (BC Act). These PCTs were assessed as being in moderate / good condition.

No threatened flora or fauna species listed under the BC Act or EPBC Act were recorded during the targeted surveys. Potential seasonal foraging habitat for a number of EPBC listed threatened species, including the Regent Honeyeater, Swift Parrot, Large-eared Pied Bat and Grey-headed Flying Fox was identified, however the native vegetation does not provide habitat for an ecologically significant proportion of these species.

The residual impacts of the proposed removal of 0.34 ha of native vegetation would be offset through the purchase of 10 ecosystem credits and implementation of a Biodiversity Offset Strategy. The Colliery has established clearing protocols in place as part of its Environment Management System (EMS) and these would continue to be implemented during the project. Additional mitigation measures recommended to minimise potential impacts of the project would also be implemented.

Overall therefore it is concluded that biodiversity impacts have been minimised where possible, appropriate management measures are in place with regards to unavoidable clearing, and finally offsets have been appropriately accounted for as required.

<u>Groundwater</u>

A Groundwater Impact Assessment was prepared for the project by AECOM to assess the potential hydrogeological impacts of the project including potential changes to the site water balance and water management system at the Colliery. The assessment was based on data from a predictive groundwater model for the Colliery developed independently by HydroSimulations.

Drawdown was found to be generally less than 0.5 m outside the Bloomfield lease area apart from the south-west corner where the 2 m drawdown contour extends outside the lease approximately 600 m beneath Buttai Creek. The predicted drawdowns are not expected to negatively impact the nearest GDE's which are approximately 8km from the project, and as historical mining in the area has lowered water levels far below the ground surface. Groundwater loss as a result of the project would therefore be minimal.

Potential impact to groundwater quality as a result of Bloomfield's current and future operations relate to the risks of contamination from disturbed catchments, mine water, and process water being released off site to natural waterbodies. The project would not increase or decrease the probability of unplanned discharges or water quality risks from Bloomfield's operations. Management measures are currently in place and would continue to be enforced to manage potential impacts to water quality or unplanned discharges.

A minimal impact assessment has been conducted for the groundwater potentially impacted by the project in accordance with the AIP. All predicted impacts are less than Level 1 minimal impact considerations (as defined in the AIP) and are therefore considered acceptable with appropriate monitoring during operation.

In accordance with the NSW Aquifer Interference Policy (AIP) (NSW Office of Water, 2012) an independent peer review of the groundwater modelling has been undertaken confirming the modelling has met AIP requirements. Reference is made to **Appendix F.**

<u>Air Quality</u>

An Air Quality Impact Assessment (AQIA) was prepared for the project by Todoroski Air Sciences to predict the potential air quality impacts on receivers in the vicinity of the project and to recommend measures to mitigate the impacts. As the project is not seeking changes to the intensity or general extent of mining, or changes in the mining equipment fleet or mining method, the project is not expected to result in significant changes to the existing level of impact.

Dispersion modelling indicates that dust levels would be below the relevant criterion at the privately-owned receptor locations. The results also indicate that without reactive or predictive mitigation measures, there is some potential for cumulative 24-hour average PM_{10} levels to marginally exceed the EPA impact assessment criteria. However, with the use of the now routine (already in place) day-to-day reactive and predictive systems at the operations, no unacceptable levels of impact would be expected to arise.

Overall, the potential air quality impacts associated with the project, including impacts to communities, are not expected to be significantly different from the existing approved operations. Bloomfield would continue to implement air quality management measures currently used at the Colliery to mitigate air quality emissions from its operations, which includes a reactive dust mitigation strategy and forecast management system.

<u>Noise</u>

A Noise and Vibration Impact Assessment (NVIA) was prepared for the project by SLR Global Environmental Solutions (2017) to assess the potential noise, vibration and blasting impacts associated with the project.

Predicted noise levels show that generally project operations have the potential to exceed the relevant Project Specific Noise Levels (PSNLs) and existing noise limits under prevailing noise enhancing weather conditions. However, during reduced night-time operations, noise levels were generally predicted to meet the relevant PSNLs and existing noise limits under prevailing noise enhancing weather conditions. The predicted maximum night-time noise levels meet the sleep disturbance criteria under standard operating conditions and therefore are not likely to cause sleep disturbance at assessed residential locations.

The cumulative impact of mining in the area surrounding the project, including the resumption of operation of the Abel Underground Mine, is predicted to comply with the relevant amenity criteria at relevant receiver locations or on more than 25 percent of, any privately owned land, with the exception of Lot 30/DP1113350 (vacant land owned by JD Hestlow within the mining lease).

Bloomfield would continue to implement noise and blasting management measures currently utilised at the Colliery to minimise the noise and vibration impacts to surrounding receivers. The Noise Monitoring Plan and Blasting Monitoring Program would continue to be implemented for the duration of the project and would be updated to reflect the project as required. Noise impacts to nearby communities as a result of the project is therefore expected to be minimal.

Greenhouse Gas Emissions

The modification would result in a small increase in total coal production. This would result in a minor increase in greenhouse gas (GHG) production compared to the approved project and would have negligible environmental impacts. In accordance with the existing approval, the Colliery is operated in accordance with an Energy Savings Action Plan (ESAP) that drives reductions in energy use in operations over time. This ESAP would continue to be in place for the life of the Colliery. With efficiency measures in place, the Colliery would be operated in a manner that reduces GHG production to the extent possible.

3.2 Youth Off The Streets

Youth off the Streets made the following comment:

> *The Bloomfield Group and Foundation has been a major supporter of Youth Off The Streets since our entry into the Hunter Community, and started providing financial support in 1999. As well as the organisation donating to our programs, staff also get involved via their payroll giving program, and have also lent a hand at times through volunteering. The organisation invites engagement and participation and last year invited a group of disadvantaged youth to visit the site and see what happens, and how they may be able to consider employment pathways into the sector. The ongoing support of the organisation has meant that we can also fund staff training and development to create opportunities for the community. Without their valued support we wouldn't be able to stay in the Hunter Valley community, and thanks to their longstanding commitment we now have an expanded presence with a drop in centre.*

Youth off the Streets support for the project is noted.

3.3 Kings Engineering

Kings Engineering made the following comment:

> *PWG King and Sons (Kings Engineering) has been operating in Maitland for over 90 years and works closely with the Hunter Valley Coal industry and particularly Bloomfield Mine.*
> *Bloomfield Mine is a significant contributor to our revenue in a time when the manufacturing industry is under heavy pressure to survive and maintain Australian jobs. Our workforce of seventy one requires mines like Bloomfield to remain open providing work to ensure our business is viable now and into the future.*
> *Without the ongoing support from Bloomfield Mine Kings Engineering business would not be able to maintain the level of employment we currently have after reducing our employees from ninety three years ago.*
> *Kings Engineering supports the Bloomfield Colliery Modification 4 and ask that you look favourably on approving the Modification.*

Kings Engineering support for the project is noted.

3.4 Community Submissions

Submissions received from members of the general public are summaries in the attached **Table 3**. It is noted that all public submission received during the exhibition of the EA are in support of the project.

Table 3 Submissions from Community Members

Submitter	Comment
Andrew Nicholas Brandy Hill NSW.	I support Bloomfield's application. The Bloomfield Group have proven themselves over several generations to be good corporate citizens; through supporting the community, its employees and their families and ensuring their rehabilitation practices are always ahead of the industry standard.
Darren Wilton North Lambton NSW	I would like to voice my support for the extension of Bloomfield. As this is an existing mine I believe it is imperative to maintain operations not only for the ongoing employment of the current workforce, but also the continuing economic boost it brings to the community as a whole. Hopefully this mine continues to operate for the benefit of everyone
Karen Cotton Kotara NSW	I support the proposed mod 4 extension of the Bloomfield Mine because as a local, all Australian company it supports the community that I and my friends and family live in. The group is generous with their donations and time to local charities, sporting clubs and community projects. They employ a large local workforce and offer many training opportunities to young people. They do all this in an unobtrusive way with the highest environmental standards.
Mark Nolan Hamilton NSW	I have worked at Bloomfield Open Cut Mine for the past 27 years. I wish to make a personal submission in support of the Modification 4, before the Department. Bloomfield is a small operation and has successfully mined the coal lease by open cut methods since 1964. We have always had a good relationship with our immediate and outlying neighbours. Any issues that have arisen from time to time have always been dealt with promptly and sympathetically, and have always been resolved to the satisfaction of both parties. There is no reason why this good relationship should not continue into the future. Bloomfield Colliery is a great employer in the Lower Hunter Valley. It has a stable long term workforce and makes a great contribution to the economy of the Lower Hunter. The workforce is made up predominantly of local people who live in the area. The company also gives generously to many local community projects including the Cancer Council, Youth Off The Streets, Hunter Medical Research Institute and many sporting groups. Our environmental credentials are second to none. The whole workforce is proud of the quality of our mine rehabilitation. Due to Bloomfield's past good record and continued small scale mine production, I can see no reason why this modification should not be granted and I hope that it is dealt with favourably in your approval process.
Melissa Gordon Thornton NSW	The Bloomfield Group is an organisation that endeavours to ensure it conducts its mining operations in a way that respects both the environment and the health and safety of its employees and the wider community. I support the Bloomfield Colliery modification 4.
Phillip Reichert Cameron Park NSW	I am an employee at Bloomfield Colliery. I strongly support the modification of Bloomfield coal mine. This modification will benefit not only my family and other families but also local business by supplying more jobs within the area. The mine has been established for many years where we have been working closely with our community and neighbours on environmental and within noise constraints levels by modifying production outputs which results in all parties being cater for.
Rod Green Merewether NSW	I support the Mod 4 extension at Bloomfield because; - we are an Australian owned company - we are a family owned and operated company - we employ local people - we support local charities - we support local sporting groups - we make large donations to organisations like the Westpac Helicopter - we have a vision for environmental awareness and

Submitter	Comment
	the future in regards final land form - we closely we our neighbours to achieve good outcomes
Scott Munro Bonnells Bay NSW	The Bloomfield Mine has supported families and employees in this area for a long time and the impact on jobs in the area would be huge if the mine was to close. Contractors who also rely on the mine to create an income for their families will also be impacted, their employees, and families rely on local work to keep their business open, all contributing back to the community. This is why I support this consent.
Mark Gordon Thornton NSW	I have been an employee at the Bloomfield mine for past 30 years. I find the Bloomfield Group to be a trustworthy family company who care about their employees and the environment. I support the mod 4 extension to the mine.
(Name withheld) Broke, NSW	Although I am a proud employee of "The Bloomfield Group" ([TBG], however unrelated to the direct mining sector) I feel it pertinent to make a submission from an employee perspective. I can attest to any interested parties that TBG approach to community, people, health, safety & the environment is without a doubt second to none. It is with this and purely this alone that I completely endorse any extension to TBG operations as I can guarantee that the processes will be handled with the utmost integrity and with more than due consideration to any and all potential impacts in this sector. Management of TBG processes in all facets of operations is always undertaken with the utmost care, consideration and due diligence, this is only some of the reasons why I am proud to be a part of this outstanding organisation.
(Name withheld) Gillieston Heights NSW	Keep supporting local businesses which support the community.

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4.0 Management Measures

The updated Project management measures are provided in **Table 4**. New measures are those in italics for ease of reference.

Table 4 Summary of Management Measures

Ref#	Management and Mitigation Measures	Timing
Biodiversity		
1.	**Existing measures** The Colliery has established clearing practices in place as part of its EMS. These include minimisation of disturbance areas, pre-clearance surveys, salvaging and reusing material on site for habitat enhancement, conserving and reusing topsoils and weed management. These clearing practices would continue to be implemented for the project in accordance with the approved EMS.	Duration of the project
2.	**Pre-clearance surveys** Pre-clearance surveys of the forest to be removed would be conducted within 24 hours prior to commencement of clearing to identify any fauna species or habitat within areas of impact. Where clearing of vegetation and fauna habitat occurs, clearing protocols would be put in place, including checking trees for the presence of arboreal fauna prior to felling. Where feasible, animals found to be occupying trees would be safely relocated into nearby forest that would not be disturbed. Where feasible, transportable habitat features such as large logs and boulders would be placed in adjacent retained areas or in areas ready for seeding, to allow their continuation as potential fauna refuge sites.	Prior to clearing activities
3.	**Regent Honeyeater and Swift Parrot** In addition to these general fauna pre-clearance methods, the following measures would be implemented to mitigate potential impacts on habitat for the Regent Honeyeater and Swift Parrot: • A qualified ecologist would undertake a targeted pre-clearance survey within 24 hours prior to the commencement of removal of potential foraging habitat for the Regent Honeyeater and Swift Parrot (potential foraging habitat includes the entire 6.12 ha study area); • Pre-clearance surveys would be undertaken over a period of two days and surveys would be undertaken in the morning (i.e. within 3 hours of sunrise) to target the species highest activity period. Dependent on the clearing schedule, the survey effort would comprise: - 20 minute searches in areas up to 5 ha; or - 40 minute searches in areas of 6 – 30 ha. • If Regent Honeyeaters or Swift Parrots are not found within the clearance area, then searches for Regent	Prior to and during clearing activities

Ref#	Management and Mitigation Measures	Timing
	Honeyeater or Swift Parrot habitat trees (foraging trees) are not required; • If Regent Honeyeaters or Swift Parrots are found within the clearance area, targeted searches for Regent Honeyeater or Swift Parrot habitat trees would be undertaken by a qualified ecologist; • If habitat trees are found within the clearance area, a qualified ecologist would mark the trees with flagging tape and spray paint (e.g. with a ‘H’, denoting habitat tree); • The two stage clearance protocol for habitat trees comprises: - Stage 1: Non-habitat trees would be cleared 24 hours prior to any habitat trees being cleared, to encourage Swift Parrots to move out of the habitat area; and - Stage 2: When Stage 1 is complete, habitat trees can be removed.	
4.	**Weed control, microhabitat retention and demarcation** Other management strategies would include: • Appropriate weed controls to avoid incursion of exotic weed species into the remaining surrounding forest; • Salvaging microhabitat features, such as woody debris and logs, within adjacent suitable habitat, where possible to mitigate potential impacts to ground-dwelling fauna; and • Habitat adjacent to the proposed clearing would be demarcated to avoid accidental clearing. Vegetation clearing would be minimised and avoided where possible. Where opportunities for reduction in clearing extents occur, these would be implemented and micro-habitat features retained.	Duration of the project
5.	**Construction of Haul Road Upgrade** Additional mitigation measures to be implemented during construction of the haul road upgrade would include: • Appropriate exclusion fencing would be installed around vegetation to be retained directly adjacent to the development footprint; - Appropriate signage such as ‘No Go Zone’ or ‘Environmental Protection Area’ would be installed; - The location of any ‘No Go Zone’ would be identified in site inductions; - Fencing would be secured with star pickets and would use high visibility bunting; • All material stockpiles, vehicle parking and machinery storage would be located within cleared areas or areas proposed for clearing, and not in areas of retained native vegetation; • A licenced wildlife salvage team would be on-site during vegetation removal to catch and relocate (if appropriate) wildlife encountered; • Where appropriate, native vegetation cleared from the development site would be mulched for reuse on the site,	During haul road upgrade works

Ref#	Management and Mitigation Measures	Timing
	to stabilise bare ground; • Temporary stormwater controls would be implemented during construction to ensure that discharges to the drainage channels are consistent with existing conditions; and • Sediment and erosion control measures would be implemented prior to construction works commencing (e.g. silt fences, sediment traps), to protect drainage channels. These would conform to relevant guidelines, would be maintained throughout the construction period and would be carefully removed following the completion of works.	
6.	**Biodiversity Offset Strategy** Ten ecosystem credits would be required to offset the impacts arising from the project, and Bloomfield would pay the required offsetting cost (currently estimated to be $22,007.08 including GST) into the Biodiversity Conservation Trust.	Duration of the project
Noise		
7.	Bloomfield would continue to implement noise and blasting management measures in accordance with the Noise Monitoring Plan and the Blasting Monitoring Program currently utilised at the Colliery to minimise the noise and vibration impacts to surrounding receivers. This includes scheduling of mining operations with regard to predicted weather conditions. During reduced night-time operations under prevailing weather conditions, potential noise impacts at Location M would be minimised by undertaking coal haulage via the alternate haul road (that is, Scenario 2). The Noise Monitoring Plan and Blasting Monitoring Program would continue to be implemented for the duration of the project and would be updated to reflect the project as required.	Duration of the project
Air Quality		
8.	Bloomfield would continue to implement air quality management measures currently used at the Colliery, including the predictive management system, to mitigate air quality emissions from its operations. This includes a reactive dust mitigation strategy and forecast management system. Bloomfield would continue to monitor and report its GHG emissions in accordance with the ESAP and legislative requirements. The Air Quality Monitoring Program and Blast Monitoring Program would continue to be implemented for the duration of the project. Existing management plans and procedures would be updated to reflect the project as required.	Duration of the project
Soils and Water		
9.	**Mine Water Management** The existing Water Management Plan would be reviewed and revised to incorporate the project and ensure that the management of soil and water continues to: • Stay current and consistent with relevant guidelines and best practice;	Duration of the project

<table>
<tr><th>Ref#</th><th>Management and Mitigation Measures</th><th>Timing</th></tr>
<tr><td></td><td>Account for projected changes in operation; and
Update water balance modelling and projections on the basis of observed results (i.e. variations in mine water make, groundwater monitoring).
At such time that Abel returns to production, reconsideration of the water balance would be undertaken as part of the ongoing management plan review process. This would enable and support appropriate planning to ensure mine water and tailings would continue to be contained on site.</td><td></td></tr>
<tr><td>10.</td><td>Catchments
Rehabilitated catchments would continue to be managed as per the existing Water Management Plan and Rehabilitation Management Plan, in accordance with the following principles:
Rehabilitated landform would be progressively rehabilitated;
Runoff from areas undergoing rehabilitation would be managed with appropriately designed water and sediment management structures (contour banks, drains, and drop structures); and
Ongoing monitoring of the landform would be carried out to repair and restore areas of erosion or instability.
Discharge of water from the final landform would not occur to Four Mile Creek or Buttai Creek and its tributaries until the catchment is considered ‘rehabilitated’ in accordance with the Rehabilitation Monitoring Plan and associated regulator sign-off and approvals.</td><td>Duration of the project</td></tr>
<tr><td>11.</td><td>Surface Water Quality
Potential impacts to receiving waters would be mitigated through implementation of the mine water management system, which includes:
Runoff from undisturbed and rehabilitated areas would be directed away from operational areas and mine water storages via diversion banks and channels; and
Mine and sediment water would be collected for treatment before discharge via Lake Kennerson, Lake Foster and sediment basins to intercept runoff from disturbed areas.
Surface water monitoring would continue to be undertaken in accordance with Bloomfield’s EPL 396. The existing monitoring program would be periodically reviewed to ensure the program continues to be adequate and consistent with current guidelines and policy requirements.</td><td>Duration of the project</td></tr>
<tr><td>12.</td><td>Erosion and Sediment Control
The erosion and sediment control plan would continue to be implemented to ensure that the discharge of all water from the site is managed and meets appropriate quality standards. Key elements of the erosion and sediment control plan include:</td><td>Duration of the project</td></tr>
</table>

Ref#	Management and Mitigation Measures	Timing
	• Coordination of mining to minimise exposure to disturbed soils; • Separation or diversion of clean water catchments from disturbed areas to minimise sediment laden and mine water volumes for management; • Collection and management of runoff sediment control devices; • Appropriate storage and handling of topsoil materials; • Revegetation of disturbed areas following site disturbance; and • A maintenance program for control structures.	
13.	***Rehabilitation Objectives and Commitments*** *The Proponent will rehabilitate the site to the satisfaction of DRG. This rehabilitation will be generally consistent with the proposed rehabilitation activities described in the Environmental Assessment and Response to Submissions reports.*	Duration of the project
14.	***Progressive Rehabilitation*** *The Proponent must rehabilitate the site progressively as soon as reasonably practicable following disturbance. All reasonable and feasible measures must be taken to minimise the total area exposed for dust generation at any time. Interim stabilisation and temporary vegetation strategies must be employed when areas prone to dust generation cannot be permanently rehabilitated.*	Duration of the project
15.	***Rehabilitation Management Plan*** *The Proponent must prepare a Rehabilitation Management Plan for the project to the satisfaction of the Division. This plan must:* *(a) be prepared in consultation with the Department, DPI Water, OEH, DPI, Council and the CCC, and submitted to DRG for approval under this consent, unless the Secretary agrees otherwise;* *(b) be prepared in accordance with any relevant DRG guideline;* *(c) describe how the rehabilitation of the site would achieve the objectives and outcomes described in the Rehabilitation Strategy and be integrated with the Biodiversity Offset Strategy:* *(d) include a detailed Tailings Management Plan for the development;* *(e) include a detailed soil and growing medium balance for the development;* *(f) include a detailed plan for the reinstatement and review of the proposed:* • agricultural land capability of grassland areas in the final landform, including a protocol for periodic monitoring to demonstrate that the land capability is being achieved; and	Prior to and for the duration of the project.

Ref#	Management and Mitigation Measures	Timing
	• rehabilitated woodland areas and fauna habitat, including a protocol for periodic monitoring to demonstrate that the rehabilitation targets are is being achieved; *(g) include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the site, and for triggering remedial action (if necessary);* *(h) describe the measures that would be implemented to ensure compliance with the relevant conditions of this consent, and address all aspects of rehabilitation including mine closure, final landform (including final voids), final land uses and water management in the final landform;* *(i) include procedures for the use of interim stabilisation and temporary vegetation strategies, where reasonable and feasible to minimise the area exposed for dust generation;* *(j) include a program to monitor, independently audit and report on the effectiveness of the measures in paragraph (h) above, and progress against the detailed performance and completion criteria in paragraph (g) above (at a minimum these reporting requirements must be included as part of the annual review referred to in condition 5 of Schedule 5); and* *(k) build on and integrate with the other management plans required under this consent. The Applicant must implement the approved Rehabilitation Management Plan as approved from time to time to the satisfaction of DRG.*	
Groundwater		
16.	**Monitoring** Ongoing quarterly monitoring of the onsite piezometer network and monthly surface water monitoring would continue to be implemented to monitor the drawdown effects from depressurisation of the regional aquifer. The installation of additional monitoring points would be considered where areas of predicted drawdown are significantly different to that of actual drawdown. The frequency of water level measurements within the pit should be compatible with evaporation rates obtained from the site's weather station which will allow refinement of model calibration and inflow predictions.	Duration of the project
17.	**Management** Bloomfield has an existing Water Management Plan (WMP) which details the monitoring and management measures which are currently in place for the management of groundwater (and surface water) at the Colliery. The WMP would be reviewed and updated in accordance with the conditions of consent to monitor groundwater levels in monitoring wells and in the pit. Groundwater discharge would be monitored to quantify pit inflows to ensure the discharge licence conditions are satisfied. The monitoring data collected from groundwater and surface water systems enables management of groundwater by: • Establishment of groundwater and surface water trigger levels based on the beneficial use of each water body; • Development of mitigation measures which may include the provision of 'make good' measures in bores where	Duration of the project

Ref#	Management and Mitigation Measures	Timing
	excessive drawdown may be experienced. This could involve deepening a water supply bore or providing an alternative water supply. No surface water mitigation measures are proposed due to the minimal predicted impacts; • Plotting of groundwater level data as hydrographs and comparing to rainfall; and • Collation of the results of the groundwater monitoring program on an annual basis and presenting in an annual report as required under the conditions of consent.	
Visual Impacts and Rehabilitation		
18.	The Colliery has established rehabilitation and monitoring procedures as part of its RMP and MOP for the site. These rehabilitation methods would continue to be implemented for the duration of the project. Geotechnical investigations would be conducted by qualified geotechnical specialists to guide the tailings emplacement strategy and capping requirements and management strategies recommended would be implemented for the project. Existing management plans and procedures, including the RMP and MOP, would be updated to reflect the project as required. Any changes to the final landform would be subject to discussion with the relevant agencies (including DRG).	Duration of the project
Social and Economic		
19.	Bloomfield currently undertakes a number of monitoring, management and mitigation activities in relation to identified community concerns, which include noise, blasting and air quality monitoring; rehabilitation of land to minimise visual impact; manning of a 24 hour community hotline; and regular meetings of the CCC. It also contributes to wider community needs through the Bloomfield Foundation and other programs. These programs and protocols would continue to be implemented throughout the life of the project which would ensure that social amenity impacts are minimal and community benefit is maximised. No additional mitigation measures related to social and economic impacts would be required for the project.	Duration of the project
Aboriginal and Historic Heritage		
20.	Existing management measures would adequately manage potential impacts to Aboriginal heritage items. Mining operations would continue to be undertaken in accordance with the approved ACHMP and relevant legislative requirements. Bloomfield would continue to consult with the Aboriginal community groups and regulatory authorities as per the procedures set out the ACHMP. Blast monitoring would continue to be conducted to confirm that airblast and ground vibration levels meet relevant blasting criteria. The existing EMS and relevant management plans would be updated to incorporate the project.	Duration of the project
21.	*A condition survey is to be undertaken of the Buttai No. 1 reservoir and No. 2 reservoir. The reservoirs' condition is to be monitored for the life of the mine. Any mine induced damage is to be carefully repaired following best conservation practice and as advised by Hunter Water's heritage specialist.*	Within two months following determination.

Ref#	Management and Mitigation Measures	Timing
22.	*Bloomfield will undertake a condition survey of the Buttai Cemetery (Wilfred Elliott Private Cemetery) and its contents. Any mine induced damage should be mitigated. A conservation management plan should also be prepared for the cemetery in accordance with Heritage Council of NSW guidelines*	Within two months following determination.
23.	*The approved Aboriginal Cultural Heritage Management Plan (27 May 2010) for the Bloomfield Colliery be revised and updated to reflect Modification 4 (MP 07_0087 MOD 4).*	Prior to the project.
Hazard and Risk		
24.	Hazards and risks would continue to be managed through implementation of the existing mine management framework: • The storage of hazardous goods would continue to be managed under the existing management procedures; • The Colliery would continue to undertake hazard reduction burns in accordance with existing procedures and in consultation with the RFS to manage fuels load; • The potential impacts of contamination to the receiving environment would be mitigated through the continued implementation of existing plant maintenance schedules, management systems and protocols; • Incidents and emergencies would continue to be managed in accordance with the Bloomfield Incident Management System, the Bloomfield Mining Operations Incident Notification Procedure and the relevant Hazard Management System; • Monitoring for spontaneous combustion would continue to be undertaken as part of routine mine inspections; and • Existing procedures for monitoring, remediation and rehabilitation of subsidence would continue to be implemented where required.	Duration of the project
Waste		
25.	Current waste management practices would continue to be implemented for the project.	Duration of the project

5.0 Conclusion

Having fully considered the comments and issues raised in all submissions, the project management measures have been amended to accommodate those additional management measures recommended by government agencies or as otherwise required to address matters raised by submissions.

Having suitably addressed matters raised in all submissions, it is considered that the project assessment can now be finalised and a determination made accordingly.

Appendix A

Submissions

Appendix A Submissions

NSW GOVERNMENT | Dams Safety Committee

21 February, 2018

Jack Murphy
Environmental Assessment Officer
Resource Assessments | Planning Services
GPO Box 39
SYDNEY NSW 2001

Our ref: .10.121.046

Your ref: MP 07_0087 MOD 4

Dear Jack,

RE: Bloomfield Colliery Life of Mine Extension – Modification 4 (MP 07_0087 MOD 4)

The Dams Safety Committee (DSC) has read the Environmental Assessment Report for Bloomfield Colliery (MP 07_0087_MOD 4) Modification 4 for the:

- Extension of existing open cut mining operations for an additional nine years until 31 December 2030;
- Continuation of mining within approved extraction areas at existing production limits of up to 1.3 million tonnes per annum of run-of-mine coal; and
- Modification of the previously approved final landform, including moving the final void approximately 200 metres to the west.

The proposed development does not impact any prescribed dams or dam Notification Areas, therefore the Dams Safety Committee has no concerns with the development application as proposed.

However the option to build embankments, within the open cut between an area of tailings emplacement and where open cut operations are occurring, was discussed. Should this option be adopted, details of the embankment and the consequence if it failed should be submitted to the Dams Safety Committee for a decision on whether to prescribe the dam.

To discuss this situation further would you please contact William Ziegler the Manager Mining Projects at the Dams Safety Committee, on 04 9842 08077 or at bill.ziegler@damsafety.nsw.gov.au.

Yours faithfully,

C. Salkovic
Executive Engineer
Dams Safety Committee

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Postal: NSW Dams Safety Committee
Locked Bag 5123
Parramatta NSW 2124
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Address: Level 11
10 Valentine Avenue
Parramatta NSW
2150

Phone: (02) 9842 8073
http: www.damsafety.nsw.gov.au
email: dsc@damsafety.nsw.gov.au

DSC
ABN 55 079 703 705

Department of Industry

OUT18/1980

Mr Jack Murphy
Resource Assessments
NSW Department of Planning and Environment

jack.murphy@planning.nsw.gov.au

Dear Mr Murphy

**Bloomfield Colliery Life of Mine Extension - Modification 4 (MP 07_0087 MOD 4)
Comment on the Environmental Assessment**

I refer to the email of 1 February 2018 to the Department of Industry in respect to the above matter. Comment has been sought from relevant branches of Lands & Water and Department of Primary Industries.

Any further referrals to Department of Industry can be sent by email to landuse.enquiries@dpi.nsw.gov.au.

The department has reviewed the environmental assessment and provides the following recommendations for consideration in assessment of the proposal.

Recommendations

- Due to the final void being proposed in a different location, the proponent is requested to undertake an assessment of impacts to High Priority Groundwater Dependent Ecosystems (GDEs) as listed under the Water Sharing Plan for the North Coast Fractured and Porous Rock 2016, and High Priority GDEs as listed under the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009 that occur in proximity to the site.
- The proponent should also submit the independent review of the groundwater model as required under the AIP (2012).
- The proponent should confirm proposed licensing arrangements for the projected take of 26 ML/yr from the Wallis Creek Water Source and 8 ML/yr from the Newcastle Water Source, given Bloomfield Colliery does not hold licences for this take from these water sources. Given the alluvial aquifer system within the Newcastle Water Source does not form part of the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources, the proponent would need to obtain entitlement under the *Water Act 1912.*

Yours sincerely

Alison Collaros

Alison Collaros
A/Manager, Assessment Advice
9 March 2018

OUT18/3473

Jack Murphy
Environmental Assessment officer
Resource Assessments - Planning Services
Department of Planning & Environment
GPO Box 39
SYDNEY NSW 2001

Jack.Murphy@planning.nsw.gov.au

Dear Jack

Bloomfield Colliery Life of Mine Extension - Modification 4 (MP 07_0087 MOD 4) Environmental Assessment

I refer to your email dated 1 February 2018 inviting the Division of Resources & Geoscience (the Division) to provide comments on the Bloomfield Colliery Life of Mine Extension Modification 4 (the Project) Environmental Assessment (EA) submitted by Bloomfield Collieries Pty Ltd (the Proponent).

The Division has reviewed the adequacy of information supplied in relation to the abovementioned Project and provides the following advice:

The Division has undertaken a Resource and Economic Assessment of the Project, details of which can be found **in Addendum A**. Also provided are recommended inclusions for the conditions of consent if the project is approved (**Addendum B**).

The Division however, has identified inadequacies with respect to the Secretary's Environmental Assessment Requirements for Rehabilitation in the Environmental Assessment for the Project, dated 17 January 2018.

Additional information is required to demonstrate that sustainable rehabilitation outcomes can be achieved as a result of the Project. The required additional information is as follows:

i. Further specific detail regarding the post mining land use and domains, should no future residential/mixed use/industrial land uses as described within the Environmental Assessment be approved by future development applications;

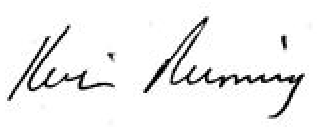
ii. Rehabilitation objectives and completion criteria that clearly define the outcomes required to achieve the post mining land use for each domain identified in requirement (i).

It should be noted that this review does not represent the Division's endorsement of the proposed rehabilitation methodologies as presented in the EA. Under the conditions of a mining authority granted under the Mining Act 1992, the Division requires an authority holder to adopt a risk-based approach to achieving the required rehabilitation outcomes. The applicability of the controls to achieve effective and sustainable rehabilitation is to be determined based on the site specific risk assessments conducted by an authority holder. This risk assessment should be used to not only establish a basis for managing risk when planning an activity, but it should also be used and updated (as required) to continuously evaluate risk and the effectiveness of controls used to prevent or minimise impacts. An authority holder may also be directed by the Division to implement further measures, where it is considered that a risk assessment and associated controls are unlikely to result in effective rehabilitation outcomes.

The Division requires a review of the draft development consent conditions prior to finalisation and any granting of development consent. This will assist in ensuring rehabilitation objectives are met and the conditions of any relevant Mining Lease, either existing or where a new lease is required, are substantially consistent with the consent.

Further enquiries regarding this matter please contact:
Adam Banister, Senior Advisor (Resources Development & Operations)
(02) 4931 6439 or industry.coordination@industry.nsw.gov.au

Yours sincerely



Kevin Ruming
Director Strategic Release Assessment and Advice
5 March 2018

INT18/7545

Addendum A

Resource and Economic Assessment – Bloomfield Life of Mine Extension (Modification 4)

Introduction

State significant development is regulated under the Environmental Planning and Assessment Act 1979 and requires a proponent to apply to the Department of Planning and Environment for development consent, supported by an Environmental Assessment (EA).

This Resource and Economic Assessment conducted for the Bloomfield Life of Mine Extension Modification 4 (the Modification or Project) by the Division of Resources and Geoscience (the Division) is designed to:

1. review the resource/reserve estimates stated in a proponent's Environmental Assessment
2. assess whether the Modification will deliver significant social and economic benefits to NSW from the efficient development of the resource and that resource recovery is optimised and waste minimised
3. estimate the royalty and export revenue to be generated over the life of the Modification.

The objects of the *Mining Act 1992* are to encourage and facilitate the discovery and efficient development of coal resources in NSW. Of particular relevance to this resource assessment are:

Section 3A Objects:

(a) to recognise and foster the significant social and economic benefits to New South Wales that result from the efficient development of coal resources, and

(d) to ensure an appropriate return to the State from mineral resources.

The relevant section of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 is Part 3, Clause 15: Resource Recovery requires that resource recovery is efficient, optimised and minimises waste.

The Project
The Project is operated by Bloomfield Collieries Pty Ltd (Bloomfield) and owned by the Bloomfield Group which is an Australian owned and operated group of private companies with interests in mining and engineering in the Hunter Valley of NSW.

The Project, if approved, will extend the life of the currently operating Bloomfield open cut coal mine by five years, until 2024. The Bloomfield open cut has been operating for many decades in the lower Hunter Valley and is one of the oldest continually operating mines in the Hunter Valley. The Bloomfield mine produced around 1.1 million tonnes of ROM coal in 2016-17. It is a small open cut mine in comparison to the majority of open cut coal mines in NSW. Product coal from the Bloomfield mine is railed to the Port of Newcastle where some blending occurs with product from the Rixs Creek mine which is also owned by the Bloomfield Group prior to export.

Size and quality of the resource
The Division has verified that the Project will provide approximately 4.8 million tonnes (Mt) of Run-of-Mine (ROM) coal and approximately 2.9Mt of product coal. The Proponent has completed the coal resource and reserve estimations for the Project in accordance with the *Australasian Code for Reporting Exploration results, Mineral Resources and Ore Reserves* (JORC Code). The JORC Code is an industry-standard professional code of practice that sets minimum standards for public reporting of minerals exploration results, mineral resources and ore reserves.

The Project will be a continuation of open cut coal mining at Bloomfield and will utilise existing surface operations and mine infrastructure (rail loop and coal handling and preparation plant). The Project would add five years to the mine life at Bloomfield. There is no proposed change to the approved maximum production rate of 1.3Mtpa of ROM coal.

There is a long history of mining the Tomago coal measures at Bloomfield using open cut extraction techniques. The seam sequence typically produces medium to high ash, high sulphur content coal product. Bloomfield expects the majority of product to be sold into export thermal coal markets, with a small percentage (approximately 10%) to be sold into metallurgical export markets. Bloomfield has long standing thermal and semi-soft coking coal contracts with customers in Asian markets.

A review of available coal quality information suggests the proposed product quality, market split and yield is achievable. ROM coal will be processed at the existing coal handling and preparation plant to improve product characteristics for export markets.

The Division considers that 2.9Mt of product (saleable) coal from the Project is feasible.

Resource Recovery
Many factors constrain the mine plan, extraction methodology and therefore the resource recovery at the Project. These include geological features, mining conditions and equipment constraints. Areas of high strip ratio are the primary constraint to pit design, however the pit design facilitates maximising coal recovery within economic limits.

The Proponent is transitioning to the use of smaller excavators that allows for the increased recovery of thin coal seams whilst limiting mining loss and dilution. All coal seams that can be extracted within the equipment constraints will be recovered.

Given the constraints outlined in the proponent's EIS, the Strategic Resource Assessment & Advice unit in the Division considers the Project mine plan for open cut mining operations to adequately recover coal resources and provide an appropriate return to the State, within the mine footprint, giving due consideration to the particular constraints of the location.

Economic benefits of the resource
Over the life of the Project, assuming production is sold on the export thermal market, the value of the coal produced would be nearly $300 million in current dollars. The net present value of this revenue stream has been estimated by the Division at approximately $218 million.

Export income is vital for the health of both the NSW and Australian economy. This income contributes to the Nation's balance of trade which provides benefits to both the NSW and Australian credit rating. This additional export income will contribute to significant coal export revenue ($18.2 billion 2016-17) generated from coal exports annually. Coal exports are the largest value export from NSW, representing around 40% of total NSW exports (both goods and services combined).

The modification if approved would not provide any additional employment at Bloomfield, however it would provide the existing 70+ employees with ongoing employment for another five years. There will be no additional capital investment as a result of this Modification.

Coal royalty calculation
A royalty rate of 8.2% applies to all saleable production and this rate is applicable to the net disposal value. Net disposal value is the price received per tonne minus any allowable deductions. The main allowable deduction is for coal processing which is

either $3.50 per tonne for coal subjected to a full washing cycle, or $2.00 per tonne for coal subjected to a simple washing process, or $0.50 per tonne for coal that is washed and screened.

All ROM coal from the Bloomfield mine is subject to the full washing process therefore a deduction of $3.50 per tonne from the value of coal produced applies. A deduction for levies also applies which amounts to less than $1.00 per tonne. The total allowable deductions for royalty for the Modification would amount to $4.50 per tonne.

One of the most important assumptions in the calculation of future Royalty for a coal proposal is the estimate of a future coal price over the life of a project. Coal from the Project is expected to be sold mainly into the export thermal market with a small percentage (usually less than 10%) sold into the export metallurgical market. A review of coal quality information by the Division suggests this is achievable. Some blending of coal from Bloomfield takes places with coal from the Rix’s Creek operation also owned by the Bloomfield Group. Blending is required at the port with coal from the Bloomfield Group’s Rix’s Creek operation near Singleton for the Asian export market. The Rix’s Creek coal is generally of a better quality, but blending with the Bloomfield Mine coal enables the company to meet the required specifications and also prolongs the life of the Rix’s Creek Mine.

Coal price forecasting is inherently difficult and over the project life there will likely be variations in coal prices. As this Modification is for five year life these variations are potentially not as great as with longer term projects. Average prices of between A$90 and A$110 per tonne for the thermal coal from the Project have been used by the Division. Marginally higher prices were estimated for the small percentage of metallurgical coal to be sold from the Modification.

Another important aspect of future royalty calculation for a proposed coal project is estimation of future annual production. The Division has estimated that if the Modification is approved, around 2.9 million tonnes of additional product coal would be able to be mined from the Modification.

Using the above parameters the Division has calculated that in a typical full production year the State will receive around $5 million per annum of additional royalty and $23 million over the life of the Modification. The net present value of this royalty stream would be around $17 million using a 7% real discount rate.

Addendum B

RECOMMENDED CONDITIONS OF APPROVAL

Rehabilitation Objectives and Commitments

The Proponent must rehabilitate the site to the satisfaction of DRG. This rehabilitation must be generally consistent with the proposed rehabilitation activities described in the documents listed in condition 2 of Schedule 2 and comply with the objectives in Table X. [*Note: DPE to insert relevant references in the Consent]*

Table X Rehabilitation Objectives

Rehabilitation Feature	**Objective**
Mine site (as a whole of the disturbed land and water)	• Safe, stable and non-polluting, fit for the purpose of the intended post-mining land use(s). • Final landforms (including final voids) to integrate with surrounding natural landforms. • Constructed landforms maximise surface water drainage to the natural environment (excluding final void catchments). • Minimise long term groundwater seepage zones. • Minimise visual impact of final landforms as far as is reasonable and feasible. • Final landforms designed in consideration of water licensing requirements, as calculated through consultation with DPI Water.
Final voids	• Designed as to ensure sufficient freeboard at all times to minimise the risk of discharge to surface waters. • Minimise to the greatest extent practicable: - The size and depth of final voids; - The drainage catchment of final voids; - Any high wall instability risk; and - The risk of flood interaction for all flood events up to and including the Probable Maximum Flood.
Rehabilitation materials	Materials (including topsoils, substrates and seeds of the disturbed areas) are recovered, appropriately managed and used effectively as resources in the rehabilitation.
Surface Infrastructure	• To be decommissioned and removed, unless DRG agrees otherwise.
Water Quality	Water retained on site is fit for the intended land use(s) for the post-mining domain(s). Water discharged from site is consistent with the baseline ecological, hydrological and geomorphic conditions of the creeks prior to mining disturbance. Water management is consistent with the regional catchment management strategy.
Community	• Ensure public safety. • Minimise the adverse socio-economic effected associated with mine closure.

Progressive Rehabilitation

The Proponent must rehabilitate the site progressively as soon as reasonably practicable following disturbance. All reasonable and feasible measures must be taken to minimise the total area exposed for dust generation at any time. Interim stabilisation and temporary vegetation strategies must be employed when areas prone to dust generation cannot be permanently rehabilitated.

Note: It is accepted that some parts of the site that are progressively rehabilitated may be subject to further disturbance at some later stage of the development.

Rehabilitation Management Plan

The Proponent must prepare a Rehabilitation Management Plan for the project to the satisfaction of the Division. This plan must:

(a) be prepared in consultation with the Department, DPI Water, OEH, DPI, Council and the CCC, and submitted to DRG for approval prior to the commencement of mining operations under this consent, unless the Secretary agrees otherwise;
(b) be prepared in accordance with any relevant DRG guideline;
(c) describe how the rehabilitation of the site would achieve the objectives identified in *Table X,* the outcomes described in the Rehabilitation Strategy in *condition X* and be integrated with the Biodiversity Offset Strategy described in *condition X*;
(d) include a detailed Tailings Management Plan for the development;
(e) include a detailed soil and growing medium balance for the development;
(f) include a detailed plan for the reinstatement and review of the proposed:

- agricultural land capability of grassland areas in the final landform, including a protocol for periodic trials to demonstrate that the land capability is being achieved; and
- rehabilitated woodland areas and fauna habitat, including a protocol for periodic trials to demonstrate that the target vegetation community is being achieved;

(g) include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the site, and for triggering remedial action (if necessary);
(h) describe the measures that would be implemented to ensure compliance with the relevant conditions of this consent, and address all aspects of rehabilitation including mine closure, final landform (including final voids), final land uses and water management in the final landform;
(i) include procedures for the use of interim stabilisation and temporary vegetation strategies, where reasonable and feasible to minimise the area exposed for dust generation;
(j) include a program to monitor, independently audit and report on the effectiveness of the measures in paragraph (h) above, and progress against the detailed performance and completion criteria in paragraph (g) above (at a minimum these reporting requirements must be included as part of the annual review referred to in condition 5 of Schedule 5); and
(k) build on and integrate with the other management plans required under this consent. The Applicant must implement the approved Rehabilitation Management Plan as approved from time to time to the satisfaction of DRG.

NSW EPA

DOC18/57201-02 ; EF13/2650

Department of Planning and Environment
GPO Box 39
SYDNEY NSW 2001

Attention: Mr Jack Murphy

By email: jack.murphy@planning.nsw.gov.au

28 February 2018

Dear Mr Murphy

Proposed Modification to Bloomfield Colliery Life of Mine Extension, Modification 4 (MP 07_0087 MOD 4) – Comments from the Environment Protection Authority (EPA)

I refer to your email to the Environment Protection Authority (EPA) received 01 February 2018, seeking comments in relation to the Bloomfield Collieries Pty Limited modification application for the Bloomfield Colliery Life of Mine Extension, located within the Cessnock City Council and Maitland City Council local government areas. The modification is seeking to extend the existing open cut mining operations for an additional nine years until 31 December 2030; continue mining within approved extraction areas at existing production limits of up to 1.3 million tonnes per annum of run-of-mine coal; and modify the previously approved final landform, including moving the final void approximately 200 metres to the west.

The EPA has reviewed the Environmental Assessment provided with the application and does not have any issue or comments to provide in relation to the proposal. The EPA considers that the project is not expected to result in any significant increases in the existing environmental impact. The project is not seeking changes to the intensity or general extent of mining, or any changes in the mining equipment fleet or mining method.

If you require any further information regarding this matter please contact Genevieve Lorang on (02) 4908 6809.

Yours Sincerely

MICHAEL HOWAT
A/Head Strategic Programs Unit – Hunter Region
Environment Protection Authority

Contact Officer: GENEVIEVE LORANG
(02) 4908 6869
hunter.region@epa.nsw.gov.au

Heritage Council of New South Wales

Level 6, 10 Valentine Avenue
Parramatta NSW 2150
Locked Bag 5020
Parramatta NSW 2124

Telephone: 61 2 9873 8500
Facsimile: 61 2 9873 8599
heritagemailbox@environment.nsw.gov.au
www.heritage.nsw.gov.au

File No: SF18/13948
Ref No: DOC18/56155

Jack Murphy
Environmental Assessment Officer
Resource Assessments | Planning Services
GPO Box 39
SYDNEY NSW 2001

Sent by e-mail to: jack.murphy@planning.nsw.gov.au

Dear Mr Murphy

Bloomfield Colliery Life of Mine Extension - Modification 4 (MP 07_0087 MOD 4)

Thank you for the invitation on 1 February 2018 for the Heritage Council of NSW to comment on the environmental assessment of Modification 4, Life of Mine Extension, of the State Significant Development at Bloomfield Colliery (MP 07_0087 MOD 4).

Modification 4 involves

- An extension of the existing open cut mining operations for an additional nine years until 31 December 2030;
- Continuation of mining within approved extraction areas at existing production limits of up to 1.3 million tonnes per annum of run-of-mine coal; and
- Modification of the previously approved final landform, including moving the final void approximately 200 metres to the west.

The Heritage Council of NSW was not invited to commented on the Secretary's Environmental Assessment Requirements, the environmental assessment of the original proposal determined 3 September 2009 or the subsequent modifications 1 to 3.

The following documents were reviewed:

- AECOM - Environmental Assessment – Bloomfield Colliery - Life of Mine Extension, Modification 4, Revision 0, 17 Jan 2018
- Appendix I – Heritage Searches

The 2008 environmental assessment did not list heritage items within the Project Area. However, the AECOM assessment for Modification 4 advises that there are three locally significant heritage items near the project area:

- The Buttai Cemetery (Wilfred Elliott Private Cemetery) is listed on the Cessnock Local Environmental Plan (CLEP) 2011 and
- Buttai Reservoir No. 1 and No. 2 are on the Hunter Water Corporation S170 Heritage and Conservation Register. The Hunter Water S170 Register advises that Buttai Reservoir No 1 (1880) is of state significance as it is the oldest operating reservoir within the Hunter Water system. Reservoir 2 (1920s) is of local significance.

The AECOM assessment for Modification 4 advises that there will be no impact on the reservoirs and any vibration impact on the historic cemetery will diminish as mining moves north away from the cemetery.

However, as Modification 4 involves extraction from deeper coal seams and extraction is moving north closer to the reservoirs, the likelihood of an adverse impact will increase in the future. Furthermore, as Buttai Reservoir No. 1 comprises vaulted brick and stone and Reservoir No. 2 comprises early C20th concrete, both may be affected by increased blasting and vibration. As modification proposes lengthening the life of the mine, it is opportune to evaluate if there was any impact of the operation to date on the Buttai Cemetery which is situated on the southern boundary of the mine.

Considering the above information, the following conditions are recommended to be included in any approval of Modification 4.

1. **A condition survey is to be undertaken of the Buttai No. 1 reservoir and No. 2 reservoir within two months of any determination of Modification 4. The reservoirs' condition is to be monitored for the life of the mine. Any damage is to be carefully repaired following best conservation practice and as advised by Hunter Water's heritage specialist.**

2. **The condition of the Buttai Cemetery (Wilfred Elliott Private Cemetery) and its contents, any memorials headstones, graves, fences and trees should be surveyed within two months of any determination of Modification 4. Any damage should be mitigated. A conservation management plan should also be prepared for the cemetery in accordance with Heritage Council of NSW guidelines, refer** www.environment.nsw.gov.au/Heritage/conservation/managementplan.htm

Any comments on Biodiversity and Aboriginal archaeological under National Parks and Wildlife Act 1974 will be provided by the Regional Operations Division, Northern Region of the Office of Environment and Heritage.

If you have any questions regarding the above matter, please contact Ed Beebe, Senior Heritage Assessment Officer, at the Heritage Division, Office of Environment and Heritage on telephone (02) 9585 6045 or at ed.beebe@environment.nsw.gov.au.

Yours sincerely

26/02/2018

Katrina Stankowski
Acting / Senior Team Leader Heritage Assessment North
Heritage Division
Office of Environment & Heritage

As Delegate of the Heritage Council of NSW

Hunter Environment Lobby Inc.

PO Box 188
East Maitland NSW 2323
2nd March 2018

Bloomfield Colliery Life of Mine Extension – Mod 4

Submission of Objection

Hunter Environment Lobby Inc.(HEL) is a regional community-based environmental organization that has been active for well over 25 years on the issues of environmental degradation, species and habitat loss, and climate change.

HEL has commented on and objected to many of the existing and further modifications to coal mines in the Hunter for the time we have existed, most of these objections relating to environmental factors.

Factors such as biodiversity impacts, loss of habitat and remnant vegetation, impacts on loss and quality of groundwater, air quality impacts on communities in the Hunter, and noise impacts on adjacent communities – have all figured in our objections, and do so today in our objection to this development modification at Bloomfield.

HEL has also recently, in the last ten years or so, objected to coal developments or expanding of modifications or mining timeframes on the grounds of increasing Green House Gas Emissions (GHGE) into the atmosphere both here in Australia in the case of fugitive emissions or overseas where the coal is burnt to achieve power generation.

Any increase in Australia's GHGE whether occurring here or overseas over the period of mining will threaten Australia's ability to meet the Paris Agreement.

HEL has some concerns it wishes to raise here in our objection today and we also ask that we may make further comments following the close of this development as we are in consultation with experts who have had many mining related issues ahead of this development and we await their comments. Please see this as a request and reply accordingly?

I bring to your notice at the moment the issue of the SEAR's which rings alarm bells on examination, especially in the communications between the Bloomfield Group and the Planning Department in November 2015.

We wish to follow the issues to see the resolution and reporting, and we find that our time to object is running out, we would like to put that issue on the agenda in our next correspondence with you?

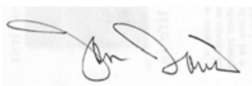
The issues which alarm us the most at this juncture are:-

The Pre-Clearance Surveys;

Biodiversity Impacts;
The slated removal of the rehabilitated water-course;
Impacts on Ground Water;
The Final Void strategy;
Increase in dust emissions adding to cumulative impacts already in the Hunter.

HEL will contact you to add to our short objection with more detail in the coming fortnight, we hope that meets with your timeframe.

Sincerely Yours



Jan Davis
President Hunter Environment Lobby Inc.

Hunter New England Local Health District
Hunter New England Population Health
Direct Contact Details
Phone: (02) 4924 6477 Fax: (02) 4924 6490
Email: Nichole.mason@hnehealth.nsw.gov.au

NSW GOVERNMENT | Health
Hunter New England
Local Health District

01 March 2018

Jack Murphy
Environmental Assessment Officer
NSW Planning & Environment
GPO Box 39
SYDNEY NSW 2001

Dear Mr Murphy

BLOOMFIELD COLLIERY LIFE OF MINE EXTENSION – MODIFICATION 4 (MP 07_0087 MOD 4)

I refer to the Environmental Assessment (EA) exhibited on the NSW Planning & Environment website in relation to the Bloomfield Colliery Life of Mine Extension.

Bloomfield Colliery is an existing open cut mine located approximately 20 km north-west of Newcastle. The modification involves: extending mining operations for an additional nine years until 2030 and moving the previously approved final landform 200 metres to the west.

The EA has been reviewed by Hunter New England Population Health (HNEPH) with particular attention being paid to the management of air quality, noise, water and other issues that may impact on public health. The EA indicates that all of the proposed modifications are within the approved project boundary and there are no changes to the existing mining methods or extraction area.

As there is no evidence of a threshold below which exposure to particulate matter (PM) is not associated with health effects, it is important that all reasonable and feasible measures are taken to minimise human exposure to PM, even where assessment criteria are met.

Should you require any additional information in relation to the above, please telephone Ms Nichole Mason, Environmental Health Officer on 4924 6477.

Yours sincerely

Professor David Durrheim
Director - Health Protection
Hunter New England Population Health

Hunter New England Local Health District
ABN 63 598 010 203

Hunter New England Population Health
Locked Bag 10
Wallsend NSW 2287
Phone (02) 4924 6477 Fax (02) 4924 6490
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KINGS ENGINEERING

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NSW 2845 AUSTRALIA
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9th February 2018

Letter of Support for Bloomfield Colliery Modification 4

PWG King and Sons (Kings Engineering) has been operating in Maitland for over 90 years and works closely with the Hunter Valley Coal Industry and particularly Bloomfield Mine.

Bloomfield Mine is a significant contributor to our revenue in a time when the manufacturing industry is under heavy pressure to survive and maintain Australian jobs. Our workforce of seventy one requires mines like Bloomfield to remain open providing work to ensure our business is viable now and into the future.

Without the ongoing support from Bloomfield Mine Kings Engineering business would not be able to maintain the level of employment we currently have after reducing our employees from ninety three years ago.

Kings Engineering supports the Bloomfield Colliery Modification 4 and ask that you look favourably on approving the Modification.

Genuinely

KINGS ENGINEERING
Paul Sawyer
General Manager

57 Gardiner St RUTHERFORD NSW 2320
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DOC18/56565
MP 07_0087 MOD 4

Mr Jack Murphy
Environmental Assessment Officer – Resource Assessments
Department of Planning & Environment
jack.murphy@planning.nsw.gov.au

Dear Jack

OEH Review of Environmental Assessment: Bloomfield Colliery Life of Mine Extension – Modification 4 (MP 07_0087 MOD 4) – Cessnock City Council LGA

I refer to your e-mail dated 1 February 2018, seeking comments on the Environmental Assessment (EA) for Modification 4 to the Bloomfield Colliery (MP 07_0087 MOD 4), near East Maitland, in the Cessnock City local government area. OEH has reviewed the relevant appendices and relevant parts of the document titled '*Environmental Assessment: Bloomfield Colliery – Life of Extension, MOD 4*' (prepared by AECOM Australia Pty Limited and dated 17 January 2018) in relation to Aboriginal cultural heritage, flood risk, and impacts on biodiversity.

OEH's recommendations are provided in **Attachment A** and detailed comments are provided in **Attachment B**. If you require any further information regarding this matter, please contact Steven Cox, Senior Team Leader Planning, on 4927 3140.

Yours sincerely

Sharon Molloy 5th March 2018

SHARON MOLLOY
Director Hunter Central Coast Branch
Regional Operations Division

5 March 2018

Contact officer: STEVEN COX
02 4927 3140

Enclosure: Attachments A and B

Locked Bag 1002 Dangar NSW 2309
Level 4, 26 Honeysuckle Drive Newcastle
NSW 2300
ABN 30 841 387 271
www.environment.nsw.gov.au

Attachment A

OEH's recommendations

Bloomfield Colliery Life of Mine Extension - Modification 4 (MP 07_0087 MOD 4)

1. OEH is satisfied with the biodiversity assessment provided and no further assessment is required.

2. OEH recommends that a condition of consent is included which requires the proponent to retire the credits listed in the credit profile in Appendix D, in accordance with the Framework for Biodiversity Assessment.

3. OEH is satisfied with the Aboriginal cultural heritage assessment and no further assessment is required.

4. OEH recommends that the approved Aboriginal Cultural Heritage Management Plan (27 May 2010) for the Bloomfield Colliery be revised and updated to reflect Modification 4 (MP 07_0087 MOD 4).

5. OEH recommends that a fit-for-purpose flood impact assessment be undertaken to quantify adverse off-site impacts. This assessment should identify potential off-site receivers by considering discharge points and distance to property boundaries.

Attachment B

OEH's detailed comments

Bloomfield Colliery Life of Mine Extension - Modification 4 (MP 07_0087 MOD 4)

Biodiversity

1. OEH is satisfied with the biodiversity assessment

The proposal will impact on approximately 3.5 hectares of vegetation for the purposes of widening a haul road, of which 3.2 hectares is described as non-native vegetation dominated by exotic grasses (predominantly *Chloris gayana*) and scattered regenerating shrubs and eucalypts (including *Corymbia*). This vegetation has been assessed as having a site value score of less than 17 and as such requires no further assessment or offsetting under the Framework for Biodiversity Assessment (FBA).

The remaining 0.3 hectares is described as native vegetation represented by two Plant Community Types (PCT): (i) PCT 1590 *Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest* (0.05 hectares) and (ii) PCT 1592 *Spotted Gum – Red Ironbark – Grey Gum – grassy open forest of the Lower Hunter* (0.29 hectares). OEH has reviewed the Biodiversity Assessment Report with respect to the impact to the above PCTs and is satisfied with the biodiversity assessment. The proposal requires the retirement of 10 'ecosystem credits' (as per 'Credit Profile' in Appendix D).

Recommendation 1

OEH is satisfied with the biodiversity assessment provided and no further assessment is required.

2. OEH recommends appropriate offsetting be incorporated into the conditions of consent

OEH notes that the proposal requires the retirement of 10 ecosystem credits, namely 1 credit equivalent to PCT 1590 and 9 credits equivalent to PCT 1592. The proponent has included a Biodiversity Offset Strategy (BOS, within Appendix D), which states these 10 credits will be retired via:

- purchase of 'like-for-like' credits from a registered biobanking / stewardship site
- purchase of credits under the variation rules from a registered biobanking / stewardship site, if 'like-for-like' cannot be achieved
- payment into the Biodiversity Conservation Trust or
- other suitable supplementary measures.

OEH is satisfied with the BOS and proposed offset mechanisms, given they are in accordance with the FBA. OEH recommends that DP&E include a condition of consent, if they approve the proposal, to retire 10 ecosystem credits in accordance with the FBA.

Recommendation 2

OEH recommends that a condition of consent is included which requires the proponent to retire the credits listed in the credit profile in Appendix D, in accordance with the Framework for Biodiversity Assessment.

Aboriginal Cultural Heritage

3. OEH is satisfied with the Aboriginal cultural heritage assessment provided

OEH considers that the existing Aboriginal cultural heritage management measures will continue to adequately manage potential impacts to Aboriginal heritage within the Bloomfield Colliery.

Recommendation 3

OEH is satisfied with the Aboriginal cultural heritage assessment and no further assessment is required.

4. The approved Heritage Management Plan should be updated

All mining operations will continue to be undertaken in accordance with the approved Aboriginal Cultural Heritage Management Plan (ACHMP), including ongoing and continuous consultation with the registered Aboriginal parties identified in the ACHMP. OEH also notes that blast monitoring will continue to be conducted to confirm that air blast and ground vibrations level meet the established criteria with respect to protecting and preserving Aboriginal cultural heritage within the mine complex.

Recommendation 4

OEH recommends that the approved Aboriginal Cultural Heritage Management Plan (27 May 2010) for the Bloomfield Colliery be revised and updated to reflect Modification 4 (MP 07_0087 MOD 4).

Flooding and Flood Risk

5. The planning proposal does not adequately address adverse off-site flood impacts

The planning proposal has the potential for adverse localised flooding impacts. The proposal seeks to modify the final landform such that the Buttai Creek catchment will increase in size by 41 hectares and Four Mile Creeks by 10 hectares. It is acknowledged that the proposed catchment area changes are small in the context of the wider catchments and are unlikely to have significant impacts on Wallis Creek's lower flood storage areas. However, they do have the potential to cause significant, adverse localised impacts on Buttai and Four Mile Creek.

OEH does not have adequate information to assess potential impacts. The surface water assessment provided (AECOM's, Jan 2018) does not address adverse off-site flooding impacts resulting from redistributing runoff into different catchments nor justify the diversion. The Buttai Creek catchment, which drains to Testers Hollow is a sensitive catchment with existing flooding issues. To assess this proposal, OEH requires the proponent to identify off-site receivers and to quantify the impacts.

Recommendation 5

OEH recommends that a fit-for-purpose flood impact assessment be undertaken to quantify adverse off-site impacts. This assessment should identify potential off-site receivers by considering discharge points and distance to property boundaries.

Planning Services
Resource Assessments & Compliance
Contact: Jack Murphy
Phone: 8217 2016
Email: jack.murphy@planning.nsw.gov.au

Mr Gary Bailey
General Manager of Mining Development
The Bloomfield Group
PO Box 4
EAST MAITLAND NSW 2323

Dear Mr Bailey

**Bloomfield Colliery Life of Mine Extension (MP 07_0087 MOD 4)
Modification 4**

The public exhibition of the Environmental Assessment (EA) for Modification 4 concluded on Friday 2 March 2018.

The Secretary requests that you prepare and submit a report detailing your responses to the issues raised in submissions, at your earliest convenience. The submissions can be viewed on the Department's website www.majorprojects.planning.nsw.gov.au.

In addition, the Department has identified several areas where further assessment or additional information is required (see **Attachment A**).

Please note that the Department expects further submissions in relation to the proposal. The Department will make these submissions available to you as soon as possible.

If you wish to discuss this matter, please contact Jack Murphy on 8217 2016.

Yours sincerely,

Howard Reed

Howard Reed 5·3·18
Director
Resource Assessments

Attachment A

1. Groundwater Quality

The Department notes that Groundwater pH is referred to as close to neutral in the EA. Please provide accurate pH values.

2. Air Quality

The Department notes that air quality modelling conducted as part of the EA showed there is potential for cumulative 24-hour average PM10 levels to exceed the NSW EPA impact assessment criteria. Please elaborate on the routine day-to-day reactive and predictive systems at Bloomfield Colliery that would prevent exceedances occurring.

3. Final Landform

The Department notes that in the event Abel Underground Mine remains in care and maintenance the final northern void will be "slightly larger". Please provide an estimate of the difference in size of the final northern void between scenario one and scenario two.

CR2018/000408
SF2018/034576
KML

01 March 2018

Department of Planning & Environment
Resource Assessments
GPO Box 39
SYDNEY NSW 2001

Attention: Jack Murphy

NEW ENGLAND HIGHWAY (A43): MP 07_0087, BLOOMFIELD COLLIERY LIFE OF MINE EXTENSION – MODIFICATION 4

Reference is made to Council's email dated 1 February 2017, regarding the abovementioned application which was referred to Roads and Maritime Services (Roads and Maritime) for comment.

Roads and Maritime understands the proposal to be for:

- the extension of the existing open cut mining for an additional nine years (until 31 December 2030) beyond the life of the existing consent;
- continuation of mining within approved extraction areas at existing production limits of up to 1.3 Mtpa of ROM coal;
- modification of the previously approved final landform, moving the final void approximately 200 metres to the west;
- maintain a workforce of 93 site personnel.

Roads and Maritime has reviewed the information provided including the Environmental Impact Assessment ('EIA') written by AECOM dated 17 January 2018. While Roads and Maritime acknowledges that all coal extracted from the site is to be transported via the existing rail network and the proposal will not generate any additional workforce traffic, it is noted that additional construction traffic will be generated to upgrade new haulage routes. Details on the expected timeframe for construction, number of vehicles and access from the network has not been identified in the EIA. Accordingly, Roads and Maritime recommends that a traffic and transport study shall be prepared in accordance with Austroads Guide to Traffic Management Part 12 and the Roads and Maritime's *Guide to Traffic Generating Developments 2002* and is to include (but not be limited to) the following:

- Assessment of all relevant vehicular traffic routes and intersections for access to / from the subject properties.

- Current traffic counts for all of the traffic routes and intersections.

- Identification of the anticipated additional vehicular traffic generated from both the construction and operational stages of the project.

- The distribution on the road network of the trips generated by the proposed development. It is requested that the predicted traffic flows are shown diagrammatically to a level of detail sufficient for easy interpretation.

- Consideration of the traffic impacts on existing and proposed intersections, in particular, the intersection of Four Mile Creek Road and the New England Highway, and the capacity of the local and classified road network to safely and efficiently cater for the additional vehicular traffic generated by the proposed development during both the construction and operational stages. The traffic impact shall also include the cumulative traffic impact of other proposed developments in the area.

- Identification of the necessary road network infrastructure upgrades that are required to maintain existing levels of service on both the local and classified road network for the development. In this regard, preliminary concept drawings shall be submitted with the EIS for any identified road infrastructure upgrades. However, it should be noted that any identified road infrastructure upgrades will need to be to the satisfaction of Roads and Maritime and Council.

- Traffic analysis of any major / relevant intersections impacted, using SIDRA or similar traffic model, including:

  - Current traffic counts and 10 year traffic growth projections

  - With and without development scenarios

  - 95th percentile back of queue lengths

  - Delays and level of service on all legs for the relevant intersections

  - Electronic data for Roads and Maritime review.

- Any other impacts on the regional and state road network including consideration of pedestrian, cyclist and public transport facilities and provision for service vehicles.

Should you require further information please contact Hunter Land Use on 4908 7688 or by emailing development.hunter@rms.nsw.gov.au.

Yours sincerely

Kylie-Anne Pont

Kylie-Anne Pont
A/Manager Land Use Assessment
Hunter Region

Subsidence Advisory NSW
NSW GOVERNMENT

99 Menangle Street, Picton NSW 2571
Tel 02 4677 1967 | www.subsidenceadvisory.nsw.gov.au
24 Hour Emergency Service: Free Call 1800 248 083
ABN 87 445 348 918

Jack Murphy
Environmental Assessment Officer
Resource Assessments | Planning Services
NSW Department of Planning and Environment
GPO Box 39
SYDNEY NSW 2001

Dear Mr Murphy

Bloomfield Colliery Life of Mine Extension - Modification 4 (MP 07_0087 MOD 4)

I refer to your email dated 1st February 2018 inviting comment in relation to the proposed modifications to the Bloomfield Colliery (MP 07_0087 MOD 4). Subsidence Advisory NSW (SA NSW) understands the application involves extension of the existing open cut mining operations for an additional nine years, continuation of mining within their approved extraction areas and modification of the previously approved final landform.

SA NSW has reviewed the Environmental Assessment prepared for this application and has no objection to the proposed modifications.

Yours sincerely

Matthew Montgomery
Infrastructure Manager, Subsidence Advisory NSW

21st February 2018

Appendix B

Schedule of Land

Appendix B Schedule of Land

Lot and Deposited Plan	Portion	Ownership
Lot 2 DP 456999	Part	Ashtonfields Pty Ltd
Lot 36 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 35 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 34 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 48 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 30 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 29 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 28 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 27 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 43 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 44 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 45 DP 755260	Part	Ashtonfields Pty Ltd
Lot 46 DP 755260	Part	Ashtonfields Pty Ltd
Lot 26 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 25 DP 755260	Whole	Ashtonfields Pty Ltd
Lot 24 DP 755260	Part	Ashtonfields Pty Ltd
Lot 23 DP 755260	Part	Ashtonfields Pty Ltd
Lot 18 DP 755237	Part	Ashtonfields Pty Ltd
Lot 19 DP 755237	Whole	Ashtonfields Pty Ltd
Lot 20 DP 755237	Whole	Ashtonfields Pty Ltd
Lot 23 DP 755237	Whole	Ashtonfields Pty Ltd
Lot 29 DP 755237	Part	Ashtonfields Pty Ltd
Lot 11 DP 755237	Part	Ashtonfields Pty Ltd
Lot 10 DP 755237	Part	Ashtonfields Pty Ltd
Lot 13 DP 241097	Part	Ashtonfields Pty Ltd
Lot 1 DP 136865	Part	Ashtonfields Pty Ltd
Lot 1 DP 1045722	Part	Ashtonfields Pty Ltd
Lot 2 DP 1045722	Part	Ashtonfields Pty Ltd
Lot 3 DP 1045720	Part	Ashtonfields Pty Ltd
Lot 31 DP 755237	Part	Ashtonfields Pty Ltd
Lot 4 DP 241097 (Pipeline)	Part	Hunter Water
Lot 5 DP 241097 (Pipeline)	Part	Hunter Water
Lot 1 DP 617909 (Pump station)	Part	Hunter Water
Lot 6 DP 241097 (Pipeline)	Part	Hunter Water
Lot 103 DP1131280 (pipeline)	Part	Hunter Water
Lot 104 DP1131098 (pipeline)	Part	Hunter Water
Lot 105 DP1131098 (pipeline)	Part	Hunter Water
Lot 1 DP 42349 (Road)	Part	Crown Road Reserve
Lot 1 DP 722210 (Road)	Part	Crown Road Reserve
Public Roads	Part	Cessnock City Council

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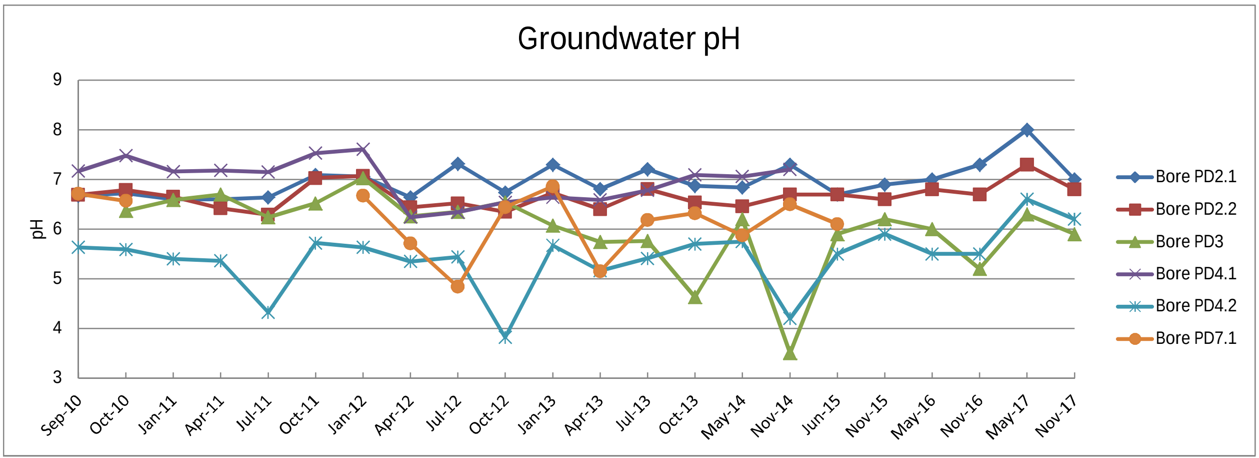
Appendix C

Groundwater pH Values

Appendix C Groundwater pH Values

Date	Bore PD2.1	Bore PD2.2	Bore PD3	Bore PD4.1	Bore PD4.2	Bore PD7.1	Bore PD8.1
Sep-10	6.67	6.69		7.17	5.63	6.71	
Oct-10	6.72	6.79	6.37	7.48	5.59	6.57	
Jan-11	6.6	6.65	6.59	7.16	5.4		
Apr-11	6.6	6.42	6.7	7.18	5.36		
Jul-11	6.64	6.29	6.24	7.15	4.32		
Oct-11	7.09	7.03	6.52	7.53	5.72		
Jan-12	7.06	7.07	7.03	7.61	5.63	6.67	
Apr-12	6.64	6.44	6.26	6.24	5.35	5.71	
Jul-12	7.32	6.52	6.35	6.34	5.44	4.84	
Oct-12	6.74	6.35	6.54	6.54	3.82	6.44	
Jan-13	7.3	6.73	6.07	6.64	5.67	6.86	
Apr-13	6.81	6.4	5.74	6.59	5.16	5.15	
Jul-13	7.21	6.81	5.76	6.78	5.41	6.18	
Oct-13	6.87	6.54	4.63	7.09	5.7	6.32	
May-14	6.84	6.46	6.2	7.06	5.75	5.87	
Nov-14	7.3	6.7	3.5	7.2	4.2	6.5	
Jun-15	6.7	6.7	5.9		5.5	6.1	
Nov-15	6.9	6.6	6.2		5.9		
May-16	7	6.8	6		5.5		
Nov-16	7.3	6.7	5.2		5.5		
May-17	8	7.3	6.3		6.6		
Nov-17	7	6.8	5.9		6.2		



Appendix D

Final Landform

Appendix D Final Landform

- Final landform with Abel Mine in care and maintenance.
- Final landform with Abel Mine resuming operation.

\Projects\60289290_RixCreek_Mine\4. Tech work area\4.7 Graphics\FIGURES\Bloomfield\RTS\60289290 F1 Proposed Final Landform - Abel Coal Mine in Care and Maintenance 23 04 2018 TO

AECOM

PROPOSED FINAL LANDFORM - ABEL COAL MINE IN CARE AND MAINTENANCE

Bloomfield Project

FIGURE 1

AECOM

PROPOSED FINAL LANDFORM - ABEL RESUMES OPERATION

Bloomfield Project

FIGURE 2

Appendix E

Flood Assessment

Appendix E Flood Assessment

DOC18/56565
MP 07_0087 MOD 4

Mr Jack Murphy
Environmental Assessment Officer – Resource Assessments
Department of Planning & Environment
jack.murphy@planning.nsw.gov.au

Dear Jack

OEH Review of Environmental Assessment: Bloomfield Colliery Life of Mine Extension – Modification 4 (MP 07_0087 MOD 4) – Cessnock City Council LGA

I refer to your e-mail dated 1 February 2018, seeking comments on the Environmental Assessment (EA) for Modification 4 to the Bloomfield Colliery (MP 07_0087 MOD 4), near East Maitland, in the Cessnock City local government area. OEH has reviewed the relevant appendices and relevant parts of the document titled '*Environmental Assessment: Bloomfield Colliery – Life of Extension, MOD 4*' (prepared by AECOM Australia Pty Limited and dated 17 January 2018) in relation to Aboriginal cultural heritage, flood risk, and impacts on biodiversity.

OEH's recommendations are provided in **Attachment A** and detailed comments are provided in **Attachment B**. If you require any further information regarding this matter, please contact Steven Cox, Senior Team Leader Planning, on 4927 3140.

Yours sincerely

Sharon Molloy 5th March 2018

SHARON MOLLOY
Director Hunter Central Coast Branch
Regional Operations Division

5 March 2018

Contact officer: STEVEN COX
02 4927 3140

Enclosure: Attachments A and B

Attachment A

OEH's recommendations

Bloomfield Colliery Life of Mine Extension - Modification 4 (MP 07_0087 MOD 4)

1. OEH is satisfied with the biodiversity assessment provided and no further assessment is required.

2. OEH recommends that a condition of consent is included which requires the proponent to retire the credits listed in the credit profile in Appendix D, in accordance with the Framework for Biodiversity Assessment.

3. OEH is satisfied with the Aboriginal cultural heritage assessment and no further assessment is required.

4. OEH recommends that the approved Aboriginal Cultural Heritage Management Plan (27 May 2010) for the Bloomfield Colliery be revised and updated to reflect Modification 4 (MP 07_0087 MOD 4).

5. OEH recommends that a fit-for-purpose flood impact assessment be undertaken to quantify adverse off-site impacts. This assessment should identify potential off-site receivers by considering discharge points and distance to property boundaries.

Attachment B

OEH's detailed comments

Bloomfield Colliery Life of Mine Extension - Modification 4 (MP 07_0087 MOD 4)

Biodiversity

1. OEH is satisfied with the biodiversity assessment

The proposal will impact on approximately 3.5 hectares of vegetation for the purposes of widening a haul road, of which 3.2 hectares is described as non-native vegetation dominated by exotic grasses (predominantly *Chloris gayana*) and scattered regenerating shrubs and eucalypts (including *Corymbia*). This vegetation has been assessed as having a site value score of less than 17 and as such requires no further assessment or offsetting under the Framework for Biodiversity Assessment (FBA).

The remaining 0.3 hectares is described as native vegetation represented by two Plant Community Types (PCT): (i) PCT 1590 *Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest* (0.05 hectares) and (ii) PCT 1592 *Spotted Gum – Red Ironbark – Grey Gum – grassy open forest of the Lower Hunter* (0.29 hectares). OEH has reviewed the Biodiversity Assessment Report with respect to the impact to the above PCTs and is satisfied with the biodiversity assessment. The proposal requires the retirement of 10 'ecosystem credits' (as per 'Credit Profile' in Appendix D).

Recommendation 1

OEH is satisfied with the biodiversity assessment provided and no further assessment is required.

2. OEH recommends appropriate offsetting be incorporated into the conditions of consent

OEH notes that the proposal requires the retirement of 10 ecosystem credits, namely 1 credit equivalent to PCT 1590 and 9 credits equivalent to PCT 1592. The proponent has included a Biodiversity Offset Strategy (BOS, within Appendix D), which states these 10 credits will be retired via:

- purchase of 'like-for-like' credits from a registered biobanking / stewardship site
- purchase of credits under the variation rules from a registered biobanking / stewardship site, if 'like-for-like' cannot be achieved
- payment into the Biodiversity Conservation Trust or
- other suitable supplementary measures.

OEH is satisfied with the BOS and proposed offset mechanisms, given they are in accordance with the FBA. OEH recommends that DP&E include a condition of consent, if they approve the proposal, to retire 10 ecosystem credits in accordance with the FBA.

Recommendation 2

OEH recommends that a condition of consent is included which requires the proponent to retire the credits listed in the credit profile in Appendix D, in accordance with the Framework for Biodiversity Assessment.

Aboriginal Cultural Heritage

3. OEH is satisfied with the Aboriginal cultural heritage assessment provided

OEH considers that the existing Aboriginal cultural heritage management measures will continue to adequately manage potential impacts to Aboriginal heritage within the Bloomfield Colliery.

Recommendation 3

OEH is satisfied with the Aboriginal cultural heritage assessment and no further assessment is required.

4. The approved Heritage Management Plan should be updated

All mining operations will continue to be undertaken in accordance with the approved Aboriginal Cultural Heritage Management Plan (ACHMP), including ongoing and continuous consultation with the registered Aboriginal parties identified in the ACHMP. OEH also notes that blast monitoring will continue to be conducted to confirm that air blast and ground vibrations level meet the established criteria with respect to protecting and preserving Aboriginal cultural heritage within the mine complex.

Recommendation 4

OEH recommends that the approved Aboriginal Cultural Heritage Management Plan (27 May 2010) for the Bloomfield Colliery be revised and updated to reflect Modification 4 (MP 07_0087 MOD 4).

Flooding and Flood Risk

5. The planning proposal does not adequately address adverse off-site flood impacts

The planning proposal has the potential for adverse localised flooding impacts. The proposal seeks to modify the final landform such that the Buttai Creek catchment will increase in size by 41 hectares and Four Mile Creeks by 10 hectares. It is acknowledged that the proposed catchment area changes are small in the context of the wider catchments and are unlikely to have significant impacts on Wallis Creek's lower flood storage areas. However, they do have the potential to cause significant, adverse localised impacts on Buttai and Four Mile Creek.

OEH does not have adequate information to assess potential impacts. The surface water assessment provided (AECOM's, Jan 2018) does not address adverse off-site flooding impacts resulting from redistributing runoff into different catchments nor justify the diversion. The Buttai Creek catchment, which drains to Testers Hollow is a sensitive catchment with existing flooding issues. To assess this proposal, OEH requires the proponent to identify off-site receivers and to quantify the impacts.

Recommendation 5

OEH recommends that a fit-for-purpose flood impact assessment be undertaken to quantify adverse off-site impacts. This assessment should identify potential off-site receivers by considering discharge points and distance to property boundaries.

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Jack Murphy
Level 22, 320 Pitt Street
Sydney NSW 2000

19 April 2018

OEH Review of Environmental Assessment: Bloomfield Colliery Life of Mine Extension – Modification 4 (MP 07_0087 MOD 4)

Dear Jack

In response to the letter issued by Department of Planning & Environment dated 5 March 2018, AECOM has undertaken further work to address the comments raised by the Office of Environment and Heritage (OEH) regarding flooding and flood risk as documented in the above letter.

1. Overview

1.1 Location and water courses

The Bloomfield Colliery is an open cut mine is located south of East Maitland (refer to **Figure 1**). The mine adjoins, and discharges surface water to Buttai Creek and Four Mile Creek.

The mine produces approximately 0.6 million tonnes per annum (Mtpa) (Bloomfield, 2017) of product coal from its existing operations, and is one of the Hunter Valley's oldest, continuously operating, open cut mines. Bloomfield Collieries Pty Ltd ('Bloomfield') operates the site in accordance with Project Approval 07_0087 which was granted on 3 September 2009 under Part 3A (now repealed) of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Bloomfield is seeking approval for the following modifications to Project Approval 07_0087, as follows:

- Extension of mining operations up until to 31 December 2030; and
- Approval of an amended mine schedule to access previously unrecoverable resource and final landform.

To facilitate these changes, the proposed final landform (subject of this application for consent modification) varies from the previously approved final landform, in which the void was placed approximately 200 m further to the east. As part of these changes, the following drainage characteristics are proposed:

- Contour banks, channels and diversion drains will be constructed to direct water away from the final void and back into the existing water ways.
- The final eastern slopes of the overburden dump will drain east towards Four Mile Creek. The catchment area draining towards Four Mile Creek has increased by approximately 10 ha from the currently approved final landform design; and the area draining to Buttai Creek will increase approximately 41 ha.
- The proposed catchment area draining towards the final void is approximately 52 ha, a decrease from the 103 ha under the currently approved final landscape design.

These changes are discussed in detail in the *Surface Water Assessment Bloomfield Colliery - Life of Mine Extension* (AECOM, 2018).

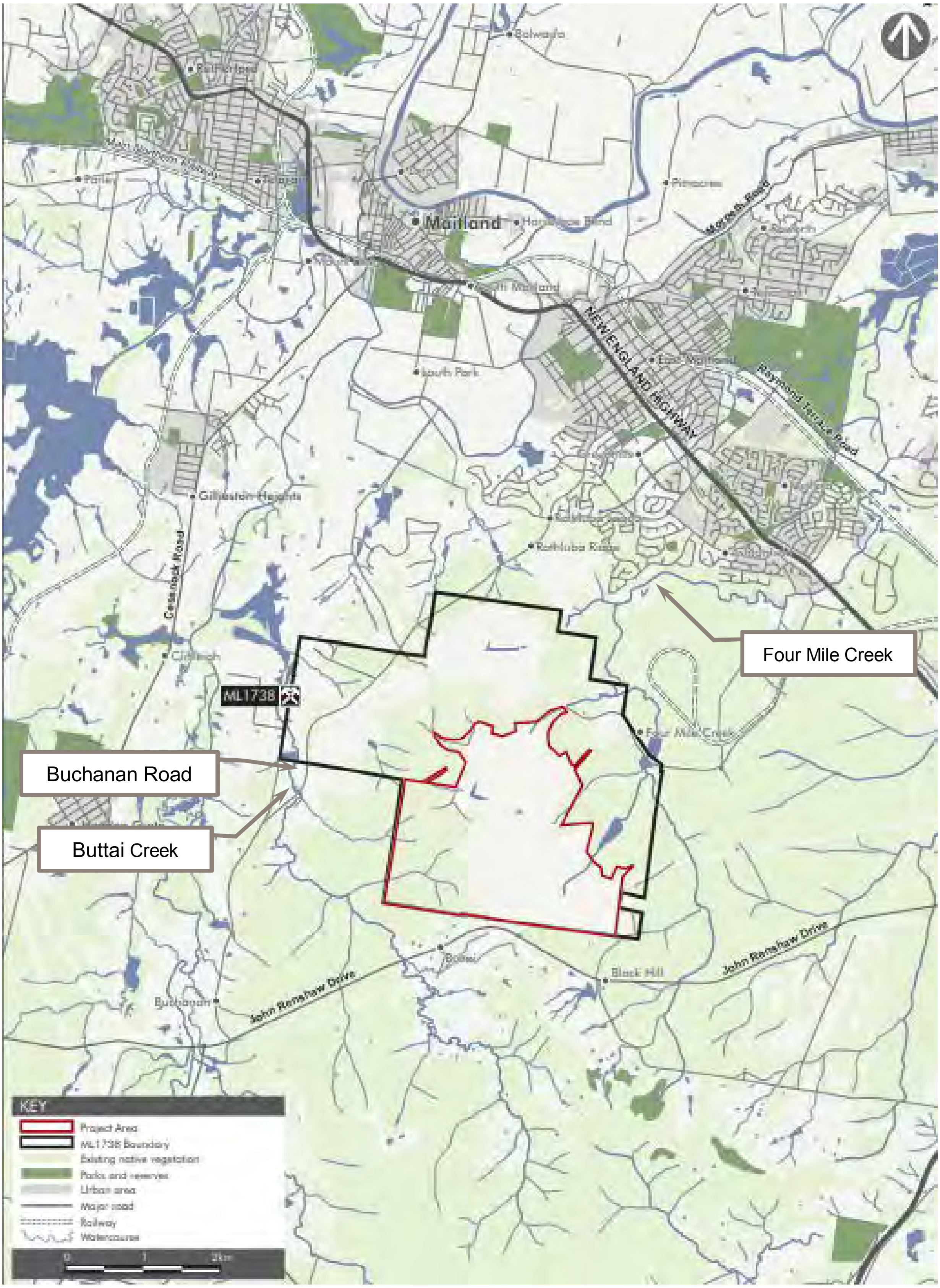

Figure 1: Site location

AECOM Imagine it. Delivered.

1.2 Existing mine water management system

The main goals of the Bloomfield mine water management system are to:

- Divert natural catchment runoff (where possible) around the mine site;
- Maintain site workability by the capture and storage of pit seepage and disturbed area runoff; and
- Maximise the usage of stored mine water for process water supply at the Bloomfield CHPP, dust minimisation on haul roads, trafficable areas and stockpiles.

Most of the operational mining areas at Bloomfield are located within the catchment of Four Mile Creek. A series of drains and levees direct Four Mile Creek around Lake Foster (mine water storage) and into Possums Puddle (clean water storage). From Possums Puddle clean water overflows are discharged back into Four Mile Creek.

Runoff from undisturbed and rehabilitated areas is directed away from operational areas and mine water storages via diversion banks and channels (refer to **Figure 2**). These banks and channels direct runoff into clean water dams or natural watercourses. The major clean water storage dam is Possums Puddle. Clean water is not accessed for operational purposes and these dams overflow into Four Mile Creek.

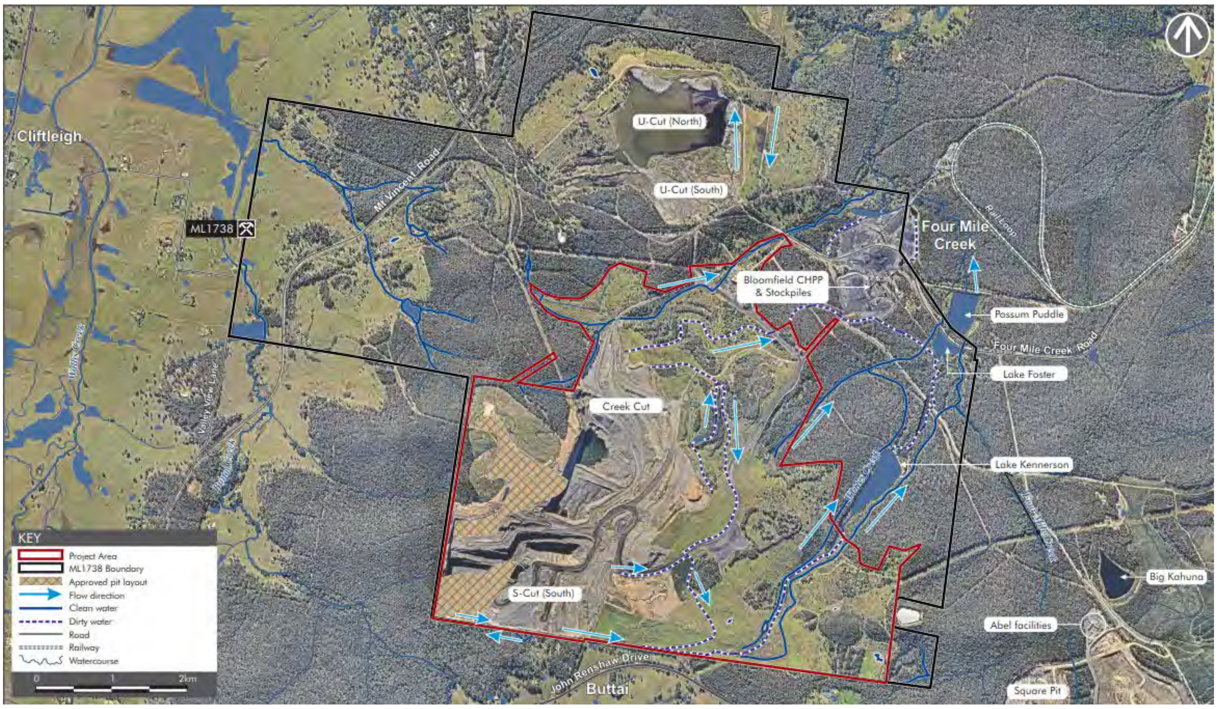

Figure 2: Mine surface water flows

1.3 Flooding background

The existing flood conditions associated with Hunter River flooding are documented in the *Hunter River Braxton to Green Rocks Flood Study* (WMAwater, 2010). This study formed the basis for the *Hunter River Floodplain Risk Management Study and Plan* (WMAwater, 2015). As indicated by the 1% AEP flood map (**Figure 3**), flooding from the Hunter River inundates the lower portions of Wallis Creek, Buttai Creek and Four Mile Creek, but is below the level Buchanan Road and the New England Highway.

Flow in the Hunter River is much greater during the 1% AEP (approximately 8,000 m^3/s), flood levels in the Hunter River are not likely to be affected by the catchment changes.

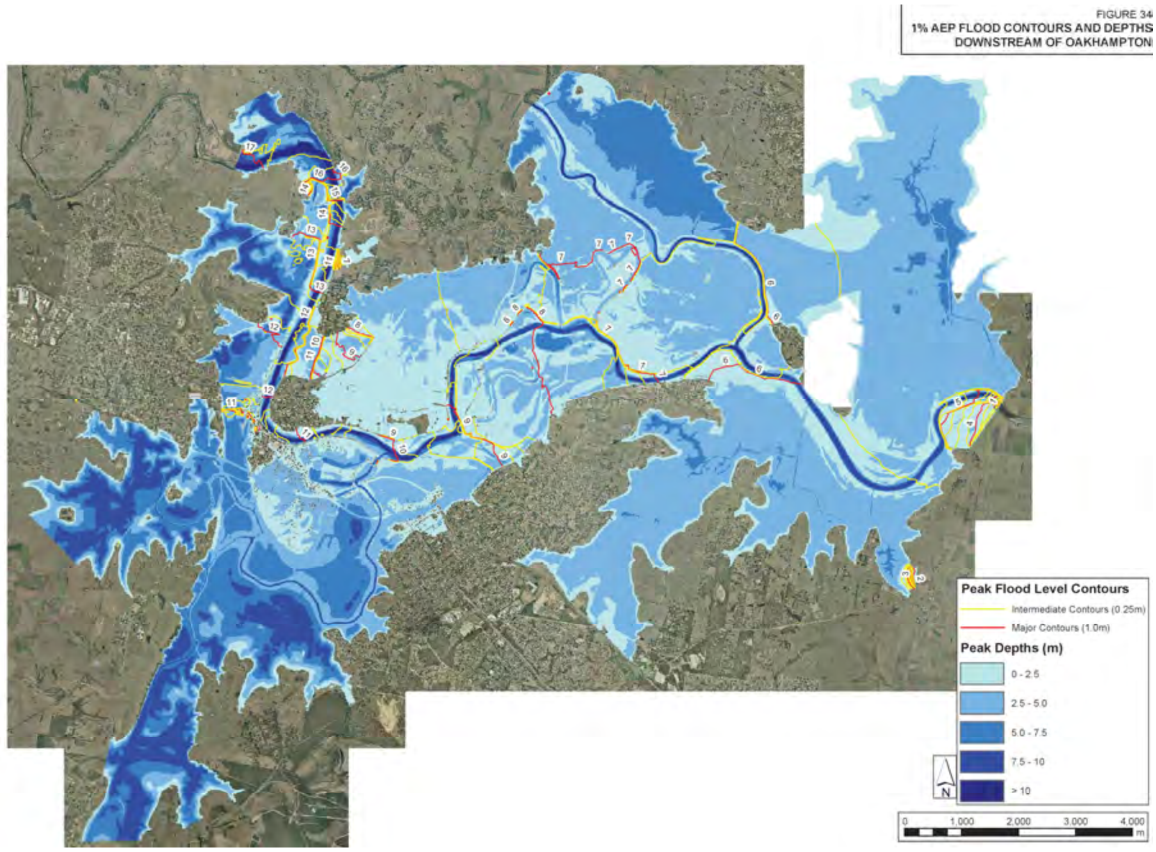

Figure 3: 1% AEP Peak flood level and depth (WMAwater, 2010)

2. Analysis

The Buttai Creek and Four Mile Creek waterways were assessed independently of the effects of the Hunter River using the methodology below.

2.1 Method

For this analysis, the total catchment area draining to the nearest receivers along Buttai Creek and Four Mile Creek was estimated using the *NSW 1:25,000 Topographic Map Series.* While it is noted that a portion of each catchment is diverted by the mine water management system, for the purposes of this assessment is assumed that storages have been filled by preceding rainfall.

Using the *Regional Flood Frequency Estimation Model* (RFFE), the peak flows for each catchment were estimated, and compared to the peak flow with the additional catchment area that is to be included as part of the Modification 4 application.

The RFFE tool uses data from 853 gauged catchments in Australia to estimate the peak flow that can be expected for a range of events. It is noted that the tool is not intended for catchments where the hydrology has been modified by the construction of a weir or dam, or where the catchment has been significantly altered by mining activities.

Using the RFFE tool for both Buttai Creek and Four Mile Creek catchments is affected by these limitations. However, it represents the best available tool with which to undertake an initial comparative assessment of the peak flows, and the consequential impact that this may have on flooding.

Using the flow estimated using RFFE, peak flood depths were calculated by using the Manning's Equation. Peak flood depths for the existing and proposed conditions were compared. To undertake the Manning's calculation, typical cross-sections and average slopes were estimated from publically available LiDAR data (Department Finance, Services and Innovation, 2012).

2.2 Buttai Creek

Buttai Creek is a tributary of Wallis Creek, which itself flows into the Hunter River downstream of Maitland. During significant floods the lower reaches of Wallis Creek, including Testers Hollow and Louth Park, are inundated due to their low lying topography. This flooding is the combined result of water from the Wallis Creek and Swamp Creek catchments, as well as flooding from the Hunter River that flows down the Oakhampton Floodway.

Downstream of the project site on Buttai Creek, the nearest receivers downstream of the project are the residences identified on the *1:50,000 Topographic Maps* along Lake View Lane, downstream of Buchanan Road. However the existing flood modelling does not extend to the Bloomfield project site.

To estimate the impact at this location, the total catchment area upstream of lake view lane was estimated to be 15.7 km^2. Using the RFFE tool, during the 1% AEP a peak flow of 333 m^3/s, with lower and upper 95% confidence intervals of 143 m^3/s and 782 m^3/s respectively. Under the proposed conditions, the total catchment is estimated to be 16.1 km^2, with would result in a peak flow of 339 m^3/s (less than 2% increase), with lower and upper confidence bounds of 146 m^3/s and 797 m^3/s.

A cross-section along Buttai Creek was taken upstream of Buchanan Road. Based on the flows above, the flood depth downstream of Buchanan Road is approximately 2.74 m. With the change to the catchment, the flood depth is increased by 0.02 m to 2.76 m.

2.3 Four Mile Creek

Four Mile Creek is a tributary of the Hunter River, and flows to the Hunter River through East Maitland. Flows have been estimated at the New England Highway, which is the closest road crossing to the Bloomfield site, and is located within the East Maitland urban area.

The total catchment under the exiting conditions is approximately 23.9 km^2. The estimated peak flow for the 1% AEP flood under the existing conditions is approximately 512 m^3/s, with lower and upper 95% confidence intervals of 218 m^3/s and 1210 m^3/s respectively. With the additional 10 ha this is increased to 514 m^3/s (less than 1% increase), with lower and upper confidence bounds of 218 m^3/s and 1220 m^3/s.

A cross-section along Four Mile Creek was taken upstream of the New England Highway. Based on the flows above, the flood depth upstream of the New England Highway is approximately 2.26 m. With the change to the catchment, the flood depth is increased by 0.01 m to 2.27 m.

3. Conclusions

A preliminary analysis of the impact that the changes in catchment area will have on the downstream flooding has been undertaken using the RFFE tool. The change in the total catchment area has been assessed, and the peak flow for the 1% AEP estimated for both present and future conditions.

For both Buttai Creek and Four Mile Creek, the changes in peak flow are minor (1%-2%). The peak flow in Buttai Creek for the 1% AEP is increased by less than 2%, while for Four Mile Creek the increase is less than 1%. It should be noted that the changes in peak flow associated with the catchment reconfiguration proposed in the application are significantly less than the uncertainty associated with the flow estimates.

Using Manning's equation, the effect on the nearest downstream road crossings to benchmark the effect that the changes may have of flood risk. Flood levels are increased 0.02 m in Buttai Creek at Buchanan Road, and 0.01 m in Four Mile Creek at the New England Highway. These increases in flood level are small, and are likely to only have a negligible to very minor impact on flood risk as many of the residential properties are set back from the creeks by existing planning controls which typically also require that residences and habitable buildings be above 0.5 m above the 1% AEP flood level.

When considering the project impacts to catchment areas it should also be noted that while the areas of the Four Mile Creek and Buttai Creek catchment will increase, they will still remain smaller than the original catchment size had no mining ever been undertaken.

4. References

AECOM, 2018, *Surface Water Assessment Bloomfield Colliery - Life of Mine Extension.* Prepared for Bloomfield Collieries Pty Ltd.

Bloomfield (March 2017) *Bloomfield Colliery Annual Environmental Management Report 2016*, prepared by the Bloomfield Group.

Department Finance, Services and Innovation, 2012, *Newcastle 2012-02-16 2kmx2km 1 metre Resolution Digital Elevation Model*

WMAwater, 2015, *Hunter River Floodplain Risk Management Study and Plan.* Prepared for Maitland City Council

WMAwater, 2010, *Hunter River: Branxton to Green Rocks Flood Study.* Prepared for Maitland City Council.

WorleyParsons, 2013, Swamp/Fishery Creek Floodplain Risk Management Study, Prepared for Cessnock City Council

Yours sincerely,

Joshua Atkinson
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Appendix F

Groundwater Peer Review

Appendix F Groundwater Peer Review

- Peter Dundon Independent Peer Review letter.
- Updated Groundwater Impact Assessment.
- Updated HydroSimulations Modelling report (which forms Appendix A to the AECOM report).
- Spreadsheet of response to Peters marked up comments to the Groundwater Impact Assessment.
- Spreadsheet of response to Peters marked up comments to the HydroSimulations Modelling report.

Dundon Consulting Pty Limited
ACN 083 246 459
ABN 27 083 246 459

PO Box 6219, PYMBLE NSW 2073
telephone: 02-9988 4449
facsimile: none
mobile: 0418 476 799
email: pjdundon@ozemail.com.au

9 May 2018

Bloomfield Colliery
Four Mile Creek Rd
ASHTONFIELD, NSW 2323

Attention: Mr John Bailey

Dear John,

Re: Bloomfield Life of Mine Extension – Groundwater Impact Assessment – Independent Review

Aecom Australia Pty Ltd (Aecom) in association with HydroSimulations (HS) has carried out a groundwater impact assessment to support the application for consent to allow continuing operations at the Bloomfield mine. Their assessment was documented in a report 'Groundwater Impact Assessment – Bloomfield Life of Mine Extension', dated 17 January 2018. This GIA report has been placed on public exhibition. Aecom prepared the GIA report, using groundwater numerical modelling undertaken by HS, which was documented in a report by HS dated October 2017.

Dundon Consulting Pty Ltd (Dundon) was engaged to conduct an independent model review of the GIA and the modelling report. The engagement was confirmed by email from Aecom on behalf of Bloomfield dated 15 March 2018.

The review has been conducted as a desk-based study of the Aecom and HS reports.

1. Groundwater Modelling report (HydroSimulations, 2018)

The modelling has been assessed against the Australian Groundwater Modelling Guideline (Barnett, et al, 2012), using the review checklist in Table 9-2 of the guideline. The checklist is reproduced below. Comments on the Aecom GIA report follow at the conclusion of the model review checklist.

Modelling Review Checklist (from Table 9-2 of Barnett, et al, 2012)

Review questions	*Yes/No*	*Comment*
1. Planning		
1.1 Are the project objectives stated?	Yes	Project objectives are clearly stated in Section 1.2 (page 2) of the HS report (Scope of Work). The SOW is consistent with the Secretary's |Environmental Assessment Requirements (SEARs) relating to groundwater, which are listed in Section 1.3 (page 3) of the GIA.
1.2 Are the model objectives stated?	Yes	See above
1.3 Is it clear how the model will contribute to meeting the project objectives?	Yes	
1.4 Is a groundwater model the best option to address the project and model objectives?	Yes	Modelling has been used for previous predictions of impact at Bloomfield, and incorporating the adjacent mines. The project is an extension of an existing approved mine, and so the additional

Review questions	*Yes/No*	*Comment*
		impacts are best served by re-running the previously used model.
1.5 Is the target model confidence-level classification stated and justified?	Yes	Model complexity and confidence in relation to the 2001 and 2012 modelling guidelines explained in Section 3.4. Model confidence classification is discussed in detail in Section 6. Model has been classified as Class 1/2
1.6 Are the planned limitations and exclusions of the model stated?	Yes	Section 6.
2. Conceptualisation		
2.1 Has a literature review been completed, including examination of prior investigations?	Yes	Section 3.1
2.2 Is the aquifer system adequately described?	Yes	Section 2, in particular Section 2.3
2.2.1 hydrostratigraphy including aquifer type (porous, fractured rock ...)	Yes	Section 2.3
2.2.2 lateral extent, boundaries and significant internal features such as faults and regional folds	Yes	Sections 3.2 and 3.3
2.2.3 aquifer geometry including layer elevations and thicknesses	Yes	Sections 3.2, 3.3
2.2.4 confined or unconfined flow and the variation of these conditions in space and time?	?	Not specifically discussed
2.3 Have data on groundwater stresses been collected and analysed?	Yes	Dewatering; rainfall
2.3.1 recharge from rainfall, irrigation, floods, lakes	Yes	Rainfall
2.3.2 river or lake stage heights	Yes	Modflow RIV cells used for watercourses, and Hexham Swamp. Stage heights are specified based on topography. DRN cells used for mine dewatering areas.
2.3.3 groundwater usage (pumping, returns etc)	Yes	Report states that only groundwater usages are mine dewatering and evapotranspiration
2.3.4 evapotranspiration	Yes	
2.3.5 other?	Yes	Mine dewatering
2.4 Have groundwater level observations been collected and analysed?	Yes	Up to 20 years water level data available. Monitored water levels from transient calibration period – 2,606 target water levels, 88 separate hydrographs.
2.4.1 selection of representative bore hydrographs	Yes	
2.4.2 comparison of hydrographs	Yes	All presented hydrographs show observed vs predicted.
2.4.3 effect of stresses on hydrographs	Yes	Comparison with rainfall residual mass curve trends. Other hydrograph impacts discussed in terms of previous mine dewatering.
2.4.4 watertable maps/piezometric surfaces?	No	No pre-project watertable/piezometric surface maps presented. Post-mining water level and drawdown maps are presented.

Review questions	***Yes/No***	***Comment***
2.4.5 If relevant, are density and barometric effects taken into account in the interpretation of groundwater head and flow data?	NR	Not relevant
2.5 Have flow observations been collected and analysed?	No	Not significant.
2.5.1 baseflow in rivers	No	Insufficient data for to be meaningful
2.5.2 discharge in springs	NR	Not relevant
2.5.3 location of diffuse discharge areas?	Yes	Hexham Swamp identified and described
2.6 Is the measurement error or data uncertainty reported?	No	
2.6.1 measurement error for directly measured quantities (e.g. piezometric level, concentration, flows)	No	
2.6.2 spatial variability/heterogeneity of parameters	Yes	Zonation of domain for parameters
2.6.3 interpolation algorithm(s) and uncertainty of gridded data?	NR	
2.7 Have consistent data units and geometric datum been used?	Yes	
2.8 Is there a clear description of the conceptual model?	No?	There is no specific description of a conceptual model. Elements of the conceptual model are described in Section 2. Based on existing and previous models for the project.
2.8.1 Is there a graphical representation of the conceptual model?	No	
2.8.2 Is the conceptual model based on all available, relevant data?	No	
2.9 Is the conceptual model consistent with the model objectives and target model confidence level classification?	No	
2.9.1 Are the relevant processes identified?	Yes	
2.9.2 Is justification provided for omission or simplification of processes?	NR	
2.10 Have alternative conceptual models been investigated?	No	
3. Design and construction		
3.1 Is the design consistent with the conceptual model?	Yes	WRT previous modelling reports.
3.2 Is the choice of numerical method and software appropriate (Table 4-2)?	Yes	Best practice approach adopted. However, the previous modelling was performed using MODFLOW-Surfact and this software has been retained for consistency and for ease of comparison with previous model predictions. The modelling therefore does not use the most up-to-date software tools available. The approach taken is strongly endorsed and the software used is totally appropriate.
3.2.1 Are the numerical and discretisation methods appropriate?	Yes	
3.2.2 Is the software reputable?	Yes	Industry standard.
3.2.3 Is the software included in the archive or are references to the software provided?	Yes	Referenced in model report.

Review questions	***Yes/No***	***Comment***
3.3 Are the spatial domain and discretisation appropriate?	Yes	Some alterations were made to spatial domain to exclude areas not closely relevant to Bloomfield mine.
3.3.1 1D/2D/3D	3D	
3.3.2 lateral extent	Yes	Southern part of previous Abel model was excised from the Bloomfield model.
3.3.3 layer geometry?	Yes	Appropriate layer geometry for the modelling objectives. 20 model layers, including all major coal seams and interburdens represented as discrete layers, with thicker interburden zones represented by up to 3 layers.
3.3.4 Is the horizontal discretisation appropriate for the objectives, problem setting, conceptual model and target confidence level classification?	Yes	Cell widths range from 50m x 50m to 100m x 100m at the Bloomfield mine. Lateral boundaries are sufficiently distant to prevent boundary effects.
3.3.5 Is the vertical discretisation appropriate? Are aquitards divided in multiple layers to model time lags of propagation of responses in the vertical direction?	Yes	Model layer thicknesses based on geological model.
3.4 Are the temporal domain and discretisation appropriate?	Yes	Project completion and post-project recovery addressed in prediction simulations. 100-year post-project simulation is considered adequate.
3.4.1 steady state or transient	Yes	Steady state and transient (2006-2017) for calibration. Transient for predictions of project and post-project periods.
3.4.2 stress periods	Yes	10 x 6-month SPs and 7 x 12-month SPs for calibration; 14 x 12-month SPs for project life prediction; 1 x 100 year SP for recovery prediction.
3.4.3 time steps?	?	Not stated
3.5 Are the boundary conditions plausible and sufficiently unrestrictive?	Yes	Boundary conditions generally consistent with previous modelling in project area. Possible exception may be the dyke leakage coefficient, as the model under-predicts drawdowns at VW8 west of the dyke.
3.5.1 Is the implementation of boundary conditions consistent with the conceptual model?	Yes	
3.5.2 Are the boundary conditions chosen to have a minimal impact on key model outcomes? How is this ascertained?	?	Impacts at model boundaries not able to be ascertained, as full extent of model domain is not shown in drawdown plots (Appendix D). Also, see above comment re leakage coefficient for the dyke.
3.5.3 Is the calculation of diffuse recharge consistent with model objectives and confidence level?	Yes	
3.5.4 Are lateral boundaries time-invariant?	?	Western and eastern boundaries set as RIV cells. Nature of northern and

Review questions	*Yes/No*	*Comment*
		southern boundaries not stated – GHBs?
3.6 Are the initial conditions appropriate?	Yes	First calibration run is steady state.
3.6.1 Are the initial heads based on interpolation or on groundwater modelling?		Interpolation.
3.6.2 Is the effect of initial conditions on key model outcomes assessed?	NR	Steady state start and long calibration period
3.6.3 How is the initial concentration of solutes obtained (when relevant)?	NR	
3.7 Is the numerical solution of the model adequate?	Yes	
3.7.1 Solution method/solver	?	Not stated
3.7.2 Convergence criteria	?	Not stated
3.7.3 Numerical precision	?	Not stated
4. Calibration and sensitivity		
4.1 Are all available types of observations used for calibration?	Yes	
4.1.1 Groundwater head data	Yes	
4.1.2 Flux observations	NR	
4.1.3 Other: environmental tracers, gradients, age, temperature, concentrations etc.	NR	
4.2 Does the calibration methodology conform to best practice?	Yes	
4.2.1 Parameterisation	Yes	
4.2.2 Objective function	Yes	
4.2.3 Identifiability of parameters	Yes	
4.2.4 Which methodology is used for model calibration?		Steady state and transient.
4.3 Is a sensitivity of key model outcomes assessed against?	No	Auto-sensitivity had been used for previous model by Aquaterra in conjunction with manual parameter adjustments.
4.3.1 parameters		Above auto-sensitivity used for parameters and recharge
4.3.2 boundary conditions		
4.3.3 initial conditions		
4.3.4 stresses		
4.4 Have the calibration results been adequately reported?	Yes	
4.4.1 Are there graphs showing modelled and observed hydrographs at an appropriate scale?	Yes	Time scale difficult to read. Annual or multiple year time divisions would be more helpful.
4.4.2 Is it clear whether observed or assumed vertical head gradients have been replicated by the model?	Generally yes	Calibration dataset includes several multi-level piezometer bores.
4.4.3 Are calibration statistics reported and illustrated in a reasonable manner?	Yes	Section 4 (pages 11 to 16). SRMS – 4.3% for previous Aquaterra model. RMS of 10.4% quoted by HS for current model. Scattergrams for calibration modelling

Review questions	*Yes/No*	*Comment*
		(Figure 9) – overall good calibration, but with some scatter probably relating to specific bores. Mass balance error 0.2%.
4.5 Are multiple methods of plotting calibration results used to highlight goodness of fit robustly? Is the model sufficiently calibrated?	Yes	
4.5.1 spatially		SRMS plot
4.5.2 temporally		hydrographs
4.6 Are the calibrated parameters plausible?	Yes	
4.7 Are the water volumes and fluxes in the water balance realistic?	Yes	
4.8 has the model been verified?	No	However, transient model calibration against 11 years of monitoring, during which there was mining at both Bloomfield and adjacent Abel/Tasman mines.
5. Prediction		
5.1 Are the model predictions designed in a manner that meets the model objectives?	Yes	
5.2 Is predictive uncertainty acknowledged and addressed?	Yes	
5.3 Are the assumed climatic stresses appropriate?	Yes	
5.4 Is a null scenario defined?	Yes	
5.5 Are the scenarios defined in accordance with the model objectives and confidence level classification?	Yes	
5.5.1 Are the pumping stresses similar in magnitude to those of the calibrated model? If not, is there reference to the associated reduction in model confidence?	Yes	Pit inflows derived from DRN fluxes. Transient calibration has included historical inflows, but monitoring of past inflows is not good.
5.5.2 Are well losses accounted for when estimating maximum pumping rates per well?	NR	
5.5.3 Is the temporal scale of the predictions commensurate with the calibrated model? If not, is there reference to the associated reduction in model confidence?	Yes	Calibration model – 11 years. Prediction model – 14 years. Recovery model – 100 years.
5.5.4 Are the assumed stresses and timescale appropriate for the stated objectives?	Yes	
5.6 Do the prediction results meet the stated objectives?	Yes	
5.7 Are the components of the predicted mass balance realistic?	Yes	
5.7.1 Are the pumping rates assigned in the input files equal to the modelled pumping rates?	NR	
5.7.2 Does predicted seepage to or from a river exceed measured or expected river flow?	NR	Stage heights in RIV cells set to bed level, thus no seepage from streams to aquifer are permitted by model. Exception is Hexham Swamp, where stage is set at 0.5m above ground level.
5.7.3 Are there any anomalous boundary fluxes due to superposition of head dependent sinks (e.g. evapotranspiration) on head-dependent boundary cells (Type 1 or 3 boundary	No	

Review questions	*Yes/No*	*Comment*
conditions)?		
5.7.4 Is diffuse recharge from rainfall smaller than rainfall?	Yes	
5.7.5 Are model storage changes dominated by anomalous head increases in isolated cells that receive recharge?	No	
5.8 Has particle tracking been considered as an alternative to solute transport modelling?	NR	
6. Uncertainty		
6.1 Is some qualitative or quantitative measure of uncertainty associated with the prediction reported together with the prediction?	No	No report of uncertainty analysis.
6.2 Is the model with minimum prediction-error variance chosen for each prediction?	NR	
6.3 Are the sources of uncertainty discussed?	?	Uncertainty concerning historical mining extents and impacts.
6.3.1 measurement of uncertainty of observations and parameters	No	
6.3.2 structural or model uncertainty	No	
6.4 Is the approach to estimation of uncertainty described and appropriate?	No	
6.5 Are there useful depictions of uncertainty?	No	
7. Solute transport	NR	
8. Surface water–groundwater interaction		
8.1 Is the conceptualisation of surface water–groundwater interaction in accordance with the model objectives?	Yes	
8.2 Is the implementation of surface water–groundwater interaction appropriate?	Yes	
8.3 Is the groundwater model coupled with a surface water model?	No	
8.3.1 Is the adopted approach appropriate?	Yes	
8.3.2 Have appropriate time steps and stress periods been adopted?	Yes	
8.3.3 Are the interface fluxes consistent between the groundwater and surface water models?	NR	

In terms of the Australia Groundwater Modelling Guideline check-list (Barnett, et al, 2012), I consider that the modelling has been satisfactory and is fit for purpose. The few negative comments in the check-list above do not detract overall from the soundness of the modelling and the reliability of the predictions, and in most cases they are omissions from the report rather than shortcomings with the model. To a significant degree, the reliability of the model is enhanced by the performance of the groundwater system under a long period of mining in the area, and the conformance of predictions previously made with the original model and subsequent generations of the model for the Bloomfield, Donaldson, Abel and Tasman projects. All these models have incorporated all four projects.

Additional comments made on the modelling report are as follows:

- <u>Scope of Work</u> – Is there any physical evidence for whether the dyke is a barrier, flow path or higher permeability, or neither?
- <u>2.3 Hydrogeology, last sentence</u> – I suggest that the open cuts would only have reversed the groundwater flow directions in some locations, not universally.
- <u>2.4 Recharge, second paragraph</u> – I think that there is evidence that in terms of recharge, the component of vertical leakage is very much less than lateral flow along the bedding,

- 3.1 Existing Model, last sentence – it is unclear from the report whether the sequencing of the other mines (Abel, Tasman, Tasman Extension) used in the current Bloomfield model is based on the approved sequencing, or actual, and whether the model acknowledges that mining has been suspended at Abel and deferred at Tasman Extension.
- 3.3 Modified Model, second paragraph – where Tasman is referred to, is that the historical Tasman mine (now completed) or the proposed Tasman Extension (not yet started).
- 3.4 Methodology, third paragraph – the model variants listed appear to allow the impacts of the total Bloomfield operations since 2006 to be separately assessed. However, it does not appear that the Bloomfield extension only can be assessed (ie by comparing variants 2 and 3 with a null run that includes Abel, Donaldson and Tasman and the currently approved Bloomfield mine, but not the proposed extension).
- 4.3.1 Statistics, last sentence – I suggest some comment be included on the outliers from the scattergram plot. It looks like one bore (or perhaps a couple of bores) may be responsible for the outliers. Is there a reason why this bore / these bores do not calibrate as well over time?
- 4.3.2 Mine Inflow, second paragraph – 510 ML/d in second line should be 510 ML/a.
- 4.3.3 Groundwater Levels – The calibration for VW8 (83 m) and VW8 (97 m) is poor. Is there any possible explanation for this? It seems important to me as this site is the one of the few monitoring locations between the mine and the Wallis Creek system.
- 4.3.3 Groundwater Levels, last sentence (page 15) – I'm not sure I agree with this statement. Water level is declining during the period of Abel mining, as well as Bloomfield. If it was a residual effect of historical Buchanan mine, I would expect water levels would be low to start with, and possibly slowly rising thereafter. There is likely some connection between VW8 location and the Donaldson seams being mined at Abel, or the Bloomfield active seams.
- 4.3.4 Groundwater Surface Water Interaction, second paragraph – I think it is better to use physical evidence for drawing conclusions about whether streams are losing or gaining, rather than relying on a model output.
- 4.3.5 Water Balance, second paragraph – Table 7 suggests that all of the 66% loss by leakage from water bodies occurs at Hexham Swamp, and none from streams? Perhaps use the words "from Hexham Swamp" in place of "from the water bodies".
- 5.2 Modelling Approach, second paragraph – Should the word "from" be "for"?
- 5.4 Water Balance – again refer directly to Hexham Swamp, rather than "water bodies".
- 5.5 Predicted Drawdowns, sixth sentence – Layer 1 drawdowns cannot exceed the thickness of Layer 1. So around 100m of drawdown cannot be possible.
- 5.6 Prediction Drawdowns at Registered Bores, Table 10 – Are the drawdowns shown in the table (and plotted on Figure 11) drawdowns for Layer 1 only, or all layers? Is it necessary to include monitoring bores in this table? Finally, note that not all bores in Table 10 are in alluvium as stated. Most are significantly deeper than the likely alluvium depth. I know for certain that GW078123 and GW078124 are not screened in alluvium, but in coal measures. There may be others in the table that need to be corrected.
- 5.8 Baseflow Capture, last paragraph – Perhaps the words "… and therefore no impact on Hexham Swamp is predicted …' could be added.
- Figure 11 – This figure is misleading. It says "predicted drawdown in Layer 1 (alluvium and regolith), but it has drawdowns that greatly exceed the thickness of Layer 1. This could be interpreted by a lay reader that the alluvium is going to be massively dewatered, to greater than 100m depth. The Figure should be corrected to show actual maximum drawdowns in alluvium/regolith. Alternatively, it needs to be carefully footnoted to explain just what is being shown.

I am happy to confirm that the groundwater modelling has been completed satisfactorily in accordance with the Australian Groundwater Modelling Guideline (Barnett, et al, 2012).

2. Groundwater Impact Assessment report (Aecom, 2018)

I offer the following comments on the report:

- 1.2 Interaction with Neighbouring Mines, first and second paragraphs – has the proposed Tasman Extension project (approved but not yet commenced) been included in the modelling?
- 3.4 Groundwater Numerical Model Development, second paragraph – The reports cited are not listed in the References (Section 9.0).
- 3.4 Groundwater Numerical Model Development, last paragraph (page 9) – My reading of this is that the effects of the proposed Bloomfield extension cannot be assessed separately from the currently approved Bloomfield operation.
- 4.4.1 Regional Hydrogeology, first paragraph – Probably should also mention that groundwater can also occur in shallow unconsolidated material (regolith - ie "… localised alluvium, as well as colluvium and decomposed rock") away from the main creeks. This unconsolidated material away from the creeks and swamps has negligible resource value, but is important in the groundwater recharge process. All unconsolidated materials comprise Layer 1 in the groundwater models.
- 4.4.1 Regional Hydrogeology, second and third paragraphs – The reference should be "AGC, 1984", not "AGE, 1984". AGE was not founded until 1997, and is a different company.
- 4.4.1 Regional Hydrogeology, fourth paragraph – "permeabilities" not "permeability's".
- 4.4.1 Regional Hydrogeology, fifth paragraph, first sentence – I don't think this is the case. The water table is topography influenced, whereas the potentiometric surface is more controlled by regional recharge/discharge - with recharge occurring at or near outcrop (ie to the north) and discharge somewhere way to the south?? There is exemplified at one low-lying location beside Pambalong Nature Reserve, where the potentiometric surface for the Donaldson Seam pre-mining was 20+m above the ground surface (C081A), whereas the water table was just below surface (C081B). Mining impact has since taken C081A water level well below surface, whereas C081B WL is still just below surface and has not been affected by mining.
- 4.4.2 Local Hydrogeology, third paragraph, second sentence – "… which isn't seen in the upper alluvial aquifer …" is not strictly correct. Around the Donaldson open cut, there were localised impacts on the local alluvium and regolith, which were physically intersected by the pit. Same probably applied at Bloomfield open cut, but impacts there would have occurred long ago.
- 4.4.2 Local Hydrogeology, last paragraph – natural gradient may have been reversed in some locations, but not universally.
- 4.6 Existing Groundwater Usage – Add some words that indicate what usage there may have been from the bores that are not monitoring bores, ie how many, what purpose, likely usage.
- 4.9 Groundwater Surface Water Interaction, third paragraph – It is sated that catchment area reduces by 51 Ha, 41 Ha of which is the Buttai catchment. What catchment loses the remaining 10 Ha?
- 5.3.1 Final Void – I suggest adding a comment about the lateral extent of residual drawdown >2m after 100 years of recovery.
- 5.2 Groundwater Drawdown, third paragraph – Drawdown of "… 100m in surficial aquifer …" is not possible, as the layer is only 10m thick.

- 5.2 Groundwater Drawdown, ninth paragraph – Same bore number used twice. Should be …123 and …124. Also both these bores are monitoring bores, and are not in alluvium.
- Table 10, page 20 - Need to include model layer screened by each bore in Table 10, so the correct drawdown figure is used. I also question the need to include bores in Table 10 that are purely monitoring bores.
- 6.1 Monitoring, first paragraph – Some comment needs to be made about poor calibration at VW8, and possible reasons why. Otherwise, as the text suggests, more piezometers may need to be installed as it is an area where "predicted drawdown is significantly different from actual drawdown".
- 6.1 Monitoring, second paragraph – I'm not sure how evaporation rates influence the frequency of monitoring?
- Table 11, page 26, second last paragraph – The bores GW078123 and GW078124 are not in alluvium, so they should be discussed in Table 12 not Table 11. Also, they are monitoring bores around the Donaldson Open Cut, and their drawdown is due to Donaldson, not Bloomfield. So why are mitigation measures needed? How much of the predicted drawdown would be due to Bloomfield?
- 8.0 Conclusions and Recommendations, fourth paragraph – "The final void will … lowering water levels in the vicinity …" The words "in the coal measures" should be inserted to improve clarity.
- 8.0 Conclusions and Recommendations, fifth paragraph – Is the maximum drawdown reached in 2025 everywhere? Or is the maximum reached at different times at different places?
- 8.0 Conclusions and Recommendations, fifth paragraph – Drawdowns in the surficial aquifer cannot reach 100m, as Layer 1 is only 10m thick maximum.
- 8.0 Conclusions and Recommendations, first paragraph at top of page 32 – How is monitoring frequency influenced by evaporation rates?
- 8.0 Conclusions and Recommendations, first bullet on page 32 – Aren't trigger levels required to be set in this report?
- 9.0 References – Correct reference from "Australasian Groundwater and Environment" (AGE) to "Australian Groundwater Consultants" (AGC).

I am satisfied overall with the groundwater impact assessment, with the exception of the comments listed above. Some relate to the modelling report, which I have addressed in the first part of this letter. Others are merely directed at clarifying the text.

The issues identified in this letter in my opinion do not cause the study to be defective. However, it would be improved by attention to some of the matters raised.

Overall, I believe the study to be satisfactory for public release. Amendments where necessary can be made after the receipt of submissions from the agencies and the public.

Yours faithfully,

Peter Dundon

Imagine it. Delivered.

Bloomfield Colliery Pty Ltd
14-Jun-2018
60289290

Groundwater Impact Assessment

Bloomfield Colliery - Life of Mine Extension

Groundwater Impact Assessment

Bloomfield Colliery - Life of Mine Extension

Client: Bloomfield Colliery Pty Ltd

ABN: 25 003 824 244

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Quality Information

Document Groundwater Impact Assessment

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Prepared by Angus McFarlane and Katherine Hutton

Reviewed by Graham Hawkes

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	21-Dec-2017	Draft	Simon Murphy Principal Environmental Planner	
0	17-Jan-2018	Final	Simon Murphy Project Manager	
1	14-Jun-2018	Updates from peer review	Simon Murphy Project Manager	

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Table of Contents

List of Tables

List of Figures

Glossary of Terms and Abbreviations

Term	Definition
AHD	Australian Height Datum
Alluvium	Sediments (clays, sands, gravels and other materials) deposited by flowing water. Deposits can be made by streams on river beds, floodplains and alluvial fans.
Aquiclude	An aquiclude is a geological material through which zero flow occurs.
Aquifer	Geologic formation, group of formations, or part of a formation capable of transmitting and yielding quantities of water.
Aquitard	A low permeability unit that can store groundwater and also transmit it slowly from one aquifer to another.
DI-CLW	NSW Department of Industry – Crown Lands and Water Division (formerly DPI-Water)
DLWC	NSW Department of Land and Water Conservation now DI-CLW
DoP	NSW Department of Planning. Predecessor agency to the NSW Department of Planning and Environment.
DPI-Water	NSW Department of Primary Industries – Water. State agency responsible for managing groundwater and surface water. now DI-CLW
Drawdown	A lowering of the water table in an unconfined aquifer or the potentiometric surface of a confined aquifer caused by the groundwater extraction from mining or pumping of groundwater from wells.
DWE	NSW Department of Water and Energy
Ecosystem	As defined in the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth), an ecosystem is a 'dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit'.
EC	Electrical Conductivity. A unit of measurement for water salinity. One EC equals one micro –Siemen per centimetre (μS/cm) measured at 25°C.
Environment	As defined within the *Environmental Planning and Assessment Act 1979* (NSW), all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings.
EP&A Act	*Environmental Planning and Assessment Act (1979)* (NSW)
Hydraulic conductivity	The rate at which water of a specified density and kinematic viscosity can move through a permeable medium (notionally equivalent to the permeability of an aquifer to fresh water).
Hydraulic gradient	The change in total groundwater head with a change in distance in a given direction, which yields a maximum rate of decrease in head.
Hydrogeology	The study of subsurface water in its geological context.
Hydrology	The study of rainfall and surface water runoff processes.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
LTAAEL	Long Term Average Annual Extraction Limit as outlined in the water sharing plan
MNES	matters of national environmental significance

Term	Definition
NoW	NSW Office of Water. now DI-CLW
NSW EPA	Environmental Protection Authority (NSW)
OEH	Office of Environment and Heritage (NSW)
ROM	Run-of-mine. Raw mined coal resource that includes waste material such as rocks and minerals
Salinity	The concentration of dissolved salts in water, usually expressed in EC units or milligrams of total dissolved solids per litre (mg/L TDS). The conversion factor between EC and mg/L is dependent on the chemical composition of the water, but a conversion factor of 0.6 mg/L TDS = 1EC unit is commonly used as an approximation.
Water table	The surface of saturation in an unconfined aquifer at which the pressure of the water is equal to that of the atmosphere.
WM Act	*Water Management Act 2000* (NSW)

1.0 Introduction

1.1 Project Overview

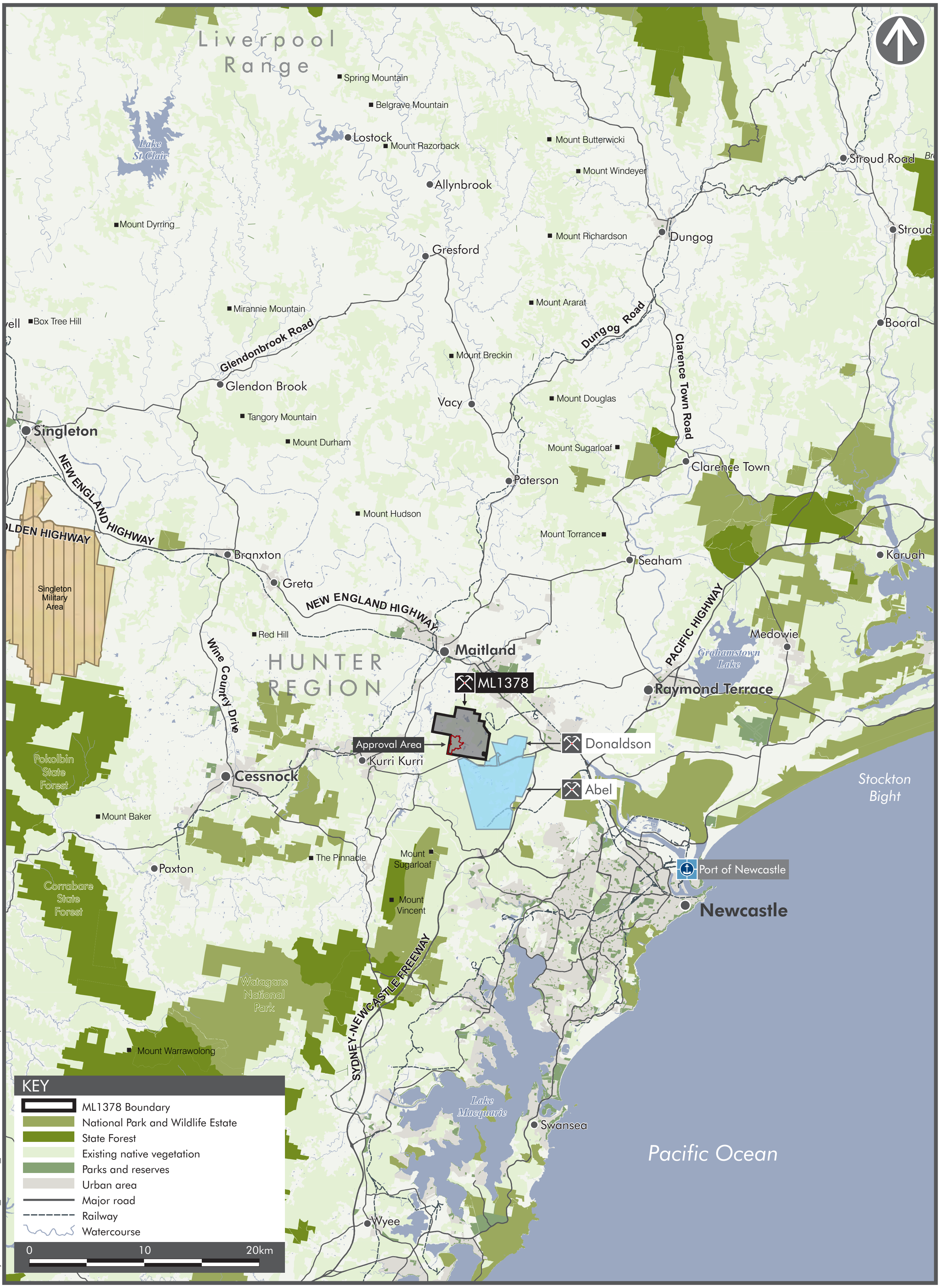
Bloomfield Colliery (the Colliery) is an open cut coal mine in the Hunter Valley, NSW, located approximately 25 kilometres (km) north-west of Newcastle and about 5 km south of Maitland. Open cut operations commenced in 1966. The Colliery currently operates in accordance with Project Approval 07_0087 under Part 3A (repealed) of the *Environmental Planning and Assessment Act 1979* (EP&A Act), granted on 3 September 2009. The Project Approval has been subsequently modified on three separate occasions (May 2011, March 2012 and February 2013). Under this approval, mining operation may take place until 31 December 2021. Bloomfield now predicts mining to extend beyond the end of 2021, having identified up to 13 million tonnes of ROM (run-of mine) coal remaining inside the approval area. Bloomfield is therefore seeking a modification to the Project Approval to allow for the continuation of mining within the existing mining lease (Consolidated Coal Lease (CCL) 761) beyond the life of its current consent to 31 December 2030. The Project includes a modification of the previously approved final landform by moving the final void approximately 200m to the west. The mining will include extraction of the Donaldson and Big Ben Seams although some of the Big Ben seam has been previously mined by underground mining methods. The mine location is shown in **Figure 1** and **Figure 2**.

In order to support the modification application to DP&E, Bloomfield requires a supporting Environmental Assessment (EA) to describe the Project and assess potential environmental impacts and statutory approval requirements. Key technical assessment areas have been identified for assessment within the EA including modelling and assessment of the hydrogeological impacts of the Project. A predictive groundwater model has been developed independently by HydroSimulations. The purpose of this report is to assess the potential impacts the Project will have on groundwater resources and changes to the site’s water balance and water management within the framework of relevant legislation and guidelines. HydroSimulations Groundwater Modelling Report is attached in **Appendix A**.

1.2 Interaction with Neighbouring Mines

Bloomfield Colliery adjoins three other mines; Donaldson open cut mine (in care and maintenance), Abel underground mine (in care and maintenance) and Tasman underground mine (closed, extension planned). The four mines all washed coal through the Bloomfield Coal Handling and Preparation Plant (CHPP). Tailings from the CHPP were deposited into former underground workings at Bloomfield until mid-2007 and are now deposited in former open cut workings on the site. Water from tailings is recovered and recycled through the CHPP.

Modelling by HydroSimulations included all neighbouring underground and open cut mines for assessment of cumulative effects. **Figure 1** shows the regional location of Bloomfield Colliery and the vicinity of the surrounding mines.



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AECOM

REGIONAL CONTEXT
Bloomfield Project

FIGURE 1

1.3 SEARs

The Secretary's Environmental Assessment Requirements (SEARs) for the Bloomfield Colliery Life of Mine Extension were issued by the Department of Planning on 16 November 2015 and revised on 22 March 2017. The SEARs relating to hydrogeological impacts and where these requirements have been addressed in this report are summarised in **Table 1**.

Table 1 How SEARs have been addressed in this report

SEARs Requirement	Section where addressed in the report
General Requirements	
A description of the existing environment likely to be affected by the development, using sufficient baseline data.	**Section 4.0**– Existing environment
An assessment of the likely impacts of all stages of the development, including any cumulative impacts, taking into consideration any relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice.	**Section 5.0**– Assessment of potential impacts
A description of the measures that would be implemented to mitigate and/or offset the likely impacts of the development.	**Section 6.0**– Monitoring and management of impacts
A description of any measures that would be implemented to monitor and report on the environmental performance of the development if it is approved.	**Section 6.0**– Monitoring and management of impacts
Groundwater	
The EA is required to assess whether the recovery of deeper coal seams would cause any changes to the groundwater resources intercepted by the development and any resultant changes to the site's water balance and water management system.	**Section 5.0** – Assessment of potential impacts

1.4 Structure of this Report

This report is structured as follows:

- **Chapter 1 – Introduction.**
- **Chapter 2 – The project** describes the project features and mining activities on the site.
- **Chapter 3 – Assessment inputs** describes the regulatory context and key inputs and assumptions for the impact assessment.
- **Chapter 4 – Existing environment** describes the existing environment (natural and built) prior to project commencement.
- **Chapter 5 – Assessment of potential impacts** describes the potential impacts on groundwater inflow, groundwater drawdown and groundwater quality resulting from the proposed project, during the mining and recovery phase.
- **Chapter 6 – Monitoring and management** describes the infrastructure and methods to be put in place to further monitor the groundwater environment and management steps to be implemented.
- **Chapter 7 – Policy compliance** outlines the relevant policy and compliance measures.
- **Chapter 8 – Conclusions** summarises the outcomes of the groundwater impact assessment.
- **Chapter 9 – References.**
- **Chapter 10 – Limitations.**
-

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2.0 The Project

2.1 Project Location

The Colliery is owned and operated by Bloomfield Collieries Pty Limited (Bloomfield). The Colliery is an open cut operation located in the Hunter Valley, NSW and 25 km north-west of Newcastle (refer to Figure 1 and Figure 2). The Colliery is located approximately 3 kilometres west of the Sydney-Newcastle Motorway and immediately north of John Renshaw Drive (B68 Freeway).

2.2 Previous Mining

Coal has been mined on the site by both underground and open cut means for approximately 170 years. Bloomfield purchased the operation in 1937, and commenced underground mining of the Donaldson, Big Ben and Rathluba seams. Underground mining on the site ceased in 1992.

Bloomfield's open cut mine commenced in 1966, using bulldozers and tractor scrapers. CCL761 was granted on 20 November 1991 and ML 1738 granted June 2017 form the boundary of the Colliery. The open cut has continued to expand and develop with the introduction of new machinery and technology.

Mining operations at the adjacent Abel Underground Mine (now in care and maintenance) required the use of certain Bloomfield infrastructure (the CHPP and rail loading facility). To enable this use, the Abel Project Approval granted on 7 June 2007 includes approval for the operation of Bloomfield CHPP and rail loading facility, including associated water management and process waste management. An Integrated Water Management System for the three adjoining mines of Bloomfield, Abel and Donaldson was approved on 5 May 2008.

Project Approval (MP 07_0087) for the Colliery was granted on 3 September 2009 for the staged completion of mining and progressive rehabilitation of the disturbed land. Prior to this, the Colliery had operated pursuant to existing use rights.

Mining operations are currently undertaken in open cut pits known as S Cut and Creek Cut. Mining in S Cut is progressively moving west, while extraction within Creek Cut is moving towards the south and west. These pits mine a range of coal seams within the Tomago Coal Measures.

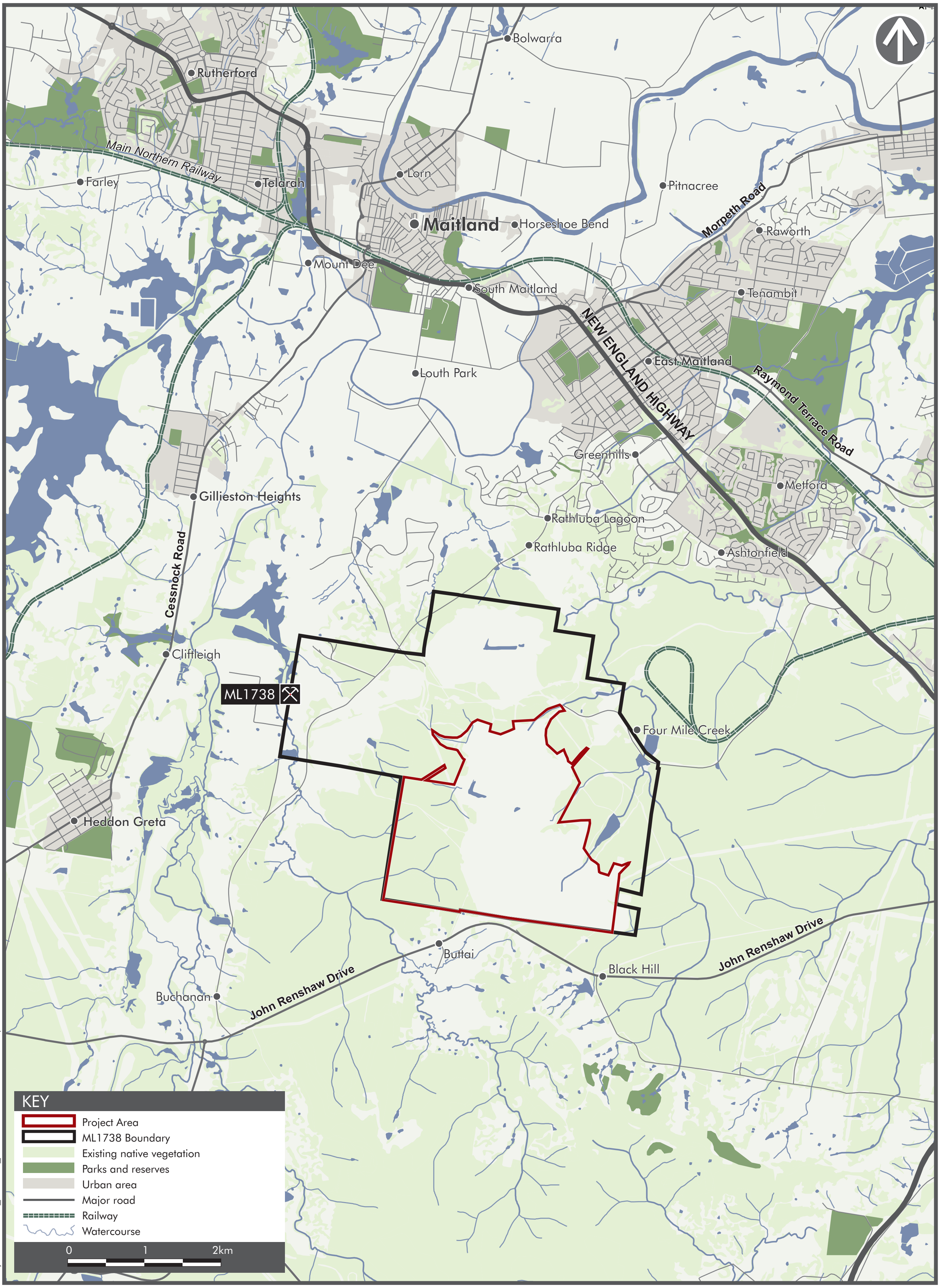
Areas within CCL 761 and ML 1738 where mining has been completed have been progressively stabilised and rehabilitated over time. To date, approximately 488 hectares of land within the Project Area has been rehabilitated. Areas of the rehabilitated land are being used for cattle grazing and for the control of surface runoff to water storage dams or natural watercourses.

2.3 Proposed Mining

Bloomfield Colliery currently operates in accordance with Project Approval 07_0087 under Part 3A (repealed) of the EP&A Act, granted on 3 September 2009. The project approval has been subsequently modified on three separate occasions (Modification No. 1 – 3). Pursuant to Schedule 5, Condition 2 of the Project Approval, mining operation under the existing consent may take place until 31 December 2021.

Changes to the mine fleet have allowed extraction of seams that were not previously considered to be a recoverable resource as part of the original 2008 EA. This has increased the amount of recoverable resource at the Mine and therefore the time required for extraction. Further exploration has been undertaken which has identified other previously unrecoverable resources that the new fleet can now access. As a result, Bloomfield has identified up to 13 million tonnes of ROM coal remaining inside the approval area. Mine planning has been undertaken for the extraction of this additional resource. The proposed change would result in a modification of the previously approved final landform by moving the final void approximately 200m to the west.

A consent modification is sought to align the Project Approval limit to coincide with the Abel consent limit of 31 December 2030. This would allow common infrastructure to be used by both mines until completion. Cumulative assessment of the potential groundwater impact has therefore been undertaken to incorporate the Project and operation of the Abel Underground Mine.



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SITE LOCATION
Bloomfield Project

FIGURE 2

3.0 Assessment Inputs

3.1 EPA Licence Conditions

Environmental management at the Colliery is undertaken in accordance with the Environment Protection Licence (EPL) No 396 issued by the Environment Protection Authority (EPA) under the *Protection of the Environment Operations Act 1997*. EPL No. 396 is attached in **Appendix B**.

The EPL conditions for the Colliery relevant to this assessment are summarised in **Table 2** and **Table 3**.

Table 2 EPL 396 Condition P1.2 - water monitoring and discharge points

EPL Monitoring Point	Type of Monitoring Point	Type of Discharge Point	Location Description
1	• Volume monitoring • Discharge quality monitoring	• Volume monitoring • Discharge quality monitoring	Lake Forster pipe outlet labelled As EPA ID1 on document dated Dec-14 and registered in the EPA Records System as DOC 17/425999 Volume must not exceed 40 kL/day.
2	• Ambient water quality monitoring	N/A	Four Mile Creek located 500m upstream of the current New England Highway culvert for Four Mile Creek.

Table 3 EPL 396 Condition L2.4 – surface water daily concentration and discharge limits

100th Percentile Concentration Limits				Volume
Electrical Conductivity (EC) (µS/cm)	pH	Total Suspended Solids (TSS) (mg/L)	Filterable Iron (mg/L)	Limit (ML/day)
6,000	6.5-8.5	30	1.0	40

3.2 Water Licence

Bloomfield Colliery operates in accordance with the Water Act 1912, and licence number 20BL172035. Under this licence, the Colliery has a maximum groundwater inflow volume of 500 ML/year into the void.

3.3 Relevant Legislation, Policy and Guidelines

This groundwater impact assessment has considered relevant guidelines, policies and both Commonwealth and State legislation.

3.3.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides the legal framework to protect and manage nationally important flora, fauna, ecological communities and water resources which are deemed to be matters of national environmental significance (MNES). An action that has, will have or is likely to have a significant impact upon MNES is declared a controlled action. Such actions require the approval of the Department of Environment and Energy (DoEE) as well as any requirements under NSW legislation.

Under the EPBC Act an expansion or modification to an existing facility may be within the definition of a large coal mining development if the activities are likely to have significant impact on a water resource (RPS, 2014)

The DoEE has provided the criteria for determining the significance of the impact that a large coal mining activity may have on a water resource. **Table 4** details the impact criteria and where these criteria have been discussed within this report.

Table 4 Impact Criteria

Assessment Criteria	Section(s) addressed
Valuation of the water resource	**Section 4.0** – Existing Environment
Changes in water quantity, including the timing of variations in quantity	**Section 5.0** – Assessment of potential impacts
Changes in the integrity of hydrological or hydrogeological connection, including substantial structure damage (e.g. large scale subsidence)	**Section 5.0** – Assessment of potential impacts
Changes in the area or extent of a water resource	**Section 5.0** – Assessment of potential impacts
The risk that the ability of relevant local or regional water quality objectives would be materially compromised	**Section 5.0** – Assessment of potential impacts **Section 7.0** – Policy compliance
A significant worsening of local water quality (where current local water quality is superior to local or regional quality objectives)	**Section 5.0** – Assessment of potential impacts
Risk of high quality water being released into an ecosystem which is adapted to a lower quality of water.	**Section 5.0** – Assessment of potential impacts
Cumulative impacts	**Section 5.0** – Assessment of potential impacts

3.3.2 Environment Planning and Assessment Act 1979

The overarching environmental planning approval framework in NSW is provided by the EP&A Act. Supporting this primary piece of legislation is the *Environmental Planning and Assessment Regulation 2000* (the EP&A Regulation) and environmental planning instruments, including State Environmental Planning Policies (SEPPs) and Local Environmental Plans (LEPs).

The Colliery currently operates under Project Approval MP 07_0087, issued under Part 3A (repealed) of the EP&A Act. As it was for the purpose of coal mining, the original development was classified as a Major Project under the *State Environmental Planning Policy (Major Projects) 2005*, which triggered the former Part 3A approval pathway.

While Part 3A of the EP&A Act was repealed in 2011, transitional arrangements set out in Schedule 6A of the EP&A Act provide that Part 3A continues to apply to approved Part 3A projects, and that section 75W of the EP&A Act continues to apply for the purpose of modifications to Project Approvals. The current Project would therefore be undertaken as a modification to the existing Project Approval (MP 07_0087) under section 75W of the EP&A Act. The approval authority is the Minister for Planning.

3.3.3 Strategic Regional Land Use Policy

Residential and agricultural land across the state is protected from the impacts of mining and coal seam gas activities under the Strategic Regional Land Use Policy. The project is not located within the Upper Hunter Region of the Strategic Agricultural Land Map and is not on land classified as biophysical strategic agricultural land (NSW Government, 2012). The NSW Office of Environment and Heritage (OEH, 2012) indicate the project area is located on land that is classified as moderate to low capability in accordance with the Land and Soil Capability (LSC) assessment.

3.3.4 Water Management Act 2000

As part of the *Water Management Act 2000*, the Department of Primary Resources - Water (DPI Water) is in the process of developing Water Sharing Plans across the state for river and groundwater systems. At the time of writing water licencing is still administered under both the *Water Management Act 2000* and the *Water Act 1912*.

Surface water and alluvial licences are administered under the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* (DPI Water, 2016) via the *Water Management Act 2000*.

Hard rock licences are administered under the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources* (DPI Water, 2016) via the *Water Management Act 2000*.

3.3.4.1 Aquifer Interference Policy

The Aquifer Interference Policy (AIP) (NoW 2012) explains the process of administering water policy under the WM Act for activities that interfere with the aquifer. The AIP outlines the assessment process and modelling criteria that DPI Water apply to assess aquifer interference projects. This assessment process and modelling criteria have been adopted for this hydrogeological assessment. Minimum impact considerations required under the AIP, for example, have been assessed for the project and are outlined in **Section 7.1** of this report.

The AIP adopts the following definition of an aquifer interference activity from the Water Management Act 2000:

- The penetration of an aquifer;
- The interference of an aquifer;
- The obstruction of the flow of water in an aquifer;
- The taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations;
- The disposal of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations;
- The policy specifies that the volume of water taken from a water source(s) as a result of an activity is required to be predicted prior to project approval and that approval will not be granted unless adequate arrangements are in force to ensure that no more than the minimum harm will be done to an aquifer or its dependent ecosystems;
- Where an activity results in the loss of water from the environment, a water access licence (WAL) is required under the WM Act to account for this water take;
- An activity must address minimal impact considerations in relation to the water table, groundwater pressure and groundwater quality; and
- Where the actual impacts of an activity are greater than predicted, planning measures must be put in place ensuring there is sufficient monitoring.

3.4 Groundwater Numerical Model Development

A numerical groundwater model was developed independently by HydroSimulations using MODFLOW-SURFACT software. MODFLOW-SURFACT is a three-dimensional model used to simulate variably saturated flow. Numerical modelling was carried out using Groundwater Vistas (Version 6.96) in conjunction with MODFLOW-SURFACT. The Groundwater Modelling Assessment Report is attached in **Appendix A**.

This model was based on a groundwater model completed by Aquaterra (2008) as part of the Groundwater Impact Assessment (Peter Dundon & Assoc., 2008) which supported the 2009 approval (07_0087). This model was subsequently built on for more detailed assessments of the Abel, Donaldson and Tasman Mines and a more extensive groundwater model was developed from this for the Abel mine by RPS Aquaterra (2013) and again by HydroSimulations (2015).

The model area extends 23.0 km west to east and 16.6 km south to north covering an area of 380 km^2. Simulation time period runs from 1 January 2006 to 31 December 2031. The model consists of 20 layers based on the lithology and separating the coal seams and interburden zones. The model includes the Donaldson, Abel and Tasman Mines for cumulative impact assessment. The revised model includes:

- A re-build of the model geometry in the Bloomfield area;
- Inclusion of the old Big Ben underground workings;
- Inclusion of a dyke in the Bloomfield area; and
- Removal of cells in the southern part of the model to allow the model to run more efficiently, stabilise the model and to not reduce the quality of the model predictions.

Time series groundwater level data from 2006 – 2017 was used to calibrate the model in steady state and transient modes. Reference to the calibration statistics indicates the model has achieved a good calibration.

The groundwater model was developed and calibrated to simulate the existing hydrogeological regime within the Tomago Coal Measures and existing coal mining workings. The model objectives were to:

- Predict groundwater inflows to the new open cut coal mine;
- Predict groundwater drawdown due to groundwater extraction from the open pit;
- Predict groundwater drawdown at registered bores; and
- Predict the impacts the final void will have on long term groundwater levels.

Two predictive model scenarios were run to replicate the long term operations groundwater impacts of the project as follows:

1. **Scenario 1:** A ‘No Mining’ or ‘Null’ run (as per Barnett *et al* 2012), without the past or future Bloomfield mining but with all other surrounding mines active; and
2. **Scenario 2:** A run with the modified Bloomfield mine plan and all other mines active.

Comparison of scenarios 1 and 2 allows the net impact on the hydrogeological environment to be evaluated separately from the effects of Bloomfield alone.

4.0 Existing Environment

4.1 Rainfall and Climate

The nearest long term Bureau of Meteorology (BoM) station to the Bloomfield Colliery is Raymond Terrace 610341, located approximately seventeen kilometres to the east. Rainfall monitoring has been continuous since 1894, although since 1999 the data has become less reliable. Evapotranspiration data has been derived from the BoM Climatic Atlas of Australia. Mean monthly rainfall (1894 – 2017), monthly rainfall for 2016 and monthly evapotranspiration is summarised on **Table 5**.

Mean rainfall is highest during late summer and autumn peaking in March and April. The lowest average rainfall is in late winter and early spring. Evapotranspiration is highest in December and January and lowest in June, exceeding mean monthly rainfall for the months of January to March and August to December. Average monthly rainfall and recorded 2016 monthly rainfall from Raymond Terrace are shown in **Figure 3**.

Mean monthly rainfall (since 1894) has been compared to the recorded 2016 monthly rainfall. Overall 2016 was a drier year with the 991.4 millimetres recorded compared to the mean annual rainfall of 1046.7 millimetres, a difference of 55.3 millimetres. January was an exceptionally wet month with 408 millimetres being recorded which compares to a monthly mean of 98.3 millimetres, a difference of 310.5 millimetres. With the exception of June and August the remaining months were below the mean monthly rainfall.

Table 5 Summary of Monthly Rainfall and Evapotranspiration (Station 610341)

Month	Rainfall mean (mm)	Rainfall 2016 (mm)	Evapotranspiration* (mm)
January	98.3	408.8	182
February	105.7	19.2	143
March	118.1	39.2	127
April	108.1	52.8	96
May	91.7	8.6	68
June	105.5	129.6	57
July	71.0	53.0	67
August	62.6	68.8	93
September	63.1	63.0	120
October	68.9	56.8	149
November	71.8	36.8	167
December	87.0	54.8	200
Total	1046.7	991.4	1470

*Source: Bureau of Meteorology (2001)

The long term data has been collated to calculate a cumulative residual rainfall analysis to assist in the identification of rainfall trends. Time series graphs of cumulative residual rainfall allow long term rainfall patterns to be assessed, with periods of above average rainfall indicated by upward trends and periods of below average rainfall by downward trends. A plot of rainfall residual mass from the Raymond Terrace BoM station for the period 1894 to the end of 2016 is presented as **Figure 4**.

The rainfall residual mass curve shows the Bloomfield area was subjected to relatively dry years from the 1890's to the 1910 followed by a relatively wet period until the late 1940's. The period between the 1940's top the present was relatively wet but punctuated with dry periods, most recently the millennium drought (2001 – 2009). The period from 2009 to 2015 has approximated long term average conditions.

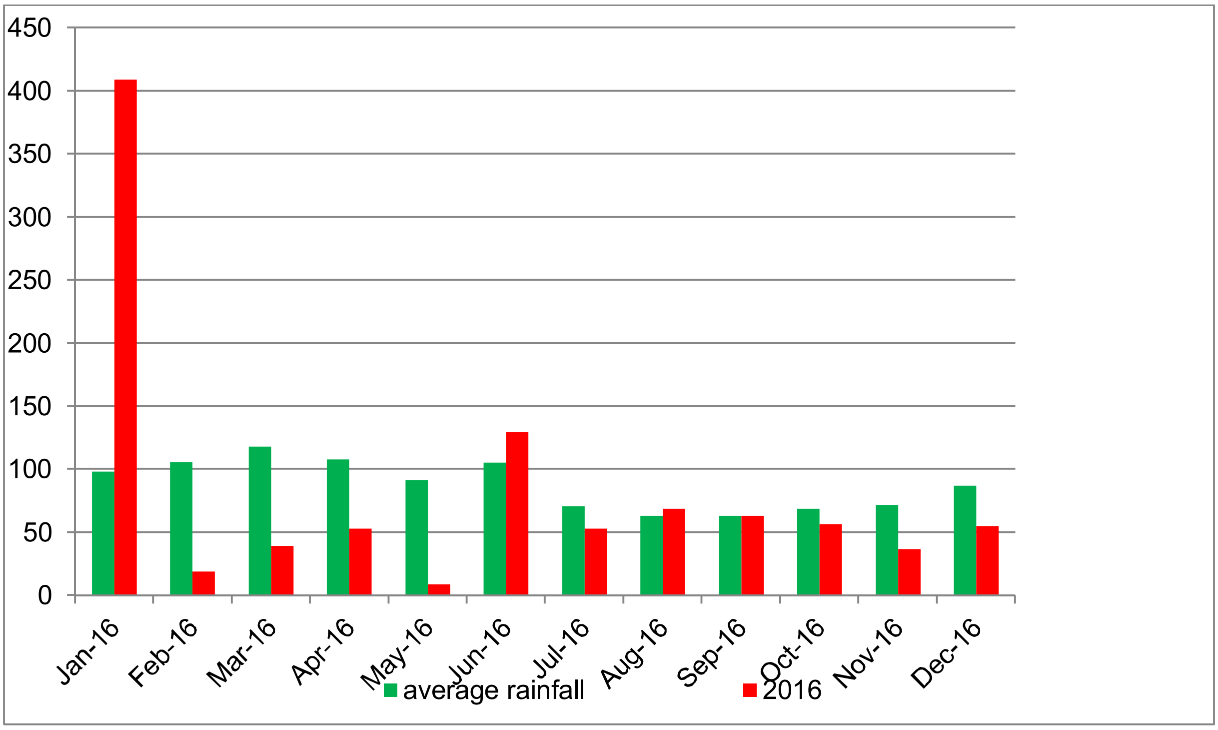

Figure 3 **Average Monthly Rainfall compared to 2016 rainfall at Raymond Terrace**

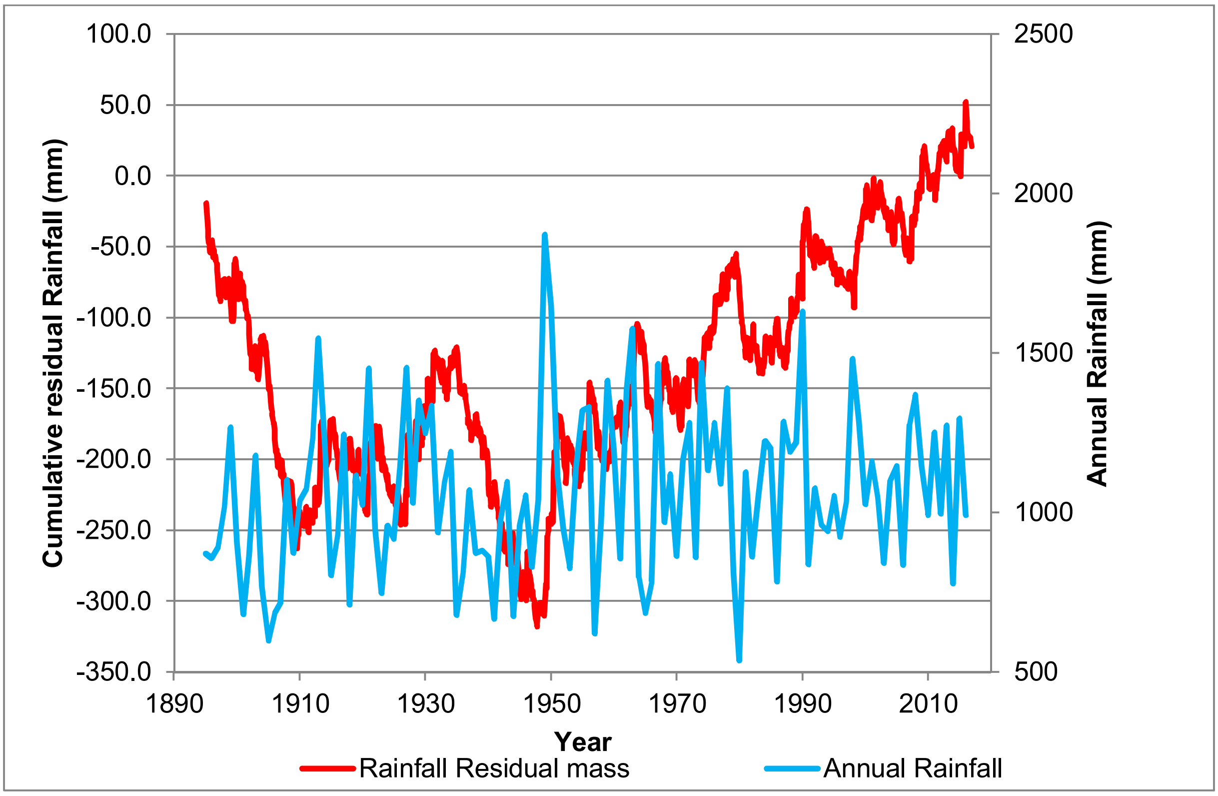

Figure 4 **Rainfall Residual Mass – Raymond Terrace 1894 – 2016**

The closest BOM station to Bloomfield is at the East Maitland Bowling Club (BOM Station 061034), located about 5 km north-east of the Site. The rainfall record for Raymond Terrace and the East Maitland Bowling Club are similar although Mean monthly rainfall at East Maitland is lower. The East Maitland rainfall record has been used to calculate rainfall recharge in the groundwater model as it is closer to the Mine.

4.2 Physiography

The topography surrounding the Colliery is dominated by gentle undulations to low hilly country. Surface drainage flows towards Whites Creek and Four Mile Creek that discharge into the Hunter River. Most of the operational mining areas at Bloomfield are located within the catchment of Four Mile Creek. Wallis Creek is located west of Bloomfield.

A series of drains and levees direct Four Mile Creek around Lake Foster (mine water storage) and into Possums Puddle (clean water storage). From Possums Puddle, clean water overflows, or is discharged, back into Four Mile Creek. The Colliery has two major mine water storage facilities, referred to as Lake Kennerson and Lake Foster.

The topography across the Colliery mine lease ranges from approximately 15 m AHD (Australian Height Datum) to more than 80m AHD.

4.3 Geology

The Colliery is located within the Permian Tomago Coal Measures of the Hunter Valley Coalfields within the Sydney Basin. The target coal seams are the Big Ben, Donaldson, Elwells Creek, Whites Creek and Upper and Lower Buttai seams (Aquaterra, 2008). Interburden between the coal seams consists of interbedded mudstone, siltstone and sandstone along with minor uneconomical coal seams. The overlying Newcastle coal measures do not outcrop at the site. The sediments dip to the south and south-west. Minor dykes and faults cross cut the strata.

To the west of the Colliery Quaternary alluvial deposits of gravel, sand, silt and clay are associated with Wallis Creek which in part forms a wetland system of disconnected ponds and swamps. To the east Quaternary sediments are associated with the Hunter River floodplain. Hexham Swamp has formed within the Quaternary sediments of the floodplain. Elsewhere across the site there are minor alluvial deposits associated with creeks such as Four Mile Creek and Buttai Creek.

4.4 Hydrogeology

4.4.1 Regional Hydrogeology

There are two aquifer groups that dominate the Upper Hunter Valley, the alluvial deposits of the Quaternary and consolidated sedimentary rocks of the Permian. Groundwater can also occur in shallow unconsolidated material that form the regolith and is composed of localised alluvium, colluvium and decomposed rock away from the main creeks. This unconsolidated material located away from the creeks and swamps has negligible resource value, but is important in the groundwater recharge process. All unconsolidated materials are included in Layer 1 of the groundwater model.

Alluvial deposits consisting of gravel, sand and clays where saturated can deliver reliable yields and good quality water which are used for domestic and agricultural purposes. These deposits are typically orders of magnitude more permeable than the Permian age coal seams.

Within the Permian age sedimentary rocks groundwater is typically of poor quality and of low yield. The coals seams represent the main water baring units of the Permian strata and can function as a semi-confined aquifer with vertical leakage from above and below interburden. Weathered zones near or at the surface can act as recharge zones and can form vertically and horizontally disconnected perched aquifers. Permeability’s within the coal seams range from 0.001 to 12 m/day and decrease exponentially with depth (AGE, 1984).

The sedimentary rock interburden has permeability in the range of 0.0013 m/ day to 0.4 m/day (AGC 1984).

Regionally the piezometric surface is a subdued reflection of the topography. At higher elevation features the watertable is typically deeper while at low lying features (e.g. valleys) it is typically closer to the ground surface. The potentiometric surface is more controlled by regional recharge and discharge features. Recharge occurs at or near outcrop to the north with groundwater discharging to the south. There is one low-lying location beside Pambalong Nature Reserve where the potentiometric surface for the Donaldson Seam pre-mining was 20+m above the ground surface (C081A), whereas the water table was below surface (C081B). Mining impact has since taken C081A water level well below surface, whereas the water level in C081B is still just below surface and has not been affected by mining. There is believed to be very limited hydraulic connectivity between the alluvium and Permian Coal Measures (Aquaterra, 2008).

4.4.2 Local Hydrogeology

The hard rock Permian coal measures are the main aquifer unit for the site, with the coal seams themselves representing the most permeable material within the formation. Groundwater typically is restricted to the cleat and fractures within the coal.

Groundwater is also present in the Quaternary alluvium, swamp, floodplain and estuarine sediments. The alluvial groundwater is shallow with groundwater levels being topographically controlled.

The Bloomfield groundwater monitoring network consists of five standpipe piezometers and five multi-level Vibrating Wire Piezometers. The potentiometric heads measured within the coal show a progressive decline with depth. There are stronger vertical gradients on the southern boundary and minimal gradients at the western sites (HydroSimulations, 2017). Piezometer logs are attached in **Appendix C**.

Groundwater in the region shows climatic trends where groundwater elevation drops in response to periods of decreased rainfall (Aquaterra, 2008). Long-term mining effects on the local groundwater system can be seen in the hydrographs prepared by HydroSimulations showing a decrease in groundwater elevation in piezometers monitoring the deeper coal seam aquifers, which isn't seen in the upper alluvial aquifer, with the exception around the Donaldson Open Cut. This infers the alluvium/ weathered overburden and the deeper coal measures are not hydraulically connected. The alluvium and weathered Permian Coal Measures can become hydraulically connected within the deeper coal measures close to the open cuts within fractured strata in the subsidence zones above underground mines, such as above the Donaldson Open Cut.

The highest groundwater levels are in the northern part of the site where the coal measures outcrop. Pre mining the lateral hydraulic gradient would have been to the south and south east, however as a result of open cut mining, large sinks now exist and the natural gradient has been reversed in some locations (Aquaterra, 2008; HydroSimulations, 2017).

4.5 Recharge and Discharge

Recharge for the surficial alluvial aquifers and outcrop areas is dominated by rainfall. The alluvial aquifer is likely to be connected to Wallis Creek and Hexham Swamp, and would discharge to the streams. In wetter periods where the stream levels are higher than that of the water levels in the alluvium, they may contribute to stream flow or seepage from the streams into the aquifer may occur, although this would be short lived after rainfall events.

Coal seams are recharged by rainfall only at outcrop areas. At depth the coal seams are recharged by lateral flow down-gradient from outcrop areas and vertical flow through the overburden (HydroSimulations, 2017).

Groundwater discharge occurs by:

- Evapotranspiration in shallow water table areas;
- Spring flow;
- Baseflow contributions in wet periods;
- Evaporation from in-pit pools and seepage faces; and
- Direct pump out.

Due to naturally high salinity and low yields there is no other significant groundwater abstraction other than mining. There are only a few stock/ domestic bores registered in the government bore database (HydroSimulations, 2017). Bore logs for registered bores within a 4.5 km radius of the Mine are collated in **Appendix D**.

Average A Class pan evaporation for Cessnock (station 061242) and Paterson (061250) are presented below, and have a daily average of 4 mm/ day (1,460 mm/a).

Table 6 Mean Daily Evaporation Data for Cessnock and Paterson Stations (mm/d)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cessnock (1966 – 2012)	5.7	4.9	3.9	2.8	1.9	1.5	1.7	2.5	3.5	4.3	5.0	5.7
Paterson (1967 – 2017)	6.2	5.3	4.2	3.2	2.4	2.1	2.4	3.3	4.4	5.2	5.8	6.6

The actual evapotranspiration (ET) in the district is approximately 800 mm/a according to BoM (2017). The definition for actual ET is "*the ET that actually takes place, under the conditions of existing water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variation are integrated to an area average. For example, this represents the ET which occur over a large area of land under existing (mean) rainfall conditions*" (HydroSimulations, 2017).

4.6 Existing Groundwater Usage

A review of the DI-CLW registered groundwater database showed there were 22 registered bores within 4.5 km of the Colliery most of which were monitoring bores. Four bores were registered for stock, domestic or farming purposes.

4.7 Groundwater Dependent Ecosystems

The *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources* (DPI Water, 2016) does not list any high priority groundwater dependent ecosystems (GDE's) in the vicinity of the site.

Similarly within the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources* (DWE, 2009) there are no high priority GDE's in the vicinity of the site.

4.8 Groundwater Quality

Groundwater in the vicinity of the mine is generally:

- Saline and of negligible beneficial use. Total Dissolved Solids (TDS) concentrations ranged from 1000 mg/L to 13,000 mg/L (Aquaterra, 2008); and
- pH is generally close to neutral (Aquaterra, 2008; Business Environment, 2008).

4.9 Groundwater Surface Water Interaction

The shallow alluvial aquifer, which is associated with Wallis Creek and the Hunter River floodplain, is inferred to be in direct hydraulic connection with the lower reaches of the major tributary streams in the area. This is based on a close correlation between the surface water and groundwater levels (Aquaterra, 2008) and groundwater baseflow in the ephemeral water courses, which is likely to reverse direction during periods of heavy surface water flow.

Groundwater in the localised surficial weathered bedrock is inferred to be in hydraulic connection with the high-level streams. These limited occurrences of surficial groundwater do not represent a significant or regionally extensive aquifer system, and are not considered to be part of the surface water flow system.

There is no evidence of connectivity between surface waters and the deeper aquifers of the coal measures (Aquaterra, 2008).

Modelling of the groundwater and surface water interactions for surface water systems surrounding Bloomfield found that all watercourses were inferred to be gaining systems with the exception of Buttai Creek and Hexham Swamp. The Surface Water Assessment conducted by AECOM (2017) found the final proposed landform will result in a reduction in the catchment area draining towards the final void to approximately 52 Ha, a decrease from the 103 Ha under the currently approved final landscape design. This increases the catchment draining to Buttai Creek by 41 hectares and the catchment draining to Four Mile Creek will increase by approximately 10 hectares.

Figure 5 and **Figure 6** show the local and regional surface water system relative to the Colliery.

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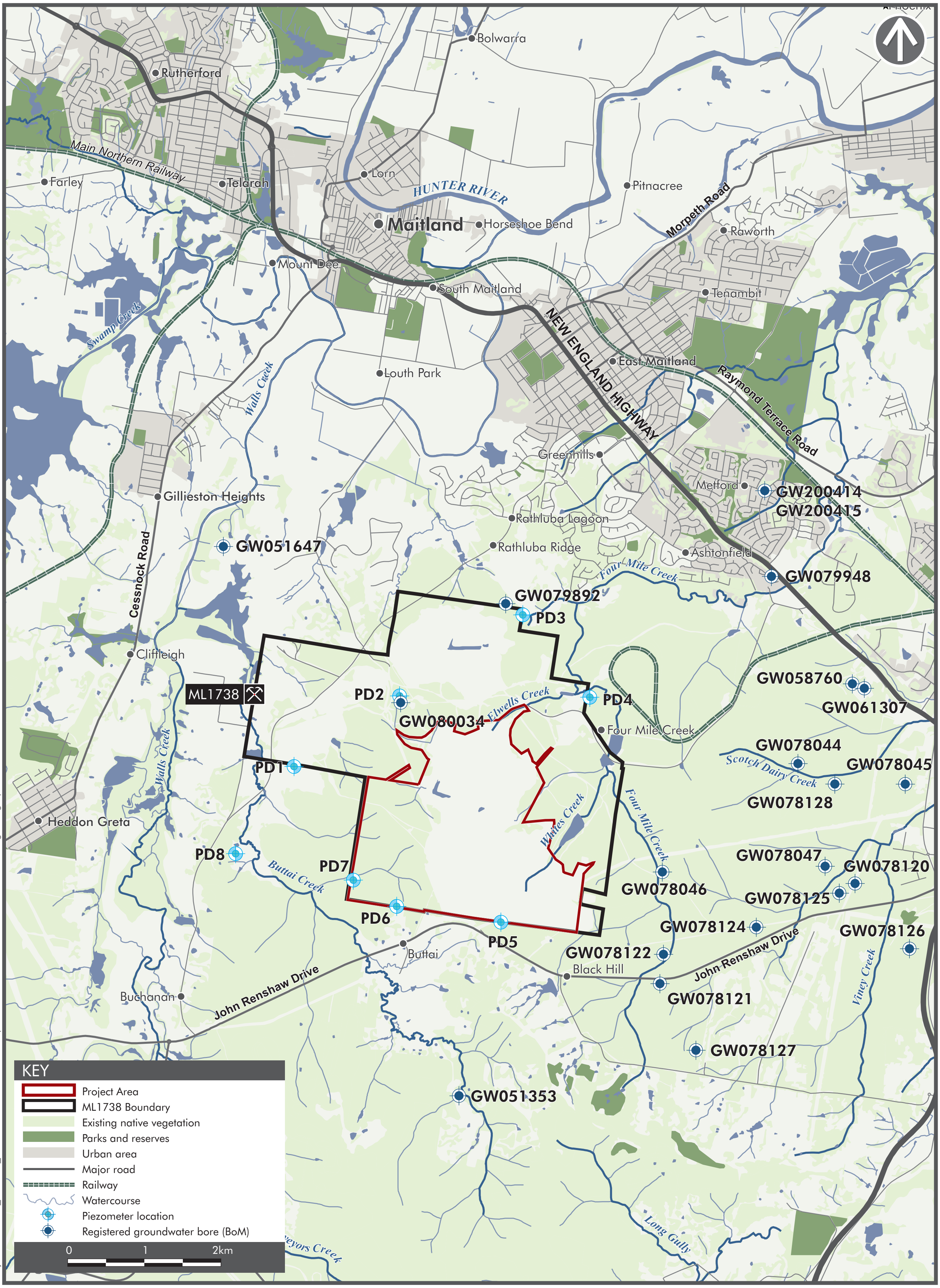
EXISTING MINING OPERATIONS
Bloomfield Project

FIGURE 5



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GROUNDWATER MONITORING BORES AND SURROUNDING REGISTERED BORES

Bloomfield Project

FIGURE 6

5.0 Assessment of Potential Impacts

5.1 Groundwater Extraction

5.1.1 Predicted Mine Inflows

Predicted groundwater extractions via mine inflows are presented in **Table 7.** Inflows in 2006 are predicted to be 0.9 ML/d at the start of open cut mining and will peak around 1.6 ML/d (year 2013) in the calibration period and a peak of 1.5 ML/d in the prediction period. These rates do not incorporate evaporation losses that will occur when the groundwater is exposed to the atmosphere. In 2025 at the cessation of mining inflows are predicted to be approximately 1.0 ML/d.

Table 7 Bloomfield Mine inflow rates (2006 - 2132)

Mine year		Stress Period	Mine inflow (ML/d)	Mine inflow (ML/year)
Calibration	2006	2	0.88	322
	2007	4	0.82	300
	2008	6	0.85	312
	2009	8	0.87	318
	2010	10	0.92	336
	2011	11	1.18	430
	2012	12	1.4	513
	2013	13	1.57	572
	2014	14	1.51	551
	2015	15	1.4	511
	2016	16	1.2	440
	2017	17	1.24	455
Prediction	2018	18	1.42	520
	2019	19	1.42	520
	2020	20	1.54	561
	2021	21	1.53	559
	2022	22	1.16	423
	2023	23	0.69	253
	2024	24	1	367
	2025	25	1	367
	2026	26	0	0
	2027	27	0	0
	2028	28	0	0
	2029	29	0	0
	2030	30	0	0
	2031	31	0	0
Recovery	2032 - 2132	32	0	0

5.1.1.1 Mine Inflow Prediction Refinement

The groundwater model is conservative and applies higher rainfall recharge to the model at various locations across the model domain, resulting in higher predicted mine flows. Two areas of increased modelled recharge are as follows:

1. Mine spoil area; and

2. Catchments of surface water run-off diversions[1]

The mine spoil area (43.3 ha) and the hardstand workshop area (7.5 ha) west of the mine spoil area will receive no rainfall recharge as runoff is captured from these areas and discharged off-site. A recharge rate of 5% of annual rainfall was applied to these areas to keep the model stable. Removal of this water from the model will reduce the mine inflows by 22.61 ML/year.

Clean water catchments across the site divert clean surface water runoff to storage dams which are part of the natural surface water system limiting rainfall recharge. There are four clean water sub-catchments with a total surface area of 623 ha as follows:

1. Buttai Creek – 269 ha;
2. Four Mile Creek – 141 ha;
3. Possum Puddle west 135 ha; and
4. Possum Puddle east 78ha.

A reduction in groundwater recharge from 5% (modelled) to 4% across these catchments is considered realistic to account for the enhanced rainfall runoff. Removal of this water from the model will reduce the mine inflows by 55.4 ML/year.

Thus in total the mine inflow refinements which include a reduction in rainfall recharge from the mine spoil area and clean water sub-catchments would reduce mine inflows by a total of 78.0 ML/year.

The estimated annual water requirements for licensing is summarised in **Table 8** based on the revised mine inflows for the water year. The water year is assumed to be from July through to June.

Table 8 Modelled Mine and Refined Inflows for the Water Year

Water Year	Licence Requirement (ML/year)	
	Modelled	Refined inflow
2016/17	447.5	369.5
2017/18	487.5	409.5
2018/19	520	442
2019/20	540.5	462.5
2020/21	560	482
2021/22	491	413
2022/23	338	260
2023/24	310	232
2024/25	367	289
2025/26	183.5	105.5
2026/27	0	0

The predicted licence requirements from the refined inflows vary from 369.5 ML/year in 2016/17, reaching a maximum of 482 ML/year in 2020/21 and declining to zero in 2026/27. These predicted mine inflows are within the existing mine licence discharge licence of 500ML/year.

[1] The clean water catchment boundaries are defined by the contours, clean and dirty water drawings provided by Bloomfield. The mine lease boundary forms the edge of the catchment areas, where in some instances the actual catchment extends beyond the mine lease boundary. Further detail on the diversion works would assist in refining these catchments.

5.1.2 Alluvial Takes

The alluvial takes from the Wallis Creek Water Source and the Newcastle Water Source are presented in **Table 9**. These takes are only as a result of Bloomfield mining operations and have been considered in the overall mine inflow rates (HydroSimulations, 2017).

Table 9 Modelled Alluvial Takes

	Wallis Creek Water Source Take Extra Leakage (ML/ year)		Newcastle Water Source Take Less Upflow (ML/ year)	
	Calibration Period (2006 – 2017)	Prediction and Recovery Period (2018 – 2132)	Calibration Period (2006 – 2017)	Prediction and Recovery Period (2018 – 2132)
Maximum	8	26	0.2	8
Mean	4	12	0.0	2

5.1.3 Final Void

The final void will remain a sink and will have a wide spread effect of lowering water levels in the vicinity of the mine in the long term. A hypothetical monitoring point within the final void is predicted to only recover 15 m after 100 years, with a void lake water surface of -40 m AHD (HydroSimulations, 2017). The lateral extent of groundwater drawdown at the end of mining (Year 2025) in Layer 1, in excess of two metres, is approximately 2.2 km in an east west orientation across the Bloomfield Mine footprint. However the modelling impacts predict that once the cumulative impacts are removed the there is no drawdown impact above the Bloomfield footprint in the regolith (Layer 1) in excess of two metres.

5.2 Groundwater Drawdown

Predicted groundwater heads have been modelled to show groundwater level and drawdown at the completion of mining in 2025.

Drawdown as a result of mining activities at the Colliery are expected to reach a maximum in the Mine Year 20 or 2025, at which time mining activities are scheduled to cease in the southern end of the approved extraction area and the groundwater levels would start to recover (HydroSimulations, 2017).

Drawdown of approximately 5 m is predicted in the surficial aquifer layer 1 in the Bloomfield extraction area and final mine void (alluvial and regolith) although it is limited in extent. Significant drawdown is also evident within the lease area to the north-west of approved extraction area corresponding with historical open cut and underground mining. Drawdown from the open cut is propagating into the high permeability underground voids, although there is some spatial confinement with the north-westerly trending dyke.

Drawdown is generally less than 0.5 m outside the Bloomfield lease area apart from the south-west corner where the 2 m drawdown contour extends outside the lease approximately 600 m beneath Buttai Creek (HydroSimulations, 2017).

The predicted drawdowns are not expected to negatively impact GDE's as historical mining in the area has previously lowered water levels far below the ground surface.

The Donaldson open cut and final void are predicted to experience significant drawdown, however there is no overlap of the water table drawdowns produced by the various mines (HydroSimulations, 2017).

Predicted drawdown at the end of mining in nearby registered bores (within 5 km) are shown in **Table 10**. All predicted drawdown values are cumulative. As outlined in Table 10 the purpose of the majority of registered bores within 5 km of the mine are for monitoring. Only four bores are constructed for non-monitoring purposes and the predicted drawdown in each of these bores is less than one metre.

Most of the drawdown are predicted to be less than one metre, however drawdowns between 1-2 m are predicted for three bores (GW078047, GW078128 and GW078044), which is within the Aquifer Interference Policy threshold of 2 m.

Parts of the regolith (Model Layer 1) are predicted to be dewatered due to the watertable drawdown associated with the Donaldson open cut and final void.

Table 10 Predicted Drawdown in Registered Bores at End of Mining 2025

Bore number	Easting (MGA)	Northing (MGA)	Lithology	Bore depth (m)	Purpose	Drilled year	Predicted drawdown (m)
GW200415	369986	6373738	sandstone	20.1	monitoring	2004	<1
GW078120	371176	6368590	mudstone/shale	24	monitoring	1997	<1
GW080034	365222	6370959	#	NA	monitoring	NA	<1
GW078125	370970	6368464	siltstone/sandstone	30	monitoring	1997	<1
GW058760	371142	6371207	sandstone/siltstone	33	farming	1983	<1
GW061307	371299	6371148	shale/sandstone	30	domestic	1984	<1
GW200414	369960	6373761	sandstone	10	monitoring	2004	<1
GW078123	369309	6386165	sandstone/siltstone	33	monitoring	1997	17
GW051647	362896	6373006	sandstone	12	stock	1980	<1
GW078047	370784	6368800	siltstone	54.3	monitoring	1997	1.5
GW078122	368666	6367663	sandstone	35.4	monitoring	1997	<1
GW078124	369883	6368018	mudstone	40	monitoring	1997	20
GW078045	371836	6369892	siltstone	30.5	monitoring	1997	<1
GW078128	370912	6369893	siltstone/mudstone	30	monitoring	1997	2
GW051353	365986	6365810	shale	49.7	domestic	1997	<1
GW079892	366598	6372257	regolith	6.69	monitoring	1980	<1
GW078046	368651	6368741	siltstone/sandstone	30.4	monitoring	NA	<1
GW079948	370081	6372613	#	NA	monitoring	1997	<1
GW078044	370428	6370151	siltstone	30.1	monitoring	NA	1.4
GW078127	369073	6366406	siltstone/mudstone	30	monitoring	1997	<1
GW078126	371890	6367736	Siltstone/mudstone	30	monitoring	1997	<1
GW078121	368619	6367262	siltstone	43	monitoring	1997	<1

Notes: # unknown

5.3 Groundwater Quality Impacts

Groundwater within the Bloomfield mine lease is saline and of negligible beneficial use. The potential impacts of Bloomfield's current and future operations relate to the risks of contamination from disturbed catchments, mine water, and process water being released off site to natural waterbodies.

Discharges to Four Mile Creek from Bloomfield occur from Lake Foster discharge pipe outlet and are monitored and reported in accordance with EPL 396. Since the approval of the Project there have been four unplanned discharges as a result of large rainfall events or pipe failure which resulted in water overflowing from storage dams and leaving the site. These incidents were reported to the EPA in accordance with Project Approval and EPL requirements.

The proposed modification being sought by Bloomfield will not increase or decrease the probability of unplanned discharges, or water quality risks, from Bloomfield's operations. However these risks will continue to exist up until the end of extraction (2030) and until such time as the site is rehabilitated noting that risks would decrease with the progressive rehabilitation of post mining areas across the life of the project. As part of the management measures described in Section 6.0 Bloomfield will update the environmental management systems as part of the project to further minimise the risk of unplanned discharges.

5.4 Baseflow Impacts

The model was set up to accept baseflow if groundwater levels exceeded riverbed elevations, but not to allow leakage as most streams in the area are ephemeral. The model was able to predict reduction to baseflow but was unable to predict increases in leakage from losing streams. Baseflow simulations were run for both mining and null simulations.

The predictions are:

- Four Mile Creek is predicted to be converted to a losing stream around 2011, therefore its average baseflow of 0.24kL/ day would be lost;
- The difference between mining and null runs for all other water courses was negligible, indicating that Bloomfield mining (as distinct from cumulative impacts) is having an insignificant effect on baseflow capture; and
- Leakages for Hexham Swamp differed by no more than 1 kL/ day between both mining and null. This would be within numerical error bounds.

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6.0 Monitoring and Management of Impacts

6.1 Monitoring

In order to monitor the drawdown effects from depressurisation of the regional aquifer ongoing quarterly monitoring of the onsite piezometer network and monthly surface water monitoring is recommended. In addition the installation of additional monitoring points will be considered if areas of predicted drawdown are significantly different to actual drawdown.

The frequency of water level measurements within the pit should be compatible with the frequency of evaporation measurements obtained from the site's weather station which will allow refinement of model calibration and inflow predictions.

The groundwater monitoring level data was used to calibrate the model and in most cases good matches were made for the existing historical data. Exceptions were recorded in VW7 and VW8. The poor match in VW7, located at the south-western edge of the extension is attributed to the assumed timing of mining. In the case of VW8 the poor match is attributed to its location close to the edge of the old Buchanan Mine workings for which no data was readily available.

6.2 Management

Bloomfield has an existing Water Management Plan (WMP) which details the monitoring and management measures which are currently in place for the management of groundwater (and surface water) at the Colliery. The WMP will be reviewed and updated in accordance with the conditions of consent to monitor groundwater levels in monitoring wells and in the pit. Groundwater discharge will be monitored to quantify pit inflows to ensure the discharge licence conditions are satisfied.

The monitoring data collected from groundwater and surface water systems enables management of groundwater impacts through the following recommendations:

- Establishment of groundwater and surface water trigger levels based on the beneficial use of each water body;
- Mitigation measures may include the provision of 'make good' measures in bores where excessive drawdown may be experienced. This could involve deepening a water supply bore or providing an alternative water supply. No surface water mitigation measures are proposed due to the minimal predicted impacts;
- Groundwater level data will be plotted as hydrographs and compared to rainfall; and
- The results of the groundwater monitoring program will be collated on an annual basis and presented in an annual report as required under the conditions of consent.

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7.0 Policy Compliance

7.1 Aquifer Interference Policy

The *Water Act 1912* (NSW) has been replaced by the WM Act and does not apply to areas of the state where water sharing plans are in place. Groundwater and surface water within the project footprint are covered by the *Water Sharing Plan for the Hunter Regulated River Water Source* and the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016*.

The AIP explains the requirements of the WM Act. It clarifies the requirements for licences for aquifer interference activities and establishes the considerations required for assessing potential impacts on key water dependent assets. Any potential impact on local aquifers would be assessed under this policy.

A controlled activity approval (such as a water access licence or aquifer access licence) and/or an aquifer interference approval is required under the WM Act for any activity that results in interference to an aquifer. Under section 91F of the WM Act, approval is required for aquifer interference activities. These activities include the taking of groundwater. The policy applies to all aquifer interference activities, but has been developed to address a range of high risk activities.

7.2 Minimal Impact Assessment

The AIP outlines minimal impact considerations that must be met as a result of the proposal. The minimal impact considerations are dependent upon the impacted aquifer type (alluvial, coastal, fractured rock or special cases such as the Great Artesian Basin) and whether the aquifer is 'highly productive' or 'less productive groundwater'. The impacts to be considered are to groundwater levels (or water pressure in artesian basins) and water quality as follows:

- **Water table** (drawdown) – impact is considered to be minimal where there is less than a cumulative two metre decline at any water supply work. If the impact is greater than two metres than make good provisions apply;
- **Water table** (receptors) – impact is considered to be minimal where the water table change is less than 10 percent of the cumulative variation in the water table 40 metres from any high priority GDE or high priority culturally significant site listed in the water sharing plan;
- **Water pressure** – impact is considered to be minimal where the cumulative decline in head is less than two metres at any water supply work; and
- **Water quality** – impact is considered to be minimal where the change in groundwater quality is within the current beneficial use category of the groundwater beyond the 40 metres of the activity.

If the predicted impacts are less than Level 1 minimal impact considerations (as defined in the AIP) then these impacts are considered acceptable. If, however, the impacts are assessed as greater than Level 1 but these predicted impacts exceed the Level 1 thresholds by no more than the accuracy of a robust model, the project would be accepted as suitable with appropriate monitoring during operation. To reduce the impacts, mitigation measures such as make good provisions may be required to protect a resource or receptors. Where the groundwater impacts are deemed not acceptable the project may have to be modified to reduce the groundwater impacts on an acceptable level.

The majority of the project footprint is considered to be within a 'Less Productive Groundwater Source' within fractured rock, based on the low number of registered bores in the area. In outlining the Minimal Impact Considerations (Table 1, AIP) the policy considers porous and fractured rock water resources together.

A minimal impact assessment has been conducted for the groundwater potentially impacted by the project in accordance with the *NSW Aquifer Interference Policy Step by Step Guide* (NoW, 2013b). The minimal impact considerations for 'highly productive groundwater' in a fractured rock aquifer and for 'less productive groundwater' in a coastal aquifer are presented in **Table 11** and **Table 12** respectively.

Table 11 Minimal Impact Considerations for a 'highly productive groundwater alluvial aquifer"

Minimal Impact Considerations	Response
Water Table – Level 1 Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic 'post water sharing plan' variations, 40 m from any: High priority groundwater dependent ecosystem; or High priority culturally significant site listed in the schedule of the relevant water sharing plan, or A maximum of a 2 m decline cumulatively at any water supply work.	There are no high priority groundwater dependent ecosystems listed under the *North Coast Fractured and Porous Rock Groundwater Sources* No culturally significant sites were identified within the *North Coast Fractured and Porous Rock Groundwater Sources* Groundwater modelling indicates that drawdown effects on the surficial aquifer are not expected to have any adverse impact on groundwater dependent ecosystems because the groundwater levels are already well below ground surface.
Water Table – Level 2 If more than 10% cumulative variation in the water table, allowing for typical climatic 'post water sharing plan' variations, 40 m from any: High priority groundwater dependent ecosystem; or High priority culturally significant site; listed in the schedule of the relevant water sharing plan, if appropriate studies demonstrate to the Minister's satisfaction that the variation will not prevent the long term viability of the dependent ecosystem or significant site. If more than a 2 m decline cumulatively at any water supply work then make good provisions should apply.	The alluvium of both the Wallis Creek Water Source and the Newcastle Water Source (along the lower Hunter) are classified as 'Highly Productive' by DPI Water. The calculated alluvial takes (rounded to the nearest ML/a) for separate simulation phases are recorded in **Table 9**. These takes are due only to Bloomfield mining. The standpipe SP4-2 is located near Four Mile Creek. It is more likely that the water level in this bore is influenced by water level in the creek, when it flows. The simulated hydrograph shows a rising trend for some years, followed by stabilisation. SP7-1 is located at the western border of the Bloomfield mine. The prediction and recovery stages of the simulated hydrograph suggest that the water level will decline due to mining and not recover significantly. This bore would remain within the zone of influence of the final void. Most of the drawdown for registered bores calculated by the model are much less than 1 m, while drawdown greater than 1 m and up to 2 m are predicted at three bores (GW078047, GW078128 and GW078044), which is within the AIP's 2 m threshold.
Water Quality – Level 1 Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	Not applicable
Water Quality – Level 2 If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long term viability of the dependent ecosystem, significant site or affected water supply works.	Not applicable

Table 12 Minimal Impact Considerations for a 'Less Productive Fractured Rock Aquifer'

Minimal Impact Considerations	Response
Water Pressure – Level 1 A cumulative pressure head decline of not more than a two metre decline, at any water supply work.	Significant drawdown is also evident within the lease area to the north-west of the approved extraction area, coincident with historical open cut and underground mining. Drawdown from open cut mining is propagating into the high-permeability underground voids, with some spatial confinement offered by a north-westerly trending dyke. The drawdown is generally less than 0.5 m outside the Bloomfield lease boundary except for the south-west corner where a 2-m drawdown contour extends off-lease. The 2 m of drawdown extends beneath Buttai Creek for a distance of about 600 m.
Water Pressure – Level 2 If the predicted pressure head decline is greater than condition 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long term viability of the affected water supply works unless make good provisions apply.	Whites Creek Seam: All three vibrating wire piezometers (VWP) lie along the southern boundary of the Bloomfield lease. All simulated hydrographs show significant mining effects, with the degree of recovery being minimal but increasing from east to west, due to the effects of adjacent underground mining. Donaldson Seam: Four out of seven bores (SP2-1, VW1(35m), VW6(114m) and VW7(95m)) in this layer show slow water level recovery post-mining. Water levels at bores SP3-1 and VW5(71m) show no sign of recovery. Most bores are influenced by adjacent underground mining. Big Ben Seam: All simulated hydrographs show significant declines due to mining, with slow or negligible recovery in some cases. Most bores are influenced by adjacent or historical underground mining.
Water Quality – Level 1 Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	Not applicable
Water Quality – Level 2 If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long term viability of the dependent ecosystem, significant site or affected water supply works.	Not applicable

7.3 Compliance with the Water Sharing Plan

The project is covered by the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016*, which applies to 13 groundwater sources. The Water Sharing Plan outlines a series of rules for granting access licences (Part 7), managing access licences (Part 8), water supply works approvals (Part 9), access licence dealings (Part 10) and mandatory conditions (Part 11). A summary of relevant rules and an assessment of project compliance are provided in **Table 13**, it was found that all rules are complied with.

Table 13 Project Compliance with the Water Sharing Plan

Rule	Assessment
Rules for granting access licences	Groundwater access is managed under Licence 20BL172035. There are no surface water licences.
Rules for managing access licences	The EPL and Water Management Plan detail the process in which water access is managed and discharged.
Distance restrictions to minimise interference between supply works	There are no supply works within the area of the Colliery.
Distance restriction from the property boundary is 50 m	Property boundary is outside the 50 m restriction.
Distance restriction from an approved water supply work is 100 m	No bores registered to property outside the Mine have been identified within 100 m of the project.
Distance restriction from a Department observation bore is 200 metres	There are no DPI Water observation bores within 200 m of the project footprint.
Distance restriction from an approved work nominated by another access license is 400 m.	There are no water supply works nominated by another access licence within 400 m of the project footprint.
Distance restriction from an approved water supply work nominated by a local water utility or major utility access licence is 1000 m	There are no local or major water utilities within 1000 m of the project footprint.
Part 9 – 40 Rules for water supply works located near contaminated sources	There are no identified contamination sources located near the project area.
Part 9 – 41 Rules for water supply works located near sensitive environmental areas	The project footprint is located outside the required distance for the following sensitive environmental areas: • 200 m of a high priority groundwater dependent ecosystem; • 500 m of a karst groundwater dependent ecosystem; and • 40 m from a lagoon or escarpment. The project footprint is not located outside the required distance of the following sensitive environmental areas: • 40 m from third order streams or above. The non-compliance of the third order streams is considered acceptable as the creeks form part of the surface water discharge system under the Mines EPL.
Part 9 – 42 Rules for water supply works located near groundwater dependent	The project footprint is not located near a groundwater dependent culturally significant site.

Rule	Assessment
culturally significant sites	
Part 9 – 44 Rules for water supply works located within distance restrictions	There are no water supply works that are located within restricted distances along the project footprint.
Part 10 – Access dealing rules	Groundwater access is managed under Licence 19027. There are no surface water licences.

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8.0 Conclusions and Recommendations

Bloomfield is seeking approval for modifications to Project Approval 07_0087, for the extension of mining operations up until 31 December 2030 and a revised final landform.

Mine scheduling to support the Project Approval identified that the resource would be exhausted by the end of 2021. However, Bloomfield now predicts mining to extend beyond 2021 due to:

- Actual run of mine (ROM) production levels have been lower than the predicted ROM production rates of 1.3 Mtpa, over the life of the project to-date;
- Changes to the mine fleet have allowed access to, and extraction of seams that were not previously considered to be a recoverable resource as part of the original 2008 EA; and
- Further exploration has identified other previously unrecoverable resources that the new fleet can now access.

Bloomfield has identified up to 13 million tonnes of ROM coal remaining inside the approval area. Based on current annual mining rates of approximately 1 million tonnes of ROM per year, mining will extend beyond 2021. The intention of this consent modification is to align the Bloomfield mining operations consent limit to coincide with the adjoining Abel Underground Mine consent limit of 31 December 2030. Maximum annual production levels will continue at 1.3 Mtpa ROM per year.

For licencing purposes the maximum inflow predicted by the model across the life of the proposed Project is 561 ML/a in 2020. However the groundwater model is conservative and applies higher recharge across parts of the model domain. The mine inflows have been recalculated reducing recharge to these areas and the resultant mine inflows are within the licence conditions of 500ML/a. The final void will remain a sink and will have a wide spread effect of lowering water levels in the coal measures in the long term, which is the vicinity of the mine. A hypothetical monitoring point within the final void is predicted to only recover 15 m after 100 years.

The maximum groundwater drawdown as a result of mining activities is expected to reached in 2025, at which time mining activities are scheduled to cease in the southern end of the approved extraction area and groundwater levels would start to recover. A drawdown of 5 m is predicted in the surficial aquifer in the Bloomfield approved extraction area and final mine void. Drawdown is generally less than 0.5 m outside the Bloomfield lease area apart from the south-west corner where the 2 m drawdown contour extends outside the lease approximately 600 m beneath Buttai Creek. The predicted drawdowns are not expected to negatively impact GDE’s as historical mining in the area has lowered water levels far below the ground surface.

Discharges to Four Mile Creek from Bloomfield occur from Lake Foster discharge pipe outlet and are monitored and reported in accordance with EPL 396. The proposed modification will not increase or decrease the probability of unplanned discharges, or water quality risks from Bloomfield’s operations.

Predicted surface water impacts were considered negligible, indicating that Bloomfield mining is having an insignificant effect on stream baseflow. Four Mile Creek is predicted to have been converted to a losing stream around 2011, losing an average baseflow of 0.24kL/ day.

A minimal impact assessment has been conducted for the groundwater potentially impacted by the project in accordance with the AIP. All predicted impacts are less than Level 1 minimal impact considerations (as defined in the AIP) and are therefore considered acceptable with appropriate monitoring during operation.

The project is covered by the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016*. An assessment of project compliance found that all rules are complied with.

Monitoring and Management Recommendations

In order to monitor the drawdown effects from depressurisation of the regional aquifer ongoing quarterly monitoring of the onsite piezometer network and surface water monitoring is recommended. In addition the installation of additional monitoring points will be considered where areas of predicted drawdown are significantly different to that of the actual drawdown.

The frequency of water level measurements within the pit should be compatible with the evaporation monitoring frequency obtained from the site's weather station which will allow refinement of model calibration and inflow predictions.

The monitoring data collected from groundwater and surface water systems enables management of groundwater impacts through the following recommendations that would be implemented in a groundwater management plan:

- Establishment of groundwater and surface water trigger levels which require an assessment of the ongoing impact at each location;
- Mitigation measures may include the provision of 'make good' measures in bores where excessive drawdown may be experienced. This could involve deepening a water supply bore or providing an alternative water supply. No surface water mitigation measures are proposed due to the minimal predicted impacts; and
- Groundwater monitoring is to be undertaken in accordance with a groundwater monitoring plan developed in accordance with the approval consent conditions.

9.0 References

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Appendix A

Groundwater Modelling Report
HydroSimulations

Appendix A Groundwater Modelling Report HydroSimulations

Bloomfield Colliery Extension
Groundwater Modelling Assessment

FOR

AECOM and

The Bloomfield Group

BY

NPM Technical Pty Ltd

trading as

HydroSimulations

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Role	Persons
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Internal Reviewer	Dr N. Merrick
External Reviewer	P. Dundon

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

The Bloomfield Colliery (Bloomfield) is an existing open cut mining operation located near Buttai in the Hunter Valley of New South Wales (NSW), about 25 kilometres (km) north-west of Newcastle, and about 5 km south of Maitland. The project site is located a few kilometres west of the M1 Motorway and immediately North of John Renshaw Drive (B68 Freeway) (**Figure 1).**

Bloomfield is one of two open cut coal mines owned by its parent company, Big Ben Holdings Pty Limited. It produces approximately 0.6 million tonnes of product coal per annum (Mtpa) by open cut methods. Coal has been mined on the site for approximately 170 years. Underground mining commenced in 1937 to the west and north-west of current open cut mining (**Figure 2**), and the last coal extracted from underground operations was in 1992. Bloomfield produces mainly thermal coal with some semi-soft coking coal, principally for the Asian export market.

The current operation consists of open cut mining, a Coal Handling and Preparation Plant (CHPP) and a rail loading facility that transports processed coal to the Port of Newcastle. The open cut commenced operations in 1964 and has continued to the present day. Part 3A approval was granted in September 2009, with three Modification approvals since then (May 2011, March 2012, February 2013). The 2009 approval (07_0087) was supported by a Groundwater Impact Assessment conducted by Peter Dundon & Associates Pty Ltd with groundwater modelling conducted by Aquaterra Consulting Pty Ltd (Aquaterra, 2008).

The continued use of the coal washery and rail loading facility (including the management of water associated with the washery, coarse reject and tailings disposal, and coal handling) was approved in June 2007 as part of the Abel Underground Mine project. Bloomfield is currently progressing its approved open cut mining program and is actively rehabilitating former mining areas on the site.

This Modification seeks extension of open cut mining operations approximately 200 metres (m) to the west, to the boundary of the lease (**Figure 3**). Over this interval, the deepest mining of the Big Ben Seam will step up to the Donaldson Seam to allow for the Big Ben Seam having been mined previously by underground mining methods.

This report is limited to the *Groundwater Modelling Assessment* of open cut mining, taking into account the cumulative effects of neighbouring underground mines. The focus of the modelling is on cumulative and incremental impacts to the baseflow/leakage interactions with Hexham Swamp and key watercourses, with quantification of likely mine inflow, groundwater heads generally and drawdowns at registered bores. The groundwater takes from each designated water source are quantified and provided as an input for assessment of licensing requirements in the *Groundwater Impact Assessment* prepared by AECOM. Similarly, quantification of other groundwater impacts is passed to AECOM for assessment in accordance with the Aquifer Interference Policy (NSW Government, 2012).

1.1 Interaction of Bloomfield with District Mines

Other mines in the vicinity of Bloomfield are located on **Figure 1**. Coal from the Bloomfield Colliery, together with coal from the Donaldson open cut mine, the Abel underground mine and the Tasman underground mine, is processed through the Bloomfield CHPP.

The tailings from the CHPP are disposed at the Bloomfield site. Until mid-2007, tailings were deposited predominantly underground in former workings, but are now deposited in abandoned open cuts on the Bloomfield site. Water is recovered from the tailings and recycled through the CHPP.

For assessment of cumulative effects, all neighbouring underground and open cut mines are included in the numerical groundwater model.

1.2 Scope of Work

The tasks to be addressed to achieve the objectives of the groundwater modelling study are:

- Modification of the existing numerical groundwater model used for previous investigations at Abel Mine.
- Contraction of the southern extent of the model from northing 6350000 to 6357425 (to reduce prohibitive model size).
- A re-build of the model geometry in the Bloomfield area using the latest geological model in that area.
- Inclusion of historical Big Ben underground works (not in the current Abel model).
- Inclusion of a dyke in the Bloomfield area (not in the current Abel model).
- Retention of MODFLOW-SURFACT software for consistency with previous assessments, with use of the TMP facility for time-varying changes in permeability and storage to represent open cut infill (and underground fracturing);
- Extension of model calibration from December 2015 to April 2017.
- Construction of prediction models for all mines, with and without Bloomfield operations.
- Prediction model for the proposed extension at Bloomfield plus the approved operations at Abel and Donaldson.
- Construction of a recovery model for the Bloomfield extension and neighbouring mines.

2 HYDROGEOLOGICAL ANALYSIS

2.1 Geology

The Bloomfield Colliery is located in the Newcastle Coalfield where the Permian Tomago Coal Measures are dominant (**Figure 4**). The target seams at Bloomfield are the Big Ben, Donaldson, Elwells Creek (EC), Whites Creek (WC) and Upper and Lower Buttai Coal Seams (C, B, A seams) (Aquaterra, 2008). The strata of the coal measures dip towards the south and south-west.

Quaternary alluvial deposits of gravel, sand, silt and clay are most pronounced to the west of Bloomfield along Wallis Creek, and far to the east associated with the Hunter River (**Figure 1**). The underlying interburden sediments consist of mudstone, siltstone and sandstone (Aquaterra, 2008).

Surface topography in the Bloomfield project area ranges from less than 20 mAHD (Australian Height Datum) to more than 80 mAHD.

2.2 Hydrology

Lake Kennerson and Lake Foster (**Figure 3**) are the major mine water storage facilities on site. Water is pumped from the open cut pits through open drains to Lake Kennerson. Runoff from disturbed areas is also transferred to Lake Kennerson, where suspended solids are allowed to settle. From there, water feeds to Lake Foster by controlled release. Lake Foster also receives decant water from the tailings dam (**Figure 3**). From there, water is pumped to the CHPP for use in coal processing and dust suppression.

Mine water is discharged under Environmental Protection Licence (EPL 396) into Four Mile Creek via an open drain (**Figure 5**).

Four Mile Creek, the main stream near the site, has been diverted around Lake Foster by a series of drains and levees. Diversion banks and channels have been constructed to direct runoff from undisturbed and rehabilitated areas away from operational areas and mine water storages. This clean water is directed into clean water dams or natural watercourses. The major clean water storage dam is Possums Puddle which overflows into a natural drainage system. No clean water is used for operational purposes.

Other watercourses in the vicinity of Bloomfield and the district mines are located on **Figure 5**. Creeks are generally ephemeral and are sustained by runoff and occasional baseflow contributed by groundwater discharge during wet conditions.

The Bloomfield area consists of low undulating hills and is bordered by Buttai Creek and Four Mile Creek catchments to the west and east, respectively. Buttai Creek drains westwards into Wallis Creek and then into Hunter River east of Maitland. Four Mile Creek drains eastwards into the Hunter River floodplain east of Morpeth.

2.3 Hydrogeology

Shallow groundwater is present in alluvial, swamp, floodplain and estuarine sediments. Groundwater also appears locally in the shallow weathered Permian, which extends to depths of 10-20 m (Aquaterra, 2008). Shallow groundwater levels are topographically controlled. Deeper groundwater is present in the coal measures, with relatively higher permeability in the coal seams.

The Bloomfield groundwater monitoring network consists of five standpipe piezometers (measured quarterly) and five bores instrumented with datalogged vibrating wire piezometers (VWPs). Their locations are shown in **Figure 6**. The potentiometric heads within the coal measures show a progressive decline with depth, with stronger vertical gradients on the southern boundary of the lease (at VW5 and VW6, close to Abel workings) and minimal gradients at the western sites.

Many monitoring bores show evidence of depressurisation due to mining (**Appendix B**). Drawdowns due to mining range from 10 m to about 60 m. Shallow alluvium and regolith bores do not show mining effects. This indicates limited hydraulic connectivity between the alluvium/weathered overburden and the deeper coal measures.

Aquaterra (2008) reported representative properties for the main hydrogeological units based on hydraulic testing on the Bloomfield site, supplemented by previous investigations for the

Abel and Donaldson projects, and experience in other parts of the Hunter Valley coalfields. Representative values are summarised in **Table 1**.

Table 1
Representative Properties of Hydrogeological Units

Units	Horizontal Hydraulic Conductivity (m/d)	Storage Coefficient [-]	Specific Yield [%]
Coal Seams	0.01 to 0.1	0.0001	1
Interburden (Undisturbed)	0.001	0.00001	0.5
Interburden (Disturbed by subsidence from underground mining)	0.1 to 10	0.0001	1 to 5
Alluvium	1 to 5	0.0001	10

Note: Vertical hydraulic conductivity for coal measure units are generally less than one tenth of the value of horizontal hydraulic conductivity

Groundwater within the coal measures is controlled by recharge-discharge processes, with the highest groundwater levels in the northern parts of the lease where the coal measures outcrop. Under pre-mining conditions, the lateral hydraulic gradient would have been to the south and south-east. Open cut mining has created groundwater sinks which have reversed the natural groundwater flow directions in some locations.

2.4 Recharge

The surficial alluvial aquifers and outcrop areas are recharged from rainfall. Most likely the alluvial aquifers are in hydraulic continuity with Wallis Creek to the west and Hexham Swamp to the east. The shallow aquifer system normally discharges to the streams, although during wet periods stream flow may contribute some recharge to these alluvial aquifers for short periods while stream water levels are temporarily higher than the adjacent alluvium groundwater levels. Stream flows from runoff are generally short-lived after rainfall events.

Coal seams are recharged directly from rainfall only where they are outcropping or subcropping on the north-eastern side of the lease. At depth, coal seams are recharged by lateral flow down-gradient from the outcrop areas, and to a lesser extent vertical flow through the overburden. Rainfall recharge rates within the hard rock outcrop area are expected to be relatively low (1-10 mm/a).

Long term records of rainfall data are available for several nearby stations, the closest being the East Maitland Bowling Club (station 061034) about 5 km north-east of Bloomfield. **Table 2** lists the mean monthly and annual rainfall, based on more than 90 years of daily rainfall data from 1902 to closure of the station in 1994.

Table 2
Mean Monthly Rainfall at East Maitland Bowling Club (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean (mm)	89.0	94.1	96.5	87.4	70.3	84.2	58.1	52.2	54.8	65.5	61.6	81.3	889.9

2.5 Groundwater Discharge

Groundwater discharge can occur by evapotranspiration in areas of shallow water table, or spring flow where the water table intersects the land surface, or through baseflow contributions to watercourses. Open cut mining facilitates groundwater losses by evaporation from in-pit pools or seepage faces on excavation walls, or direct pump-out.

Due to naturally high groundwater salinity and low bore yields, there is no significant groundwater abstraction other than coal mine dewatering. Only a few stock/domestic bores are registered in the government bore database.

Average A Class pan evaporation data are available for Cessnock (station 061242) and Paterson (station 061250). **Table 3** summarises mean monthly evaporation rates, giving an average of about 4 mm/day (1,460 mm/a).

Table 3
Mean Daily Evaporation Data for Cessnock and Paterson Stations (mm/day)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cessnock [1966-2012]	5.7	4.9	3.9	2.8	1.9	1.5	1.7	2.5	3.5	4.3	5.0	5.7
Paterson [1967-2017]	6.2	5.3	4.2	3.2	2.4	2.1	2.4	3.3	4.4	5.2	5.8	6.6

The actual evapotranspiration (ET) in the district is approximately 800 mm/a according to BoM (2017). The definition for actual ET is: "... the ET that actually takes place, under the condition of existing water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average. For example, this represents the ET which would occur over a large area of land under existing (mean) rainfall conditions."

3 GROUNDWATER SIMULATION MODEL

3.1 Existing Groundwater Models

The 2009 approval (07_0087) was supported by a Groundwater Impact Assessment conducted by Peter Dundon & Associates Pty Ltd with groundwater modelling conducted by Aquaterra (2008). Key features of the original Bloomfield groundwater model were:

- MODFLOW-SURFACT software
- Extent 14 km x 14.5 km
- Cell size 25 m x 25 m to 100 m x 100 m
- 276 rows, 277 columns, 8 layers; 612,000 model cells
- Boundary set at deepest coal seam outcrop limits
- Boundary set at Wallis Creek and Hexham Swamp
- Inclusion of Donaldson and Abel mines.

The original Bloomfield model was developed from an earlier model for the Abel Mine. Subsequently, there have been various modifications (in lateral and vertical extent) to this model for more detailed assessments of the Abel, Donaldson and Tasman Mines.

A more extensive groundwater model with 20 layers was developed by RPS Aquaterra (2013) for the Abel Underground Mine MOD3 (known as the 'A33' model). HydroSimulations (2015) modified and partially recalibrated this model for a modified mine plan with different sequencing at Abel and Tasman. For approved mining, changes were made to the height of continuous fracturing above Abel underground panels.

3.2 Current Model

The current regional model that includes Bloomfield, Donaldson, Abel and Tasman Mines was modified and partially recalibrated by HydroSimulations in 2016, with emphasis on the Abel Mine.

The model domain is discretised into about 1.9 million cells comprising 347 rows, 332 columns and 20 layers. The dimensions of the model cells are varied from 50 m in the Abel mining area to 112.5 m near the boundaries. The cell sizes at Bloomfield range from 50 m x 50 m to 100 m x 100 m.

The model layers represent the following lithologies:

- Layer 1: Alluvium and regolith
- Layer 2: Overburden and coal seams above Fassifern Seam
- Layer 3: Fassifern Seam
- Layers 4 to 6: Fassifern – West Borehole interburden
- Layer 7: West Borehole Seam
- Layer 8: West Borehole – Sandgate interburden
- Layer 9: Sandgate Seam
- Layer 10 to 12: Sandgate – Donaldson interburden
- Layer 13: Upper Donaldson Seam
- Layer 14: Upper Donaldson – Lower Donaldson interburden
- Layer 15: Lower Donaldson Seam
- Layer 16: Donaldson – Big Ben interburden
- Layer 17: Big Ben Seam
- Layer 18: Big Ben – Ashtonfield interburden
- Layer 19: Ashtonfield Seam
- Layer 20: Basal Layer

The current model extends to northing 6374000 which is 2km north of the Bloomfield mining lease and about 4 km north of active mining.

3.3 Modified Model

Several modifications have been made to the current model to improve its suitability for assessing the effects of mining at Bloomfield. The following changes were made:

- A re-build of the model geometry in the Bloomfield area only.

- Inclusion of old Big Ben underground works (not in the current Abel model).

- Inclusion of a dyke in the Bloomfield area (not in the current Abel model).

- Contraction of the southern extent of the model from northing 6350000 to 6357420. This reduced the very large number of model cells which exceed the industry benchmark of 1 million cells[1]. Models with more than this limit are prone to numerical instability, longer runtimes, excessive memory requirements and more difficult post-processing. This contraction does not affect the results of interest.

- Extension of model calibration from December 2015 to April 2017.

No changes were considered necessary for the following features:

- Position of the northern boundary at northing 6374000.

- Cell sizes (maximum 100 m x 100 m at Bloomfield).

- Inclusion of Donaldson, Abel and Tasman mines for cumulative impact assessment.

Given the differences in coal seam nomenclature between the district collieries, a comparison was made between Bloomfield floor levels for the “Donaldson” seam and the “Big Ben” seam to infer the corresponding seams to the south. This process uncovered a very poor representation of the Bloomfield seams in the current Abel groundwater model. As a result, it has not been possible to definitively correlate northern and southern seams. The Bloomfield “Big Ben” seam is considered to match the Ashtonfield seam in the Abel mode. Model layer floor levels have been modified to match actual Bloomfield levels.

The lithologies in the new Bloomfield model are designated as follows at the Bloomfield Colliery, with typical coal thicknesses (in parentheses):

- Layer 1: Alluvium and regolith
- Layer 2: Overburden and above coal seams
- Layer 3: C seams (1.0 m)
- Layers 4 to 6: C – B interburden
- Layer 7: B seams (1.0 m)
- Layer 8: B – A interburden
- Layer 9: A seam (0.5 m)
- Layer 10 to 12: A – C Interburden
- Layer 13: WC seams (2.0 m)
- Layer 14: WC – EC Interburden
- Layer 15: EC seams (1.5 m)
- Layer 16: EC - Donaldson interburden
- Layer 17: Donaldson seams (1.5 m)
- Layer 18: Donaldson - Big Ben interburden
- Layer 19: Big Ben seams (3.0 m)
- Layer 20: Basement – Wallis Creek Subgroup.

3.4 Methodology

Groundwater modelling has been conducted in accordance with the Australian Groundwater Modelling Guidelines (Barnett *et al.*, 2012) and the Murray-Darling Basin Commission

[1] However, the number of active cells remains high at 1.46 million.

(MDBC) Groundwater Flow Modelling Guideline (MDBC, 2001). Under the earlier MDBC modelling guidelines, the model is best categorised as an Impact Assessment Model of medium complexity. That guide describes this model type as follows:

> "*Impact Assessment model - a moderate complexity model, requiring more data and a better understanding of the groundwater system dynamics, and suitable for predicting the impacts of proposed developments or management policies.*"

The more recent guidelines do not classify complexity as such, but focus on 'confidence'. This model has a reasonable amount of groundwater level data but it is not calibrated against stream baseflow or mine inflow[2]. The model is complex due to the large number of mines in the area and the low permeability strata of the Newcastle Coal Measures.

Four model variants were developed:

1. Transient calibration model from January 2006 to April 2017.
2. Prediction model for the proposed extension at Bloomfield plus the approved operations at Abel, Donaldson and Tasman.
3. Recovery model for the Bloomfield extension and neighbouring mines (based on the final heads of model #2).
4. Null model, consisting of models #1, #2 and #3 in sequence with the exclusion of all Bloomfield operations since 2006.

For model #1, particular attention was paid to good calibration at the bores in the Bloomfield monitoring network.

Differencing the results from models #2 and #3, with model #4, allowed isolation of the impacts due to the Bloomfield extension alone.

3.5 Software

MODFLOW-SURFACT software has been retained for consistency with previous assessments, with use of the TMP facility for time-varying changes in permeability and storage to represent open cut infill (and district underground fracturing).

Numerical modelling has been undertaken using the Groundwater Vistas (Version 6.96) software interface (Environmental Simulations Inc, 2011) in conjunction with MODFLOW-SURFACT (Version 4), distributed by HydroGeoLogic Inc (Virginia, USA). MODFLOW-SURFACT is an advanced version of the popular MODFLOW code developed by the United States Geological Survey (USGS). MODFLOW is the most widely used code for groundwater modelling and is considered an industry standard.

MODFLOW-SURFACT is a three-dimensional model able to simulate variably saturated flow and can handle desaturation and resaturation of multiple hydrogeological layers without the "dry cell" problems of 'standard' MODFLOW. This is pertinent to the depressurisation associated with longwall mining and the desaturation that occurs within and along the edge of open cut mines. 'Standard' versions of MODFLOW can handle depressurisation and desaturation to some extent, but model cells that are dewatered (reduced below atmospheric

[2] See Section 6 for the assigned model class

pressure) are replaced by “dry” cells, which can interfere with the simulation of various processes and also cause model instability.

3.6 Model Layers and Geometry

The new Bloomfield model covers an area of about 380 km^2 and extends 23.0 km from west to east and 16.6 km from south to north (**Figure 1**, **Figure 7**). The model has a total of 1,812,720 cells across 20 layers (**Table 4**), with 1,459,120 cells active (**Figure 8**). Model cells are not uniform, varying from 50 m to 112.5 m. The model grid consists of 273 rows and 332 columns, without any rotation.

Table 4
Model Layers and Formations

LAYER	FORMATION
1	Alluvium and regolith
2	Overburden and above coal seams
3	C seams
4	C – B interburden
5	
6	
7	B seams
8	B - A interburden
9	A seam
10	A – WC Interburden
11	
12	
13	Whites Creek Seam
14	WC – EC interburden
15	Elwells Creek
16	EC - Donaldson interburden
17	Donaldson seams
18	Donaldson - Big Ben interburden
19	Big Ben seams
20	Basal Layer (Wallis Creek Subgroup)

3.7 Model Simulation Period and Timing

Simulation commences at 1 January 2006 and ends at 31 December 2031 (**Table 5**). The first 17 stress periods (SP1 to SP17) are used for transient calibration (to the end of 2017), initially in six-monthly steps and then in annual steps (from 2011).

The model prediction assumes that Bloomfield mining would continue until December 2025 - stress period (SP) 25. District mines are assumed to continue until December 2031 (SP31). During the prediction period, all stress periods are annual.

Post-mining recovery is simulated at SP32 (until 2132) with a single 100-year stress period. During this time, final voids are simulated at Bloomfield and Donaldson.

Table 5 shows the assumed schedules of the various mines and model stress period definition.

Table 5
Mine Evolution and Model Stress Period Definition

<table>
<tr><th></th><th>Stress Period</th><th>From</th><th>To</th><th>Days</th><th colspan="6">Mine Sequencing</th></tr>
<tr><td rowspan="18">CALIBRATION</td><td></td><td>-</td><td>31/12/2005</td><td>-</td><td colspan="6"></td></tr>
<tr><td>1</td><td>1/01/2006</td><td>30/06/2006</td><td>181</td><td></td><td></td><td></td><td></td><td rowspan="13">Donaldson OC</td><td rowspan="25">Bloomfield OC</td></tr>
<tr><td>2</td><td>1/07/2006</td><td>31/12/2006</td><td>184</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>1/01/2007</td><td>30/06/2007</td><td>181</td><td></td><td></td><td></td><td rowspan="13">Tasman Fassifern UG</td></tr>
<tr><td>4</td><td>1/07/2007</td><td>31/12/2007</td><td>184</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td>1/01/2008</td><td>30/06/2008</td><td>182</td><td rowspan="6">Abel UG</td><td></td><td></td></tr>
<tr><td>6</td><td>1/07/2008</td><td>31/12/2008</td><td>184</td><td></td><td></td></tr>
<tr><td>7</td><td>1/01/2009</td><td>30/06/2009</td><td>181</td><td></td><td></td></tr>
<tr><td>8</td><td>1/07/2009</td><td>31/12/2009</td><td>184</td><td></td><td></td></tr>
<tr><td>9</td><td>1/01/2010</td><td>30/06/2010</td><td>181</td><td></td><td></td></tr>
<tr><td>10</td><td>1/07/2010</td><td>31/12/2010</td><td>184</td><td></td><td></td></tr>
<tr><td>11</td><td>1/01/2011</td><td>31/12/2011</td><td>365</td><td rowspan="21">Abel Upper/ Donaldson UG</td><td></td><td></td></tr>
<tr><td>12</td><td>1/01/2012</td><td>31/12/2012</td><td>366</td><td></td><td></td></tr>
<tr><td>13</td><td>1/01/2013</td><td>31/12/2013</td><td>365</td><td></td><td></td></tr>
<tr><td>14</td><td>1/01/2014</td><td>31/12/2014</td><td>365</td><td></td><td></td><td rowspan="19">Final Void</td></tr>
<tr><td>15</td><td>1/01/2015</td><td>31/12/2015</td><td>365</td><td rowspan="17">Abel Lower/Donaldson UG</td><td></td></tr>
<tr><td>16</td><td>1/01/2016</td><td>31/12/2016</td><td>366</td><td></td><td></td></tr>
<tr><td>17</td><td>1/01/2017</td><td>31/12/2017</td><td>365</td><td></td><td></td></tr>
<tr><td rowspan="14">PREDICTION</td><td>18</td><td>1/01/2018</td><td>31/12/2018</td><td>365</td><td rowspan="14">Tasman Extension West Borehole UG</td><td></td></tr>
<tr><td>19</td><td>1/01/2019</td><td>31/12/2019</td><td>365</td><td></td></tr>
<tr><td>20</td><td>1/01/2020</td><td>31/12/2020</td><td>366</td><td></td></tr>
<tr><td>21</td><td>1/01/2021</td><td>31/12/2021</td><td>365</td><td></td></tr>
<tr><td>22</td><td>1/01/2022</td><td>31/12/2022</td><td>365</td><td></td></tr>
<tr><td>23</td><td>1/01/2023</td><td>31/12/2023</td><td>365</td><td></td></tr>
<tr><td>24</td><td>1/01/2024</td><td>31/12/2024</td><td>366</td><td></td></tr>
<tr><td>25</td><td>1/01/2025</td><td>31/12/2025</td><td>365</td><td></td></tr>
<tr><td>26</td><td>1/01/2026</td><td>31/12/2026</td><td>365</td><td></td><td rowspan="7">Final Void</td></tr>
<tr><td>27</td><td>1/01/2027</td><td>31/12/2027</td><td>365</td><td></td></tr>
<tr><td>28</td><td>1/01/2028</td><td>31/12/2028</td><td>366</td><td></td></tr>
<tr><td>29</td><td>1/01/2029</td><td>31/12/2029</td><td>365</td><td></td></tr>
<tr><td>30</td><td>1/01/2030</td><td>31/12/2030</td><td>365</td><td></td></tr>
<tr><td>31</td><td>1/01/2031</td><td>31/12/2031</td><td>365</td><td></td></tr>
<tr><td></td><td>32</td><td>1/01/2032</td><td>31/12/2032</td><td>36525</td><td colspan="4">Post-mining Recovery</td></tr>
</table>

3.8 Model Stresses and Boundary Conditions

3.8.1 Inactive Areas

Inactive areas are defined to the east of Hunter River and to the west of Wallis Creek (**Figure 7**).

3.8.2 Watercourses

The numerical model incorporates river/aquifer interactions, to enable quantification of the impacts of mining on surface water features. This is important to assess whether mining is likely to lower water levels and reduce baseflow to permanent streams.

MODFLOW River (RIV) cells are applied along the various watercourses in this area, as well as to represent Hexham Swamp. Bed conductance for all watercourses and the swamp are set to 25 m^2/d. The river stage heights are set generally at riverbed elevations except for the swamp which is given 0.5 m water depth. This practice means that “river” boundaries act in the same way as MODFLOW “drains”, and allow baseflow (groundwater discharge) but do not allow leakage from the watercourse to the aquifer (unless stage is greater than bed elevation).

All River cells are within Layer 1.

3.8.3 Rainfall Recharge and Evapotranspiration

For all model variants, rainfall recharge is applied to each active model cell as a percentage of long-term average rainfall using the MODFLOW Recharge (RCH) package. No changes were made to the recharge rates adopted in the previous A33 model, which had 11 distinct recharge zones with a median rate of 0.7% of annual rainfall.

Evapotranspiration (ET) from shallow water tables has been simulated using the MODFLOW EVT package. Two conceptual zones have been set based on geological outcrop. Maximum extinction depths, that is the depths to which MODFLOW-SURFACT will attempt to take ET from the water table, are assumed to be 3 m for the alluvium and 1.8 m for hard rock outcrop (regolith) areas. The corresponding maximum ET rates are 248 and 274 mm/a, unchanged from those adopted in the A33 model.

New recharge zones are set up in the Bloomfield mine area during mine progression to negate recharge during active mining, and to enhance recharge to spoil after a delay of five years. Spoil recharge is applied as 5% of mean annual rainfall.

3.8.4 Open Cut Mining

MODFLOW Drain (DRN) cells are used to simulate both open cut and underground mining, with the drain invert at the base of the relevant coal seam for each mine in the area. The Bloomfield open cut mine is set from regolith (layer 1) to the Big Ben seam (layer 19) as the maximum vertical extent. Underground mining is applied in layers 3 (Tasman), 7 (Tasman), 13 (Abel) and 15 (Abel).

MODFLOW Drains are progressed in accordance with mine progression plans. Open cut drain cell conductance was set to 1000 m^2/d to allow free drainage into pits. Generally, these drains remain active up to eight years from the beginning of their activation. After that time, spoil is emplaced in the void. The TMP package is used to allocate enhanced transmissive and storage properties to the spoil.

The temporal progression of Bloomfield open cut mining is illustrated in **Appendix A**.

3.8.5 Hydraulic Properties

While the hydraulic conductivities of the A33 model have been retained as much as possible, some changes were necessary to improve model calibration at Bloomfield. Also, several local features were not present in the A33 model:

- Historical open cut areas (**Figure 2**) (given hydraulic conductivity 1 m/day).
- Historical underground Big Ben mining areas (**Figure 2**) (given hydraulic conductivity 10 m/day).
- A north-westerly trending dyke (**Figure 7**) (given leakage coefficient 10^{-5} d^{-1}).

Spoil hydraulic conductivity is set at 1 m/day in both horizontal and vertical directions.

4 MODEL CALIBRATION

4.1 Current Abel Model

Steady state (or baseline 'long-term') calibration as the first stage of the calibration process was carried out against 60 targets, using a combination of auto-sensitivity analysis and manual modification of model zones and parameters. The steady state calibrated model yielded a 'scaled root mean squared error'(SRMS) value of 4.5% which is below the target 10% SRMS suggested in the MDBC flow model guideline (MDBC, 2001).

Transient model calibration was carried out in order to achieve a history match to the reported observed groundwater levels during the period January 2006 to June 2012 inclusive (RPS Aquaterra, 2013). The calibration was done against 2,606 target water levels, using a combination of auto-sensitivity analysis and manual modification of zones and model parameters. These targets were distributed throughout the model layers in the form of 88 groundwater hydrographs.

The SRMS value for the RPS Aquaterra (2013) six-year transient calibration period was 4.3% (within the target range of 0-10%).

4.2 New Bloomfield Model

Calibration of the modified groundwater model has focused on 'history matching' of model outputs against the following Bloomfield-specific data:

- Groundwater levels for standpipes: SP2-1, SP2-2, SP3-1, SP4-2 and SP7-1.
- Groundwater levels for vibrating wire piezometers: VW1, VW5, VW6, VW7 and VW8.

Standpipe and bore VWP locations are presented in **Figure 6**. There is no reliable baseflow data from around the site against which to calibrate the model for fluxes. Nor is there a reliable mine inflow time series for calibration.

To get a sensible initial head for the Bloomfield transient model, steady state calibration was carried out by a manual method.

Transient model calibration was designed to match recorded groundwater levels during the period January 2006 to April 2017 against 18 target water levels, using manual modification of zones and model parameters. These targets were distributed through four of the model layers:

- Alluvium and regolith (Layer 1): 2 targets
- WC seams (Layer 13): 3 targets
- Donaldson seams (Layer 17): 7 targets
- Big Ben seams (Layer 19): 6 targets

All horizontal and vertical hydraulic conductivities were allowed to vary during the calibration process. The final hydraulic conductivities in the model are presented in **Table 4.**

Table 6
Hydraulic Conductivities for Initial and Calibrated Models

ZONE	DESCRIPTIO	**Initial [m/d]**		**Calibrated [m/d]**	
		K_H	K_V	K_H	K_V
1	Alluvium	1.00E-02	1.00E-03	1.00E-03	1.00E-04
20	River bank	2.00E-01	1.00E-02	1.00E-01	1.00E-01
55	Whites Creek	5.00E-02	1.00E-03	5.00E-02	5.00E-03
56	Whites Creek	1.00E-02	5.00E-03	1.00E-04	1.00E-05
7	Interburden	2.00E-04	2.00E-05	1.00E-04	1.00E-05
14	Donaldson	5.00E-02	5.00E-03	5.00E-03	5.00E-05
29	Donaldson	5.00E-03	3.00E-04	5.00E-03	5.00E-04
15	Interburden	1.00E-04	5.00E-05	5.00E-03	5.00E-05
17	Big Ben Seam	5.00E-02	8.00E-03	1.00E-02	8.00E-04

K_H = horizontal hydraulic conductivity; K_V = vertical hydraulic conductivity

4.3 Model Performance

4.3.1 Statistics

The Bloomfield model takes approximately 4.5 hours to run, covering both the historical phase (2006-2017) and the predictive phase (out to the year 2031). The 100-year recovery phase takes an extra 2 hours.

During the historical phase (2006-2017), the model has a mass balance error of 0.2%, which is well below the accepted threshold of 1-2% (Barnett *et al.*, 2012).

The statistical performance for the 12-year calibration period is 10.4 %RMS and 9.8 mRMS with 18 water level target sites consisting of 611 observations for the local Bloomfield area. For all 3,983 observations across the full model area, the calibration performance statistics are 4.1 %RMS and 12.7 mRMS.

Scattergrams are displayed in **Figure 9**. For the local Bloomfield area, two bores in layers 17 and 19 are outliers: VW7 and VW8. The poor match at VW7, at the south-western edge of the extension, is due purely to assumed timing of mining, since the hydrographs in **Figure B5** and **Figure B7** show very good visual matches of trends. VW8 is poorly simulated due to its location close to the edge of old Buchanan Mine workings for which no data were readily available.

4.3.2 Mine Inflow

A graph of the modelled inflows to the Bloomfield open cut mine is presented in **Figure 10**. During the 2006 – 2017 calibration period, simulated inflow is predicted to have averaged 1.1 ML/d (420 ML/a) with a peak of about 1.6 ML/d (570 ML/a).

The pattern of inflow agrees with the previous Bloomfield model (Aquaterra, 2008) from 2007 to 2017, where the average was 1.4 ML/d (510 ML/a) and the peak was predicted to be about 2.0 ML/d (730 ML/a).

These rates do not account for evaporative losses from the floor and walls of the pits.

4.3.3 Groundwater Levels

Appendix B (**Figures B1** to **B7**) presents hydrographs for the relevant monitoring bores in the Bloomfield monitoring network (bore locations are shown on **Figure 6**):

- Standpipes SP4-2 and SP7-1 : for Alluvium and Regolith
- Bores VW5(62m), VW6(96m) and VW7(70m) : for Whites Creek Seam
- Standpipes SP2-1, SP3-1, bores VW1(35m), VW5(71m), VW6(114m), VW7(95m) and VW8(83m): for Donaldson Seam
- Standpipe SP2-2, bores VW1(46m), VW5(89m), VW6(128m), VW7(107m) and VW8(97m): for Big Ben Seam

These charts include both simulated and measured responses. As modelled groundwater levels are calculated on an annual basis, they cannot simulate the short-term climate variations seen in the measured hydrographs.

The overall trends of the simulated groundwater levels at the bores in alluvium and regolith match well with those measured. Standpipe SP4-2 (depth 9 m) near Four Mile creek shows a rising trend for groundwater level which probably correlates with river stage. The simulated water level matches very well with this trend. SP7-1 (depth 11 m) is positioned on the western border of the open cut operations. Its simulated water level indicates the westward progression of mining.

The overall magnitudes and trends of simulated groundwater levels at VW6(96m) and VW7(70m) in the Whites Creek Seam are perfectly matched with the measured levels. The water level patterns are showing a clear mining effect in both simulated and measured cases. An exception is bore VW5(62m) where the simulated level is showing a mining effect but the measured level is not affected.

Five of the seven bores in the Donaldson Seam are well-matched with the measured groundwater levels. Mining effects are undoubtedly visible for VW1(35m), VW5(71m), VW6(114m) and VW7(95m). Exceptions are standpipe SP2-1 (depth 65 m) and VW8(83m). SP2-1 is surrounded by historical open-cut and underground mining. Considering the position of SP2-1, the simulated water level reasonably shows drawdown but the lack of any measured drawdown suggests that recovery from historical mining might already have occurred.

In the Big Ben seam the simulated water levels at VW1(46m), VW5(89m), VW6(128m) and VW7(107m) match very well with the measured levels. As in the Donaldson seam, the bore water levels in the Big Ben seam show clear mining effects. The poor agreement at SP2-2 (depth 85 m) suggests that recovery might already have occurred from past mining in this seam at this location. VW8 responses, however, indicate residual effects from previous Buchanan mining of the Big Ben seam, and ongoing effects from the Donaldson seams being mined at the Abel Mine.

4.3.4 Groundwater Surface Water Interaction

With all district mines active during the calibration period, simulated groundwater-surface water interactions with watercourses in the Bloomfield area are presented in **Table 7.**

Table 7
Modelled Groundwater-Surface Water Interaction (2006-2017)

WATERCOURSE	MODELLED RIVER AQUIFER INTERACTION [kL/d]	COMMENT
	AVERAGE (2006-2017)	
BUTTAI CREEK	0.01	Losing stream
FOUR MILE CREEK	-0.24	Gaining stream
WALLIS CREEK	-0.02	Gaining Stream
WEAKLEYS FLAT CREEK	-20	Gaining Stream
VINEY CREEK	-0.02	Gaining Stream
BLUEGUM CREEK	-0.26	Gaining Stream
MINMI CREEK	-2.6	Gaining Stream
HEXHAM SWAMP	7,080	Losing system

These results suggest that all watercourses other than Buttai Creek and Hexham Swamp are simulated as gaining systems, at least as an ‘average’ condition across the 6-12 months model stress periods. However, the baseflow magnitudes are very low.

The locations of the creeks are presented in **Figure 5**.

4.3.5 Water Balance

A water budget for the entire model domain, averaged over the calibration period, is presented in the **Table 8**.

The water balance suggests that rainfall recharge is a small component (17%) of the water balance, and that leakage from the water bodies are the more substantial sources of groundwater replenishment (66%). Mine inflow of 15% (to all mines, not just Bloomfield) and evapotranspiration (57%) are the main discharge processes. The loss from storage (about 1.3 ML/d) is about half of the total mine inflow.

Table 8
Calibrated Model Water Balance (2006-2017)

COMPONENT	IN [ML/d]	OUT [ML/d]	NET [ML/d]
Drains (Mine inflow)	-	2.66	
Recharge (Direct Rainfall)	2.96	-	
Rejected Recharge	-	0.92	
Evapotranspiration (ET)	-	10.35	
River (Leakage / Baseflow)	11.23	4.21	7.02 LEAKAGE
Constant Head (CHD)	2.87	0.16	
Regional Groundwater Flow	-	0.02	
Storage			1.26 LOSS
TOTAL	17.06	18.31	1.25

5 PREDICTIVE MODELLING

5.1 Mining Schedule

A summary of the mining schedule that has been used for the Bloomfield mine and all other nearby mines is provided in **Table 5**. This outlines the sequencing of cumulative stresses and the transient simulation setup for calibration, prediction and recovery phases of the model. The predictive model simulates the period from January 2018 to December 2031, with completion of Bloomfield mining assumed at December 2025.

5.1.1 Prediction

Transient stress periods 18-31 are set for the predictive period from 2018 to 2031 to allow representation of the extraction and dewatering of the open cut extension. These stress periods are annual.

5.1.2 Recovery

Post-mining recovery is simulated at stress period 32 (2032-2132) with a single 100-year stress period.

Snapshots of Bloomfield open-cut mine progression are presented in **Appendix A**.

5.2 Modelling Approach

Two main predictive model scenarios were run:

1. a run with the modified Bloomfield mine plan and all other active mines; and
2. a 'No-mining' or 'Null' run without the past or future Bloomfield mining but with all other surrounding mines active.

Comparison of scenarios 1 and 2 allows the net impact on the hydrogeological environment to be evaluated separately for the effects of Bloomfield alone.

5.3 Model Implementation

As in the calibration model (**Section** 4), active mine areas were simulated in the model using MODFLOW drain cells with the invert elevation set at the floor of the relevant coal seam layer and drain cell conductance was set to 1000 m^2/d to allow a free-draining condition.

5.4 Water Balance

Shown in **Table 9** is the water balance averaged over the 2006-2025 period, when Bloomfield mining is assumed to end. The water balance reports the inflows, outflows and change in storage over the entire model domain.

The total inflow to the groundwater system within the model extent is approximately 17 ML/day, of which rainfall recharge is about 17% and leakage from water bodies provides around 66%. Groundwater discharge is dominated by evapotranspiration which is about 52% of total outflow. Mine inflow is around 22% of the total water balance. The loss from storage (about 2.8 ML/d) is about two-thirds of the total mine inflow and about twice the loss during the calibration period (to 2017).

Table 9
Predictive Model Water Balance (2006-2031)

COMPONENT	IN [ML/d]	OUT [ML/d]	NET [ML/d]
Drains (Mine	-	4.39	
Recharge (Direct	2.96	-	
Rejected	-	0.92	
Evapotranspiratio	-	10.36	
River (Leakage /	11.23	4.21	7.02 LEAKAGE
Constant Head	2.87	0.16	
Regional GW flow	-	0.01	
Storage			2.84 LOSS
TOTAL	17.06	20.06	2.94

Apart from mine inflow, which has increased from about 2.7 to about 4.4 ML/day, there is very little difference in other water balance components from those in the calibration period. This indicates that district mining is not having any significant effect overall on other components of the water balance.

5.5 Predicted Drawdowns

Predicted groundwater heads have been extracted from the model to show groundwater level and drawdown contour maps at the completion of Bloomfield mining (December 2025).

The spatial water table at the end of mining is shown in **Appendix C** (**Figure C0**); this map reports the highest water level in a model cell regardless of model layer. For individual layers, water level maps are presented in **Appendix C** (**Figures C1** to **C8**) for model layers 1, 3, 7, 9, 13, 15, 17 and 19. Where a layer is dry, the bottom elevation of the layer is shown.

Drawdown maps, relative to the model-predicted levels at 2006, are presented in **Appendix D** (**Figures D1** to **D8**) for model layers 1, 3, 7, 9, 13, 15, 17 and 19. **Figure D0** shows the water table drawdown (irrespective of layer) with shaded areas where model layer 1 is dry at the end of mining.

Appendix B shows groundwater level hydrographs for the standpipes and vibrating wire piezometers in the Bloomfield monitoring network.

Drawdowns due to Bloomfield mining are expected to reach a maximum at Mine Year 20 (year 2025), at which time mining from the southern end of the extension area is scheduled to cease, and groundwater levels would start to recover.

The drawdown map (**Figure D1**) for the surficial Layer 1 (alluvium and regolith) shows a limited area of drawdown in the south-western corner of the Bloomfield extension area where the drawdown is about 5 m. Drawdown of similar magnitude is also evident to the west of extension mining, coincident with historical open cut and underground mining. Drawdown from open cut mining is propagating into the high-permeability underground voids, with some spatial confinement offered by a north-westerly trending dyke. The drawdown is generally less than 0.5 m outside the Bloomfield lease boundary except for the south-west corner where a 2-m drawdown contour extends off-lease. The 2 m of drawdown extends beneath Buttai Creek for a distance of about 600 m. As this creek is simulated as a losing system, no additional leakage loss is anticipated from the stream. However, alluvial take is likely and this is quantified in **Section 5.10**.

The predicted drawdown effects on the surficial aquifer are not expected to have any adverse impact on groundwater dependent ecosystems because the groundwater levels are already well below ground surface. Close to Buttai Creek, the water table depth at the site of VW8 was 9 m in 2007, and the depth to water at SP7-1 was 10 m in 2015.

An area of significant water table drawdown (**Figure D0**) is associated with the Donaldson open cut and final void. As there is no overlap of the water table drawdowns produced by the various mines, there is little evidence for cumulative interference.

5.6 Predicted Drawdowns at Registered Bores

Predicted groundwater drawdowns at the end of mining at registered bores within 5 km of Bloomfield are listed in **Table 10a** for production bores and **Table 10b** for monitoring bores. and are posted on the map at **Figure 11**. These values are cumulative drawdowns from all mining activities, in the specific layer corresponding to the depth of each hole.

The contours in **Figure 11** are of water table drawdown (not layer-specific drawdown). As there is no overlap of water table effects between the various mines, the cause of the drawdown is clear from an inspection of **Figure 11** in terms of proximity to the nearest mine.

Production bores closest to the Bloomfield Mine have predicted layer-specific drawdowns of less than 1 m, while drawdowns greater than 2 m (the Aquifer Inference Policy's threshold) are predicted at five bores which are at distance and are likely to be due to regional mining influences. The two bores with large predicted drawdowns of 10 m or more (GW058760 and GW061307) are in Layer 20 of the model beneath the Big Ben seams.

Table 10a
Predicted Layer-Specific Drawdown [m] at Registered Production Bores at the End of Bloomfield mining

REGISTERED BORE NAME	LITHOLOGY	EASTING [MGA]	NORTHING [MGA]	BORE DEPTH (m)	DRILLED YEAR	BORE TYPE	PREDICTED DRAWDOWN (m) [Year 2025]
GW200415	Sandstone	369986	6373738	20.1	10/09/2004	*	3
GW080034	Unknown	365222	6370959	*	*	*	< 1
GW078125	Siltstone/ sandstone	370970	6368464	30	14/11/1997	*	< 1
GW058760	Sandstone/ siltstone	371142	6371207	33	1/10/1983	*	15
GW061307	Shale/ sandstone	371299	6371148	30	1/10/1984	Household use	10
GW200414	Sandstone	369960	6373761	10	9/09/2004	*	3
GW078123	Sandstone/ siltstone	369309	6368165	33	14/11/1997	*	<1
GW051647	Sandstone	362896	6373006	12	1/09/1980	Stock	2
GW051353	Shale	365986	6365810	49.7	1/11/1980	Household use	< 1
GW079892	Regolith	366598	6372257	6.7	*	*	< 1
GW079948	Unknown	370081	6372613	*	*	*	2.5

* Not available

Table 10b
Predicted Layer-Specific Drawdown [m] at Registered Monitoring Bores at the End of Bloomfield mining

REGISTERED BORE NAME	LITHOLOGY	EASTING [MGA]	NORTHING [MGA]	BORE DEPTH (m)	DRILLED YEAR	BORE TYPE	PREDICTED DRAWDOWN (m) [Year 2025]
GW078120	Mudstone/ shale	371176	6368590	24	14/11/1997	Monitoring	< 1
GW078047	Siltstone	370784	6368800	54.3	14/11/1997	Monitoring	< 1
GW078122	Sandstone	368666	6367663	35.4	14/11/1997	Monitoring	4
GW078124	Mudstone	369883	6368018	40	14/11/1997	Monitoring	< 1
GW078045	Siltstone	371836	6369892	30.5	14/11/1997	Monitoring	< 1
GW078128	Siltstone/ mudstone	370912	6366923	30	14/11/1997	Monitoring	< 1
GW078046	Siltstone/ sandstone	368651	6368741	30.4	14/11/1997	Monitoring	25
GW078044	Siltstone	370428	6370151	30.1	14/11/1997	Monitoring	6
GW078127	Siltstone/ mudstone	369073	6366406	30	14/11/1997	Monitoring	< 1
GW078126	Siltstone/ mudstone	371890	6367736	30	14/11/1997	Monitoring	< 1
GW078121	Siltstone	368619	6367262	43	14/11/1997	Monitoring	< 1

5.7 Groundwater Hydrographs

Predicted groundwater hydrographs at Bloomfield monitoring bores are shown in **Appendix B** (**Figures B1-B7)**. These figures show groundwater levels in the alluvium and regolith (Layer 1), Whites Creek seam (Layer 13), Elwells Creek seams (Layer 15), Donaldson seams (Layer 17) and Big Ben seam (Layer 19). Bore locations are on **Figure 6**.

Alluvium and Regolith (Layer 1) [**Figure B1**]

The standpipe SP4-2 is located near Four Mile creek. It is more likely that the water level in this bore is influenced by water level in the creek, when it flows. The simulated hydrograph shows a rising trend for some years, followed by stabilisation.

SP7-1 is located at the western border of the Bloomfield mine. The prediction and recovery stages of the simulated hydrograph suggest that the water level will decline due to mining and not recover significantly. This bore would remain within the zone of influence of the final void.

Whites Creek Seam (Layer 13) [**Figure B2**]

All three VWP sites lie along the southern boundary of the Bloomfield lease. All simulated hydrographs show significant mining effects, with the degree of recovery being minimal but increasing from east to west, due to the effects of adjacent underground mining.

Donaldson Seam (Layer 17) [**Figures B3-B5**]

Four out of seven bores (SP2-1, VW1(35m), VW6(114m) and VW7(95m)) in this layer show slow water level recovery post-mining. Water levels at bores SP3-1 and VW5(71m) show no sign of recovery. Most bores are influenced by adjacent underground mining.

Big Ben Seam (Layer 19) [**Figures B6-B7**]

All simulated hydrographs show significant declines due to mining, with slow or negligible recovery in some cases. Most bores are influenced by adjacent or historical underground mining.

5.8 Baseflow Capture

Watercourses have been set up in the model to accept baseflow if groundwater levels exceed riverbed elevations, but not to allow leakage given that most streams are ephemeral. The model can predict reductions to baseflow for gaining streams, but cannot predict increases in leakage from losing streams. Where the water table is disconnected from a losing stream, mining cannot induce any additional leakage. **Table 7** has noted that the only simulated losing systems are Buttai Creek and Hexham Swamp.

Baseflows have been extracted from the model for both the mining and the null simulations, for cumulative stresses imposed by all mines.

The status of Four Mile Creek is predicted to have converted from gaining to losing status around 2011. This means that its average baseflow of 0.24 kL/day (**Table 7)** would have been lost at that time. This is equivalent to only 0.1 ML/a.

All other watercourses had negligible differences between the null and mining runs, indicating that Bloomfield mining is having an insignificant effect on baseflow capture. The strongest effect was observed at Weakleys Flat Creek where the loss was only 0.12 kL/day (0.04 ML/a).

The leakages from Hexham Swamp differed by no more than 1 kL/day (from 7,080 kL/day in **Table 10**) between null and mining simulations. This would be within numerical error bounds. Therefore, the model predicts no impact of the Bloomfield operation on Hexham Swamp.

5.9 Predicted Mine Inflow

The predicted groundwater inflows[3] to the Bloomfield Mine are listed in **Table 11** and are graphed in **Figure 10**.

The simulated inflows are predicted to increase from about 0.9 ML/d at the start of open cut mining activities in year 2006 to peak about 1.6 ML/d (year 2013) during the calibration period, with a peak of about 1.5 ML/d in the prediction period. These rates do not take into account the evaporative losses that would occur when the groundwater discharges are

[3] Time-weighted averages

exposed to the atmosphere. At the end of mining at year 2025 the inflow is predicted to be about 1.0 ML/d.

There is expected to be a slight drop (by about 2%) in the future peak inflow compared to what should already have occurred. The expected maximum for licensing purposes is 561 ML/a.

Aquaterra (2008) conducted a sensitivity analysis which found that peak inflow could increase by about 10% for higher horizontal hydraulic conductivity and by about 5% for higher vertical hydraulic conductivity.

Table 11
Bloomfield Mine Inflow Rates
[2006-2132]

	MINE YEAR	STRESS PERIOD	MINE-INFLOW [ML/d]	MINE-INFLOW [ML/year]
CALIBRATION	2006	2	0.88	322
	2007	4	0.82	300
	2008	6	0.85	312
	2009	8	0.87	318
	2010	10	0.92	336
	2011	11	1.18	430
	2012	12	1.40	513
	2013	13	**1.57**	**572 max**
	2014	14	1.51	551
	2015	15	1.40	511
	2016	16	1.20	440
	2017	17	1.24	455
PREDICTION	2018	18	1.42	520
	2019	19	1.42	520
	2020	20	**1.54**	**561 max**
	2021	21	1.53	559
	2022	22	1.16	423
	2023	23	0.69	253
	2024	24	1.00	367
	2025	25	1.00	367
	2026	26	0	0
	2027	27	0	0
	2028	28	0	0
	2029	29	0	0
	2030	30	0	0
	2031	31	0	0
RECOVERY	2032-2132	32	0	0

5.10 Alluvial Takes

The alluvium of both the Wallis Creek Water Source and the Newcastle Water Source (along the lower Hunter) are classified as 'Highly Productive' by DPI Water (**Figure 12)**. The calculated alluvial takes (rounded to the nearest ML/a) for separate simulation phases are recorded in **Table 12** and graphed in **Figure 13** and **Figure 14**. These takes are due only to Bloomfield mining.

For licensing purposes, the additional maximum take from the Wallis Creek Water Source is predicted to be about 18 ML/a (26-8 ML/a) after 2017, and the additional maximum take from the Newcastle Water Source is predicted to be about 8 ML/a (8-0.2 ML/a).

Table 12
Modelled Alluvial Takes

	WALLIS CREEK WATER SOURCE **TAKE** EXTRA LEAKAGE [ML/YEAR]		NEWCASTLE WATER SOURCE **TAKE** LESS UPFLOW [ML/YEAR]	
	CALIBRATION PERIOD [2006-2017]	**PREDICTION AND RECOVERY PERIOD [2018-2132]**	**CALIBRATION PERIOD [2006-2017]**	**PREDICTION AND RECOVERY PERIOD [2018-2132]**
MAXIMUM	**8**	**26**	**0.2**	**8**
MEAN	**4**	**12**	**0.0**	**2**

5.11 Final Void

The final void at Bloomfield is certain to remain a sink. It would have the effect of a long-term and widespread lowering of the water table, as indicated in **Figure C9** in **Appendix C**.

The hydrograph for a hypothetical monitoring point within the final void is shown in **Figure 15**. This shows recovery of only about 15 m after 100 years, with a void lake water surface around -40 mAHD.

6 LIMITATIONS

Model confidence has been assessed in terms of the attributes of Class 1, 2 and 3 models in the model classification system of Barnett *et al.* (2012). A self-assessment is offered at **Table 13**.

As all models would have elements of Class 1, Class 2 and/or Class3 attributes, it is not possible to assign a model uniquely to a particular class. For the Bloomfield model, the occurrences of performance indicators are quantified here:

- Class 1 : 4 items [25%]
- Class 2 : 5 items [31%]
- Class 3 : 7 items [44%]

Although the classification system points to Class 3, subjective assessment would rate the model more as Class 1-2 for the following reasons:

- Mine inflow rates are not readily available for calibration purposes.
- Baseflow estimates are not ground-truthed.
- No seasonality has been attempted in replicating the detail observed in monitoring bore hydrographs.
- There is uncertainty as to the details for historical mining.
- The groundwater system is complex as the result of a large number of previous and current simultaneous mining operations.

Table 13 Model Confidence Classification

CLASS	DATA	CALIBRATION	PREDICTION	INDICATORS
1 [count 4]	Not much. Sparse. No metered usage. Remote climate data.	Not possible. Large error statistic. Inadequate data spread. Targets incompatible with model purpose. [No inflow record]	Timeframe >> calibration Long stress periods. Transient prediction but steady-state calibration. Bad verification.	Timeframe > 10x Stresses > 5x Mass balance > 1% (or single 5%) Properties <> field. Bad discretisation. No review.
2 [count 5]	Some. Poor coverage. Some usage info. Baseflow estimates.	Partial performance. Long-term trends wrong. Short time record. Weak seasonal replication. No use of targets compatible with model purpose.	Timeframe > calibration. Long stress periods. New stresses not in calibration. Poor verification.	Timeframe = 3-10x Stresses = 2-5x Mass balance < 1% Some properties <> field measurements. Some key coarse discretisation. Review by hydrogeo.
3 [count 7]	Lots. Good aquifer geometry. Good usage info. Local climate info. K measurements. Hi-res DEM.	Good performance stats. Long-term trends replicated. Seasonal fluctuations OK. Present day data targets. Head and flux targets.	Timeframe ~ calibration. Similar stress periods. Similar stresses to those in calibration. Steady-state prediction consistent with steady-state calibration. Good verification.	Timeframe < 3x Stresses < 2x Mass balance < 0.5% Properties ~ field measurements. Some key coarse discretisation. Review by modeller.

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RPS Aquaterra, 2013. *Abel Upgrade Modification – Groundwater Assessment*. Report for Donaldson Coal. Ref: 1S64DD/021f, 13 February 2013.

FIGURES

Figures 1 to 15

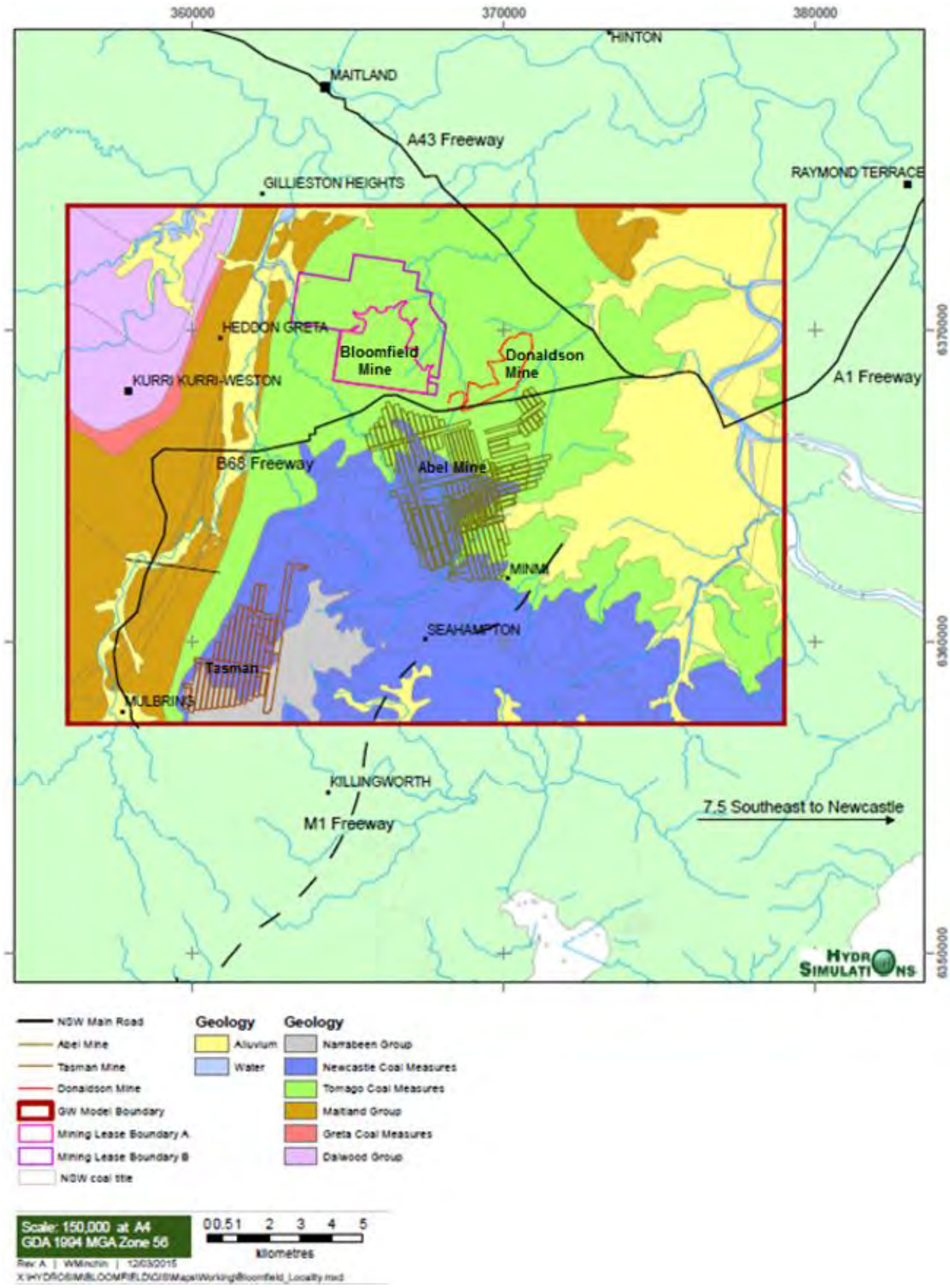


Figure 1. Location Plan

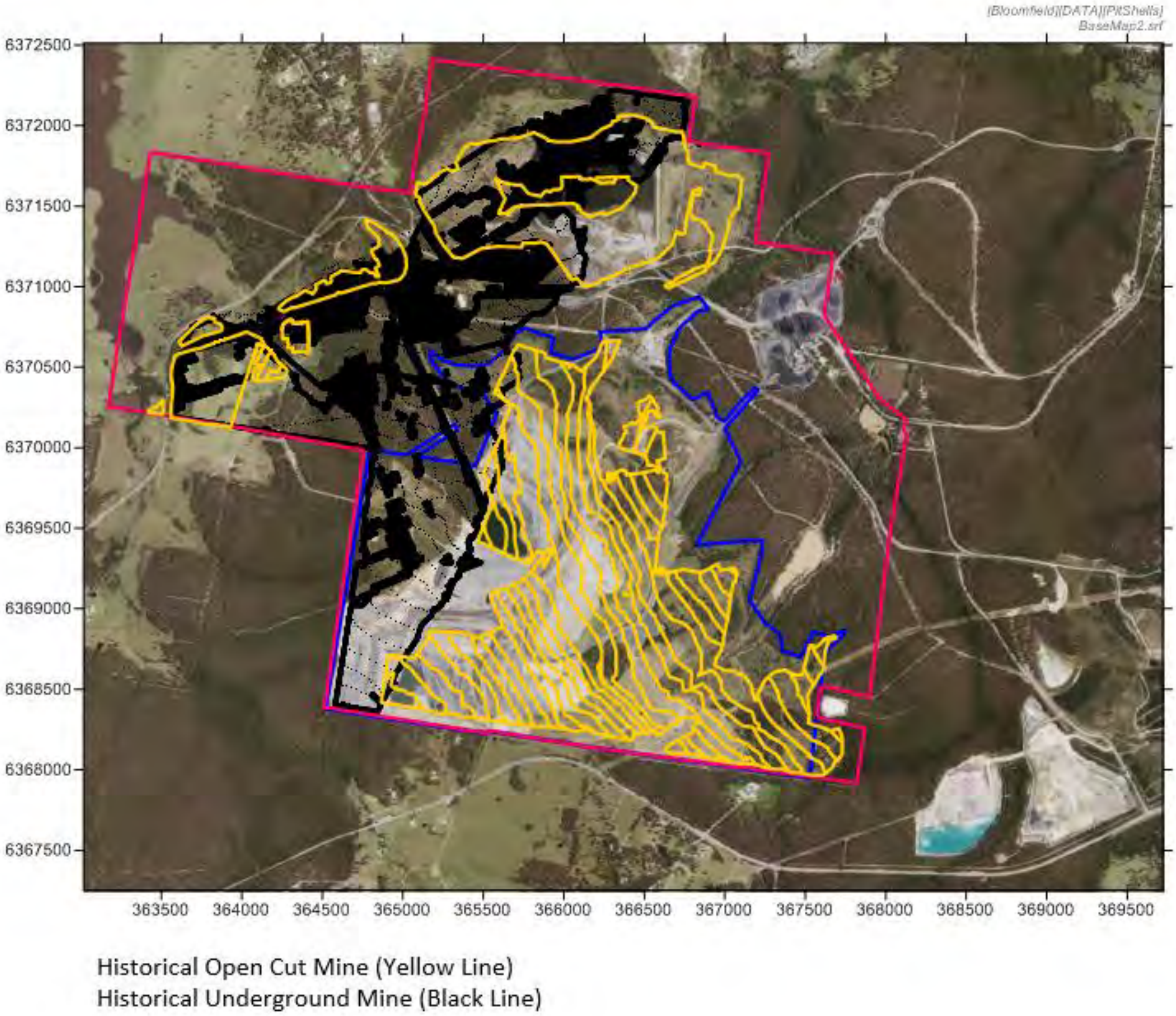


Figure 2. Historical Bloomfield Mining

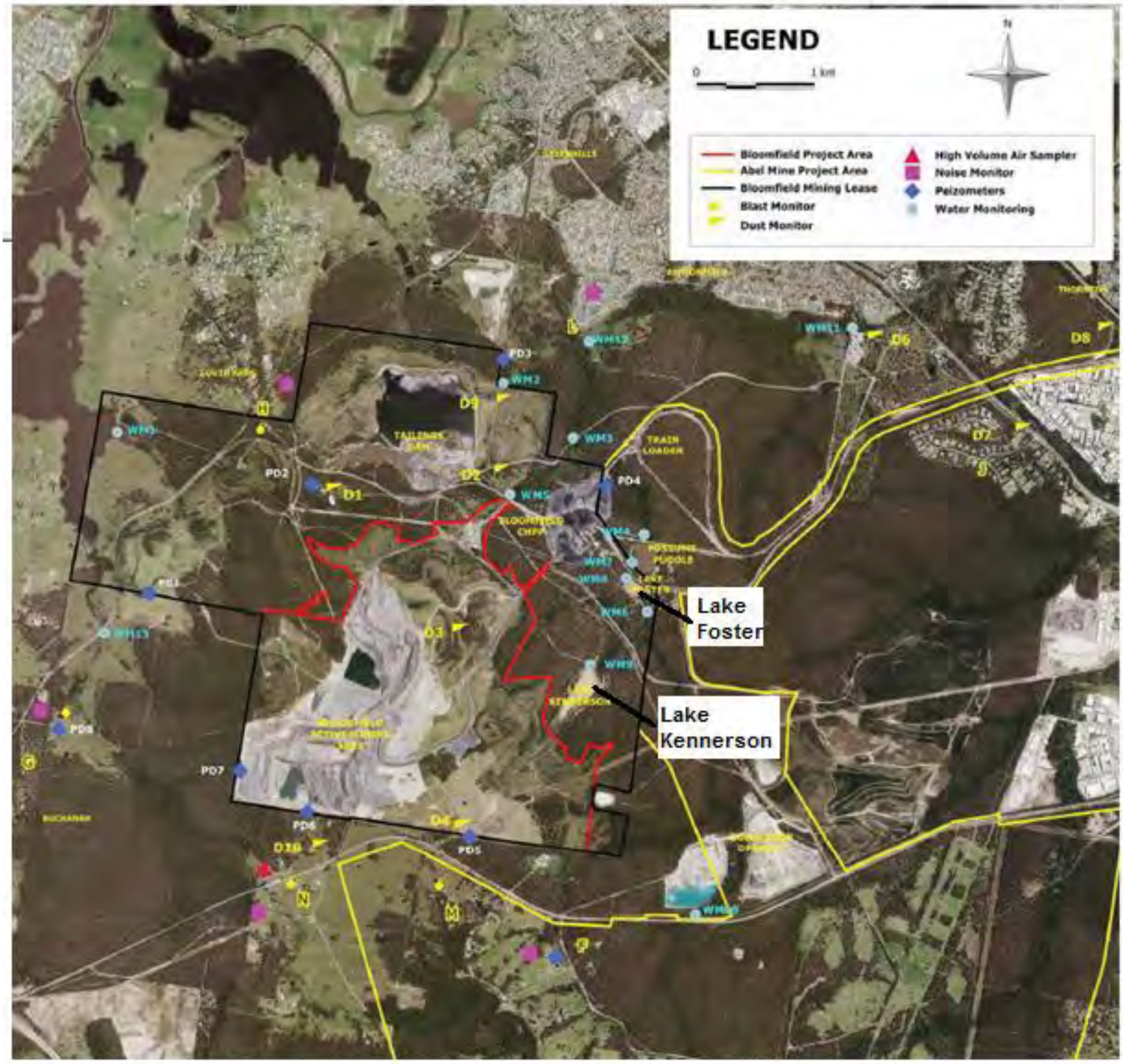


Figure 3. Lease Boundaries and Environmental Monitoring Sites [Bloomfield, 2015]

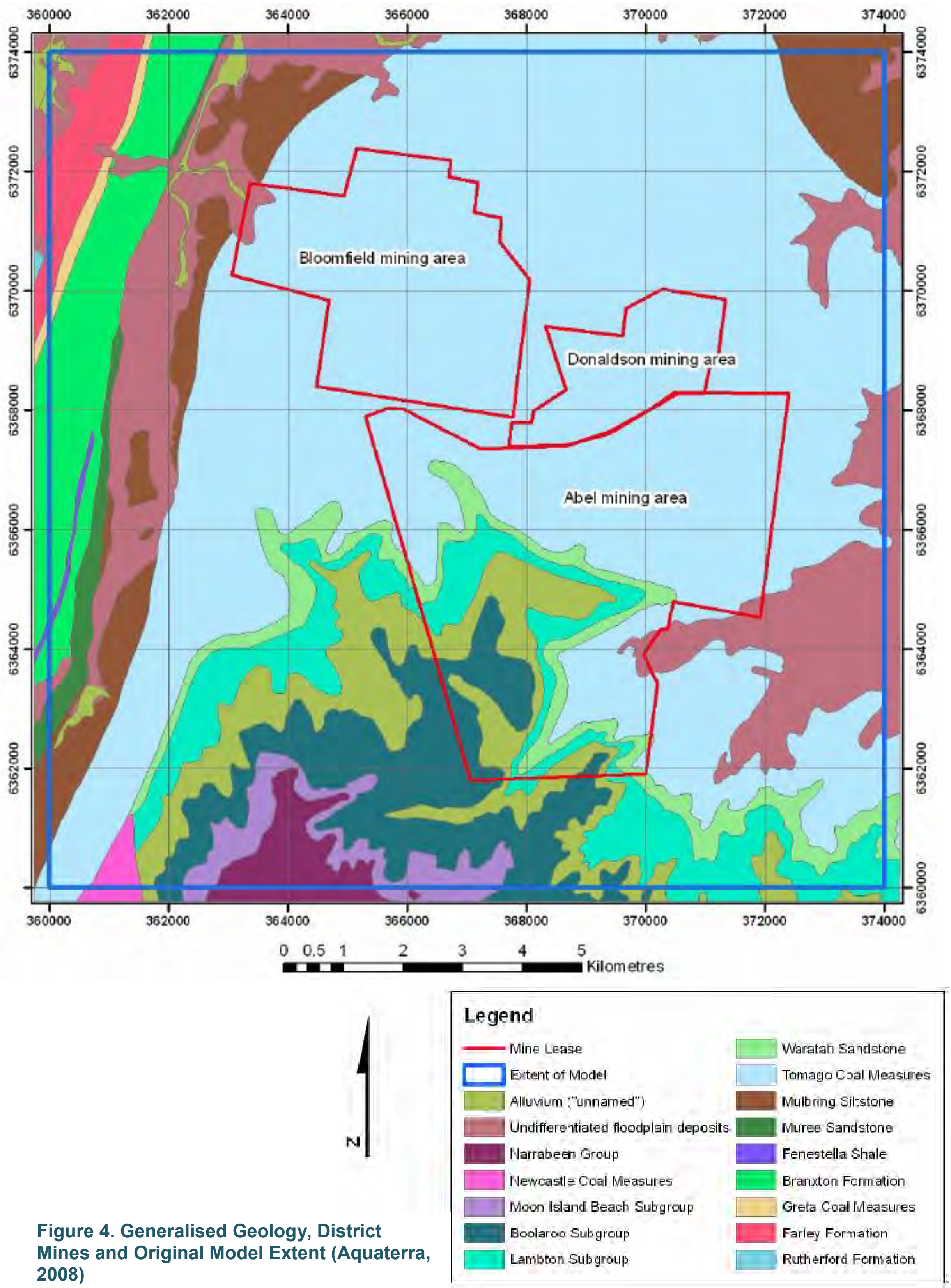


Figure 4. Generalised Geology, District Mines and Original Model Extent (Aquaterra, 2008)

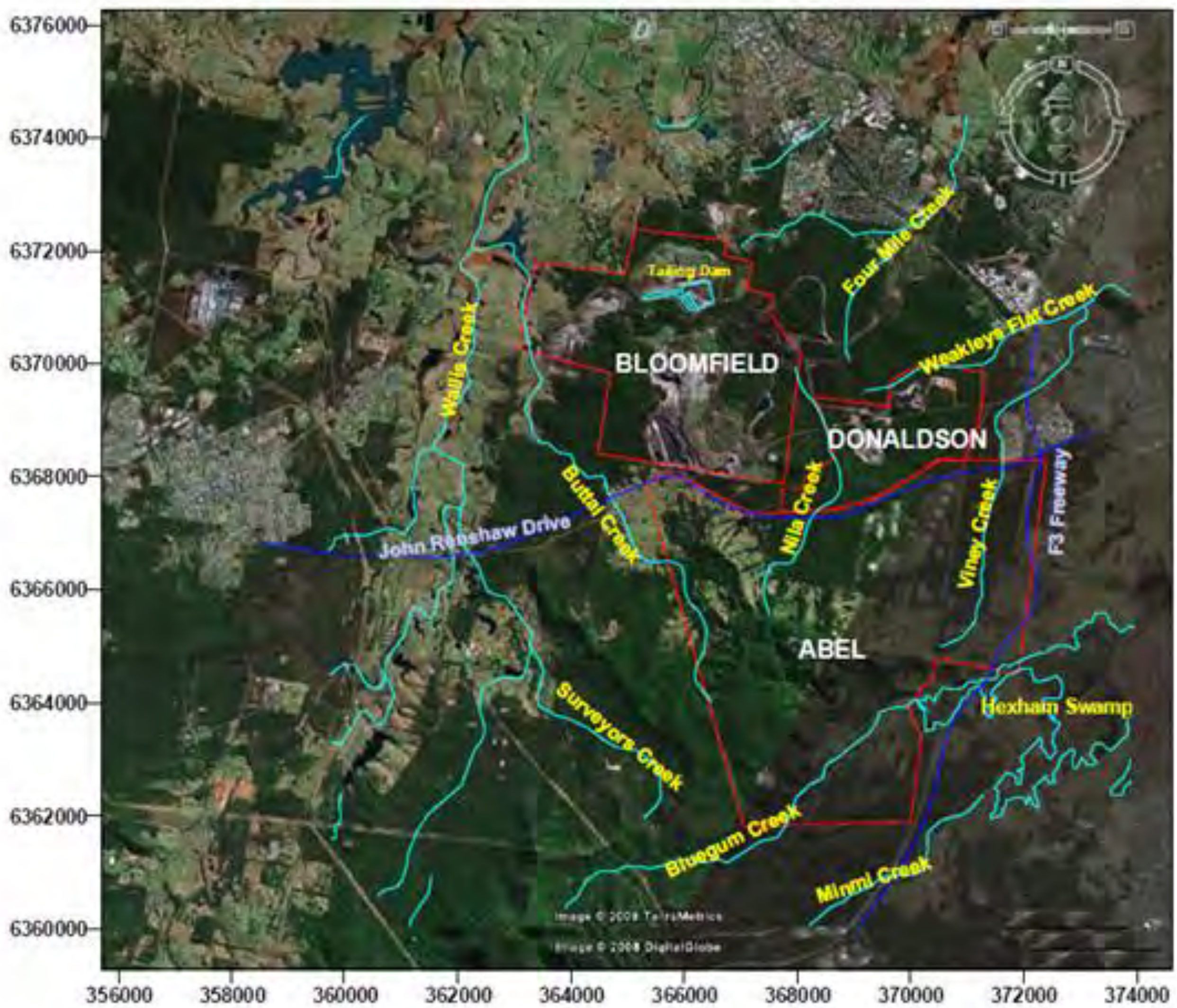


Figure 5. Watercourses (Aquaterra, 2008)

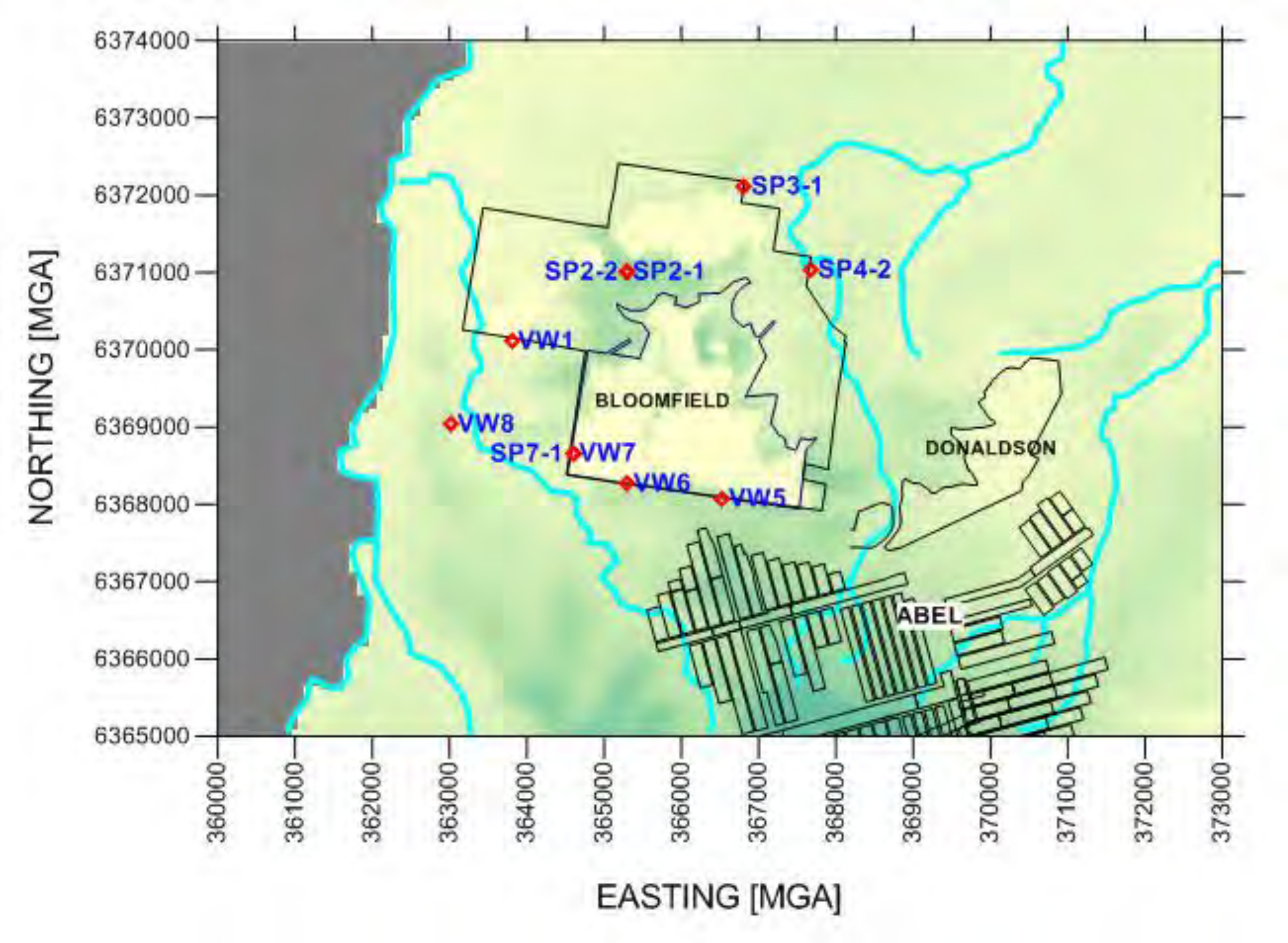


Figure 6. Bloomfield Groundwater Monitoring Network

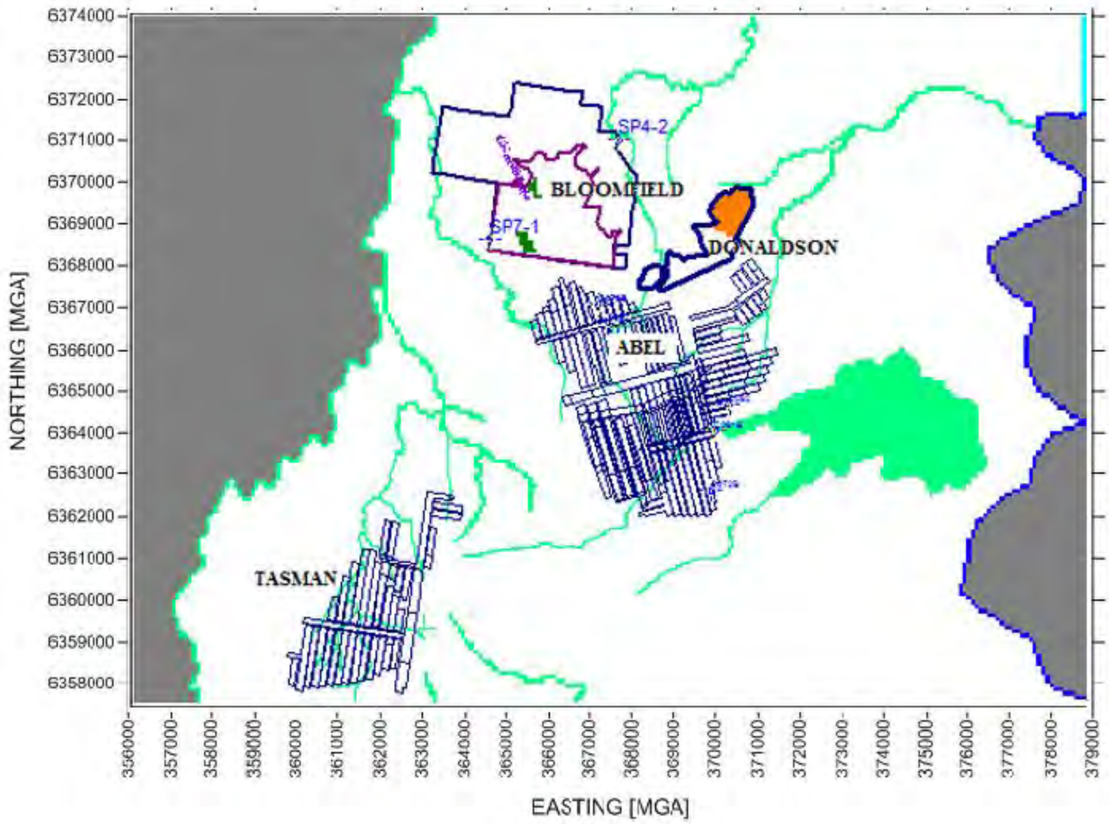


Figure 7. Bloomfield Groundwater Model Extent

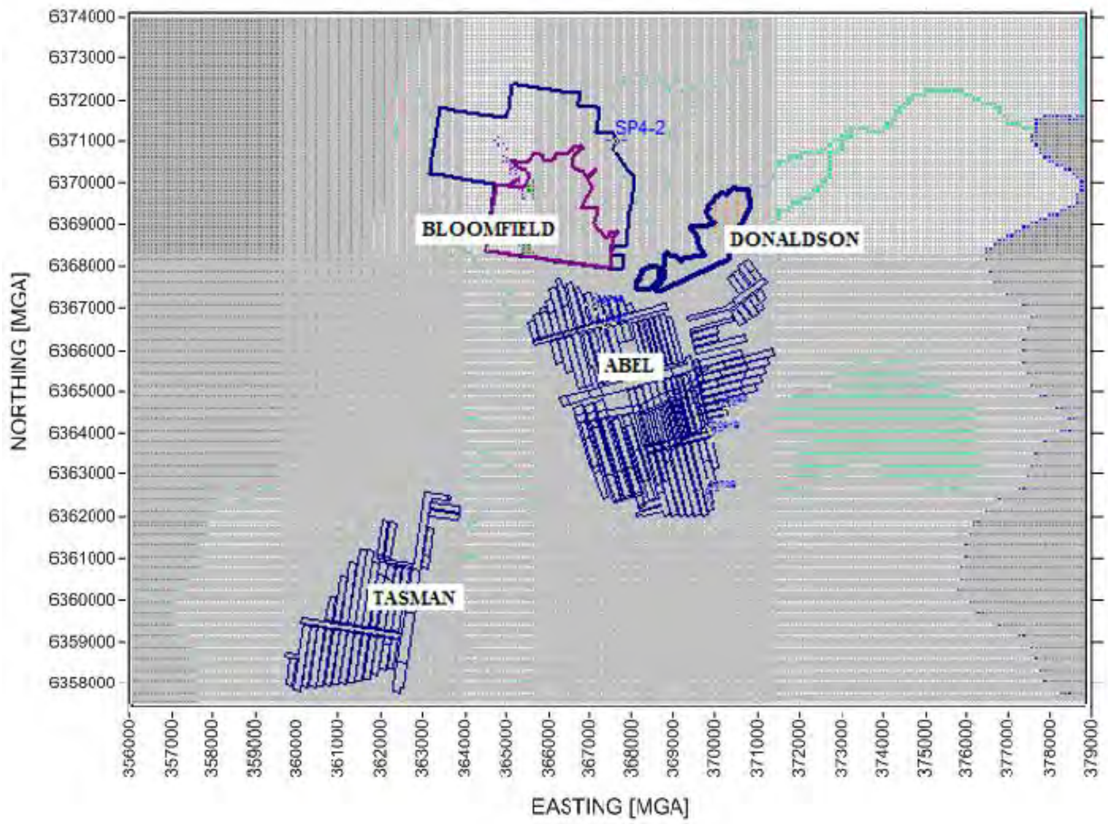


Figure 8. Bloomfield Groundwater Model Grid

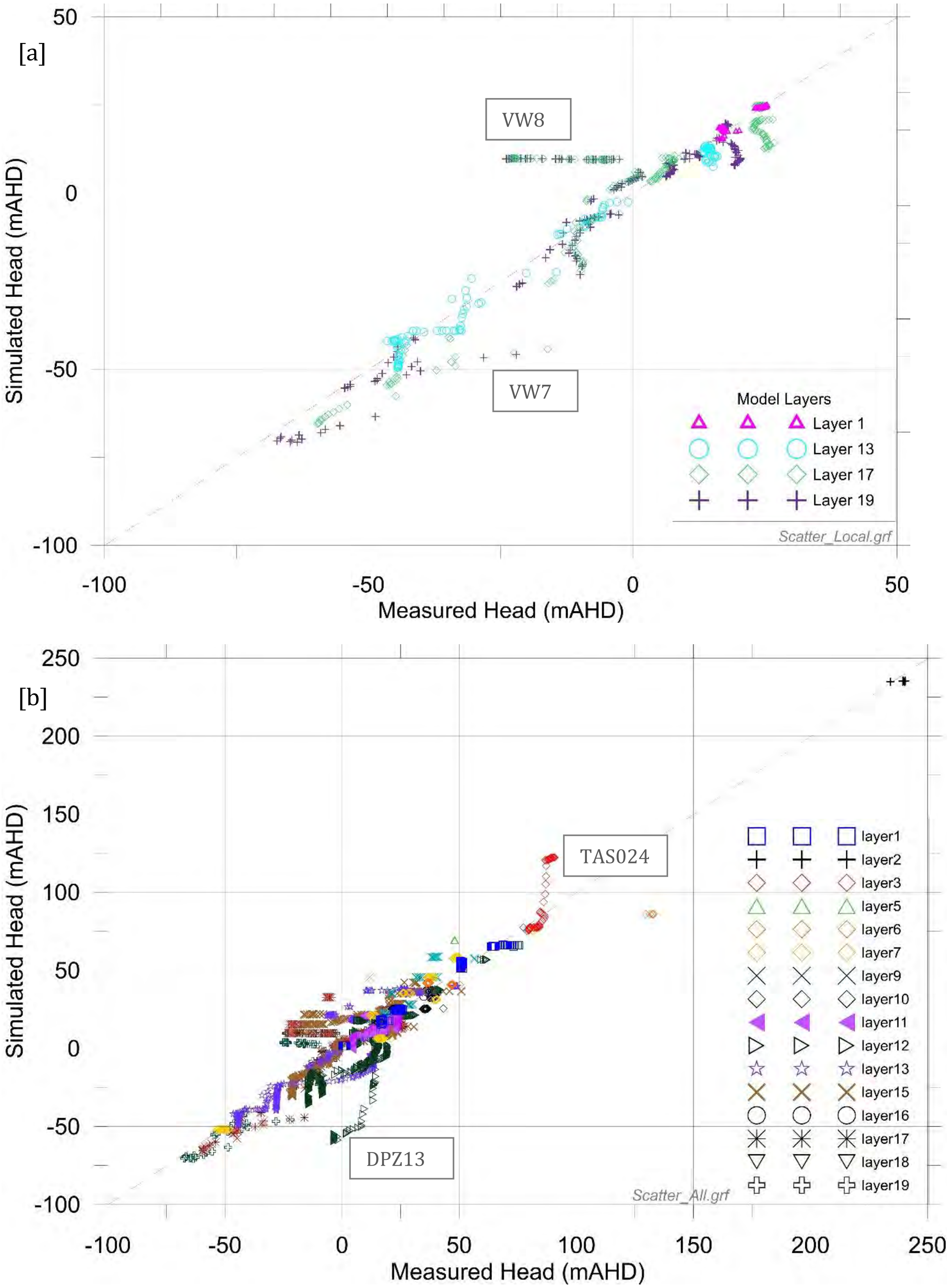


Figure 9. Calibration Scattergrams [a] Bloomfield Bores; [b] Regional Bores

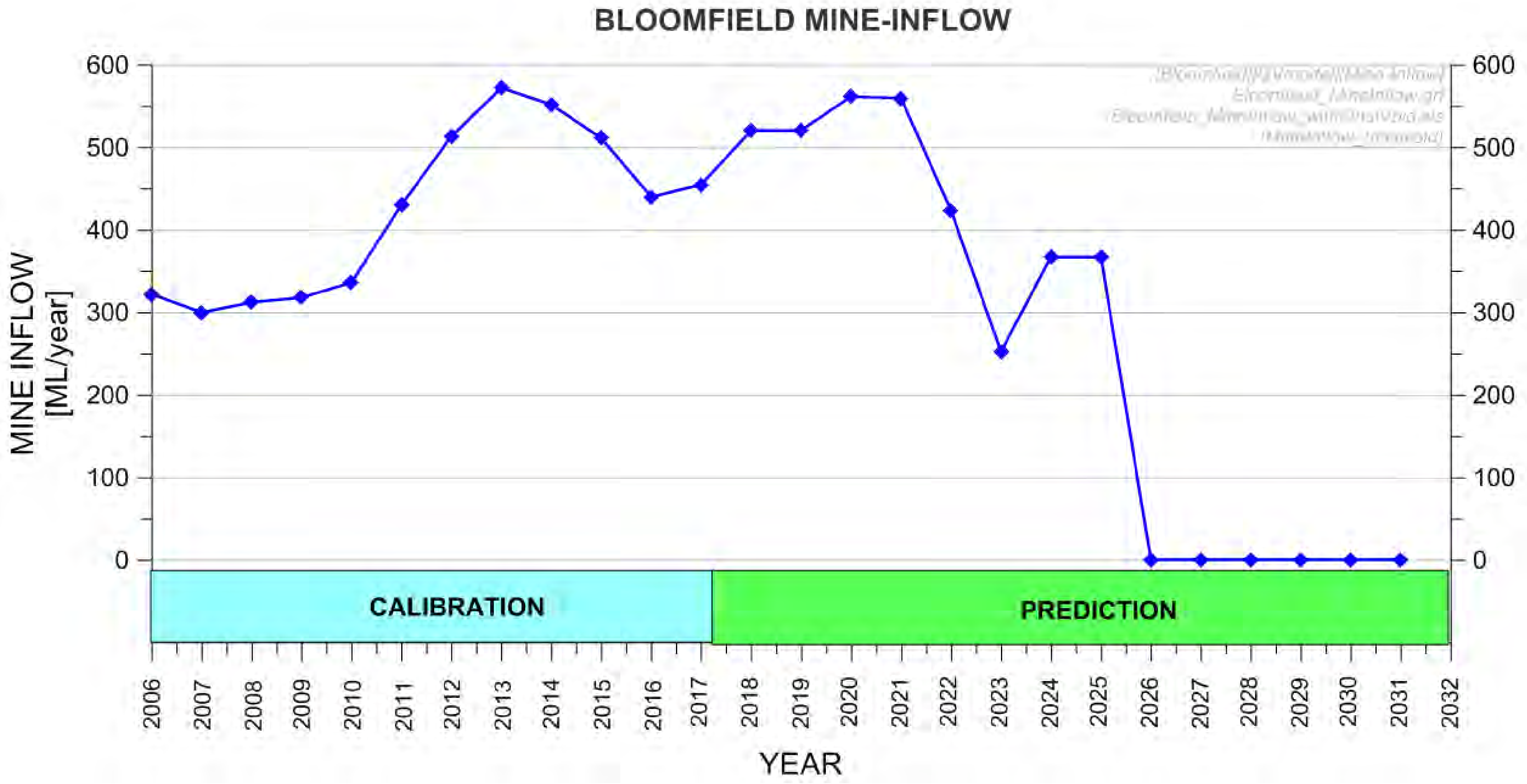


Figure 10. Modelled Mine Inflows for the Bloomfield Mine

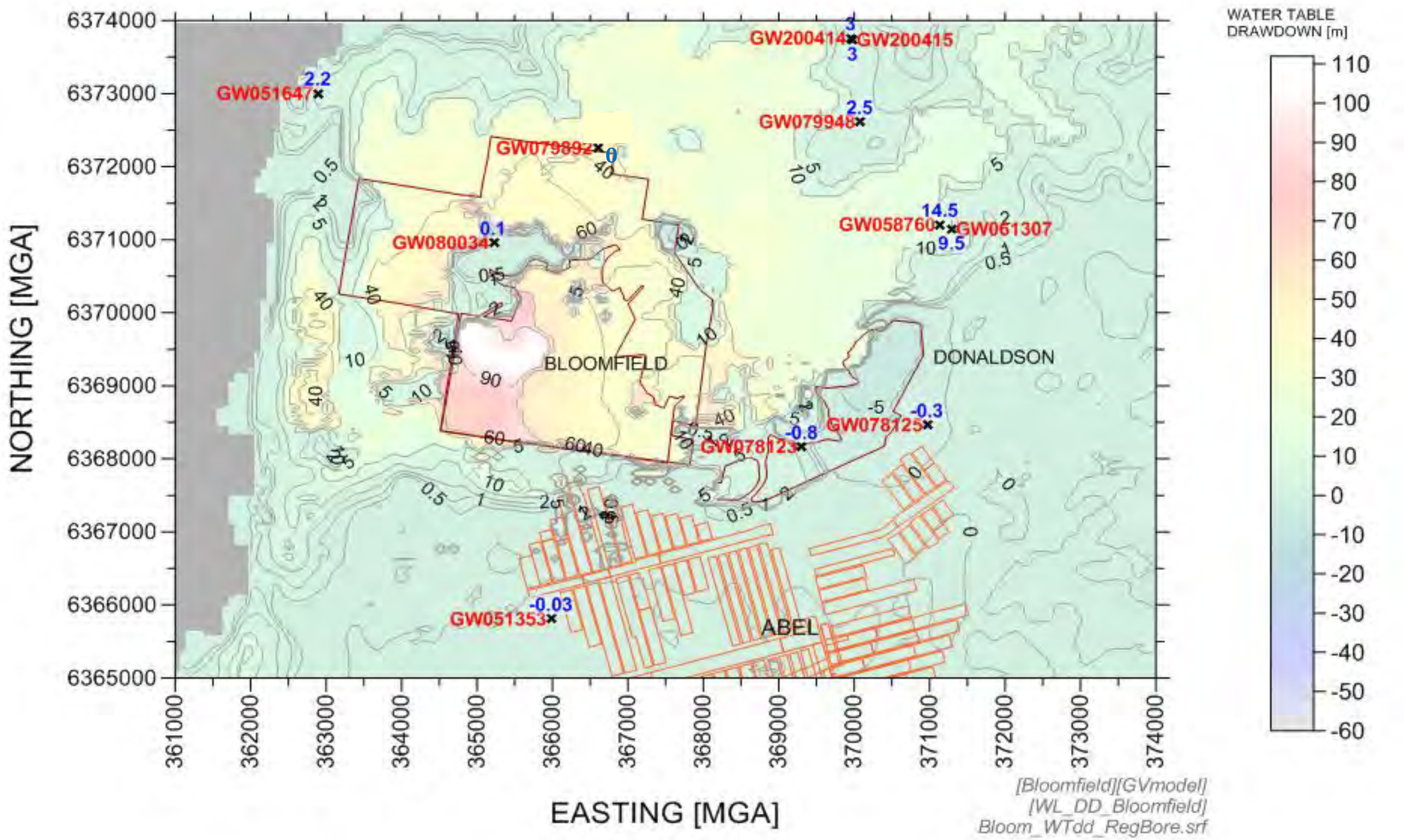


Figure 11. Predicted Water Table Drawdown Contours [m] at Registered Bores at the End of Mining (Year 2025). Posted values are specific-layer drawdowns at the base of each hole.

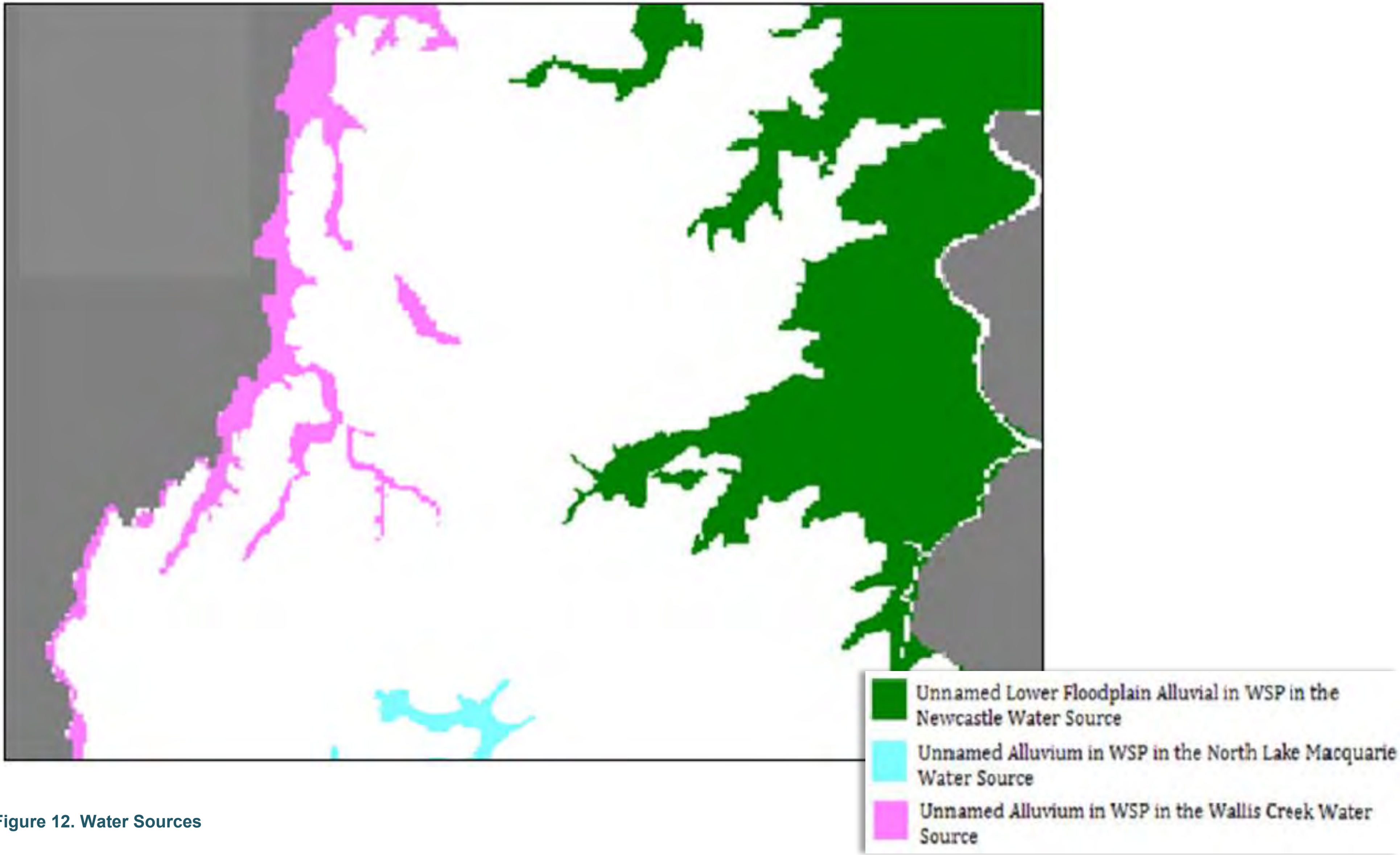


Figure 12. Water Sources

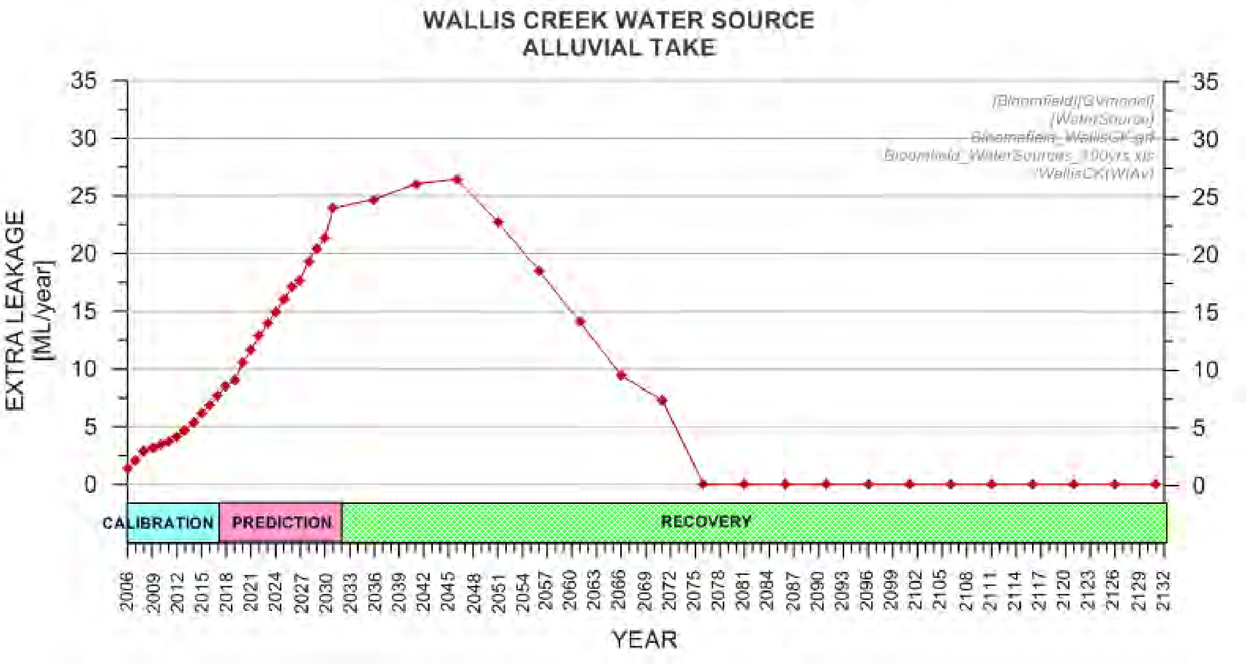


Figure 13. Wallis Creek Water Source Alluvial Take

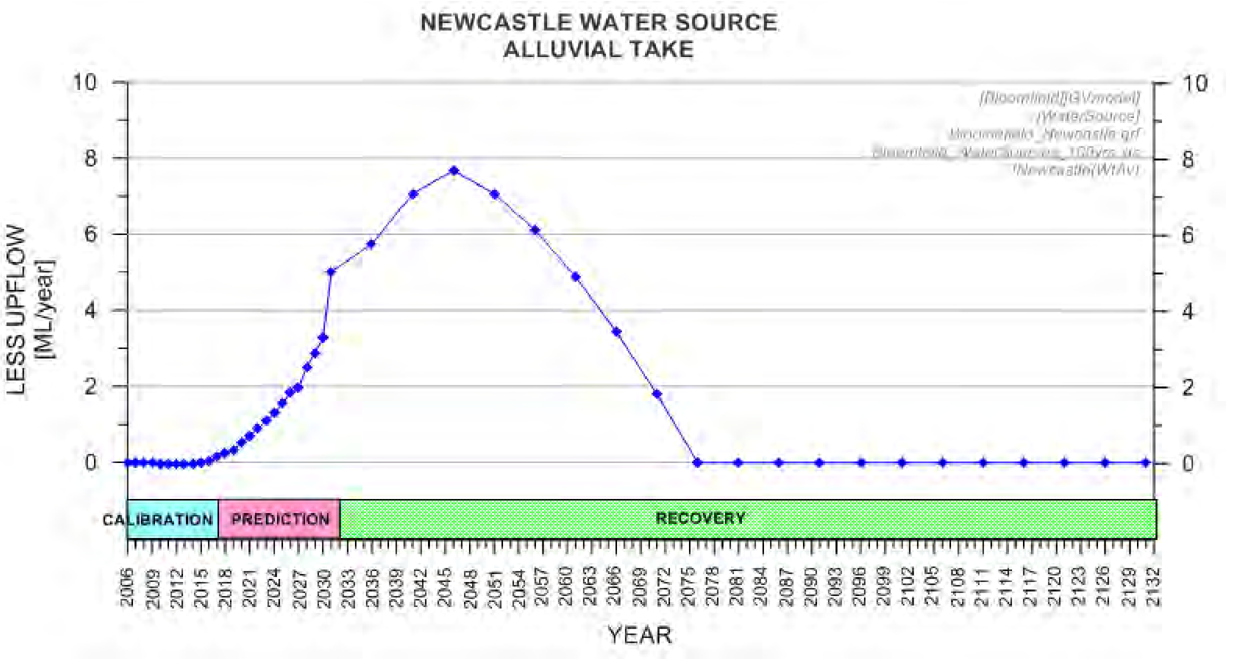
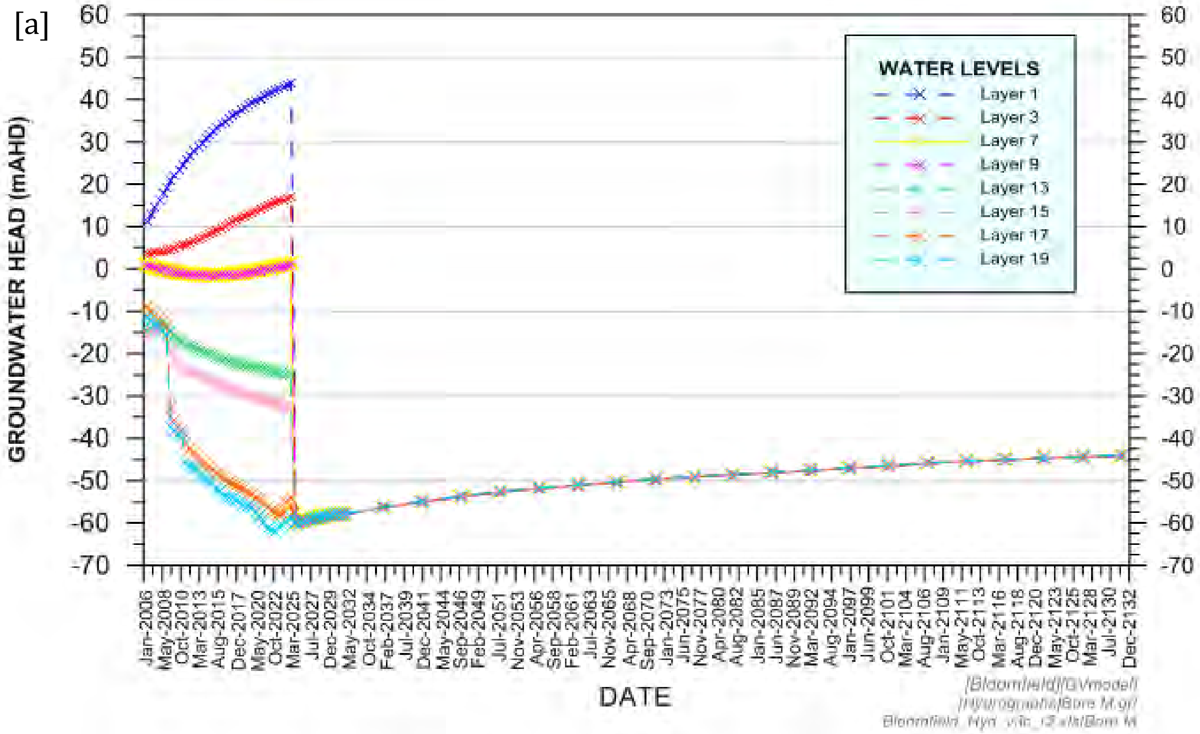


Figure 14. Newcastle Water Source Alluvial Take

[a]



[b]

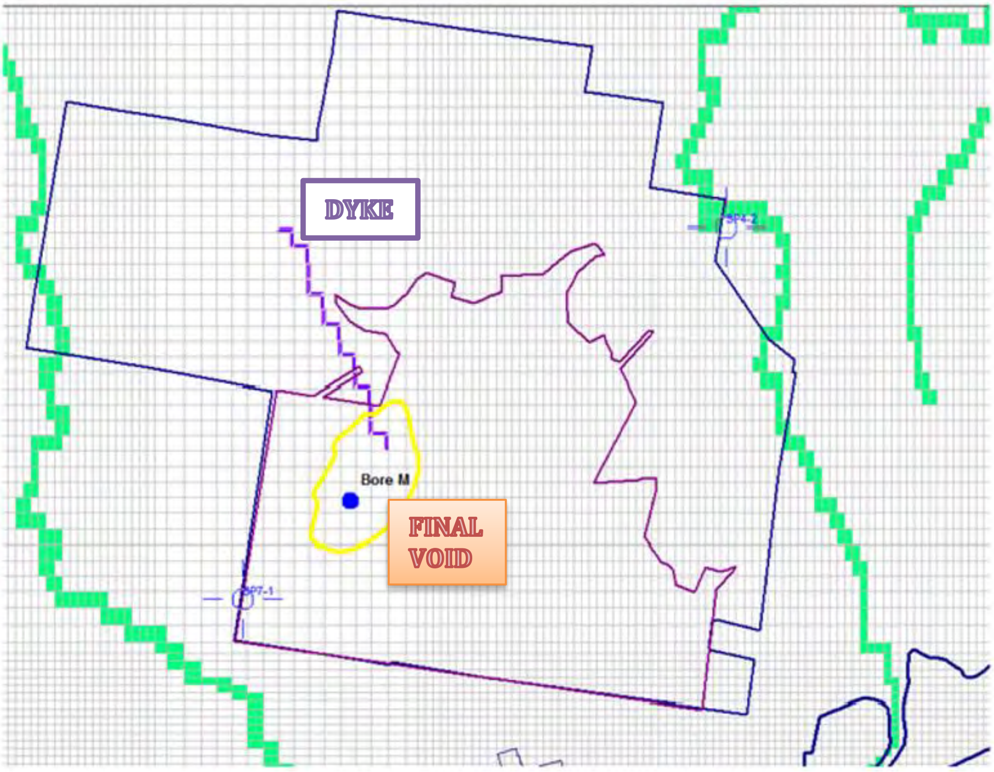


Figure 15. Simulated Recovery Hydrograph at Site M [a] within the Final Void [b]

APPENDIX A

Mining Progression

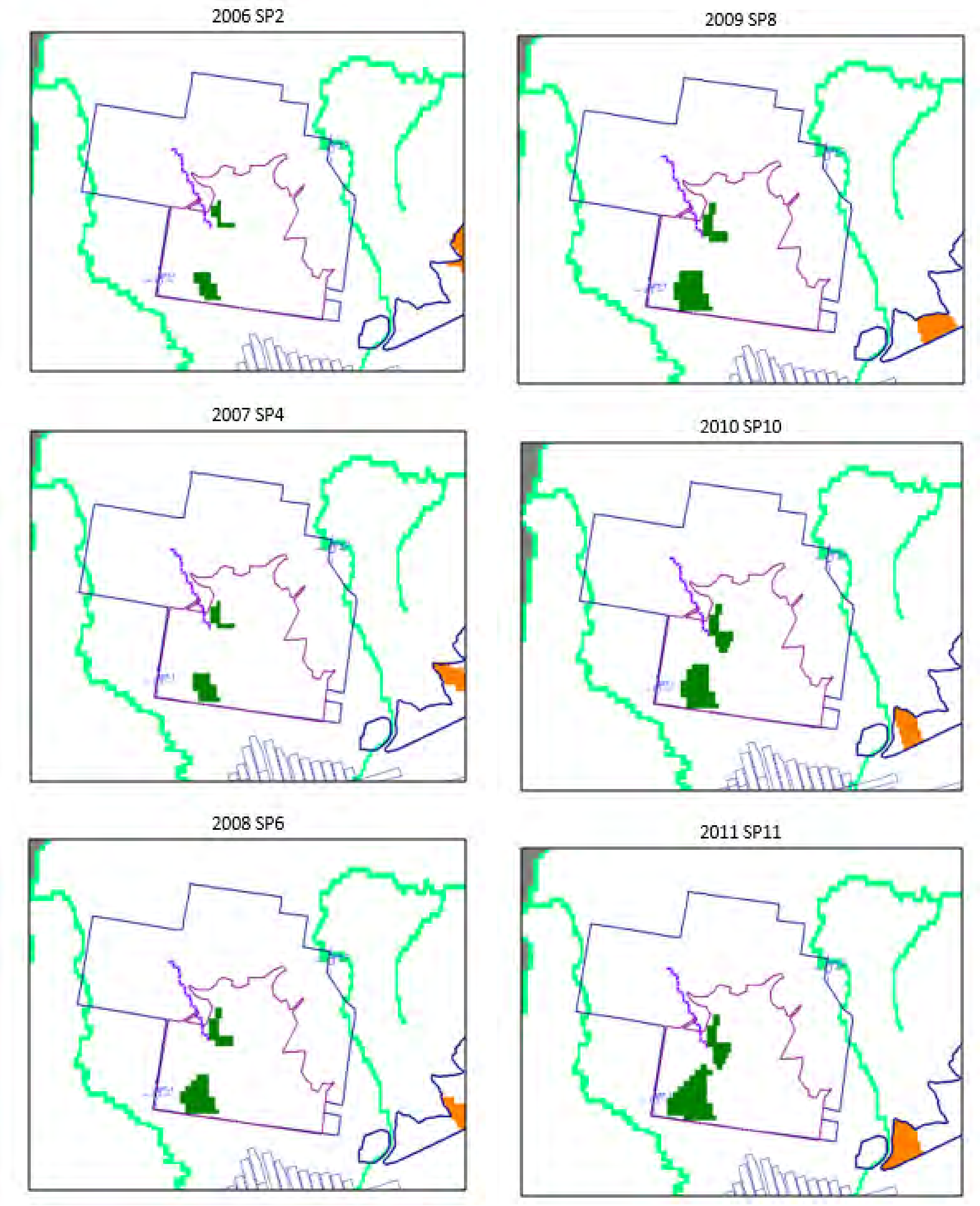


Figure A1. Mining Progression 2006 to 2011

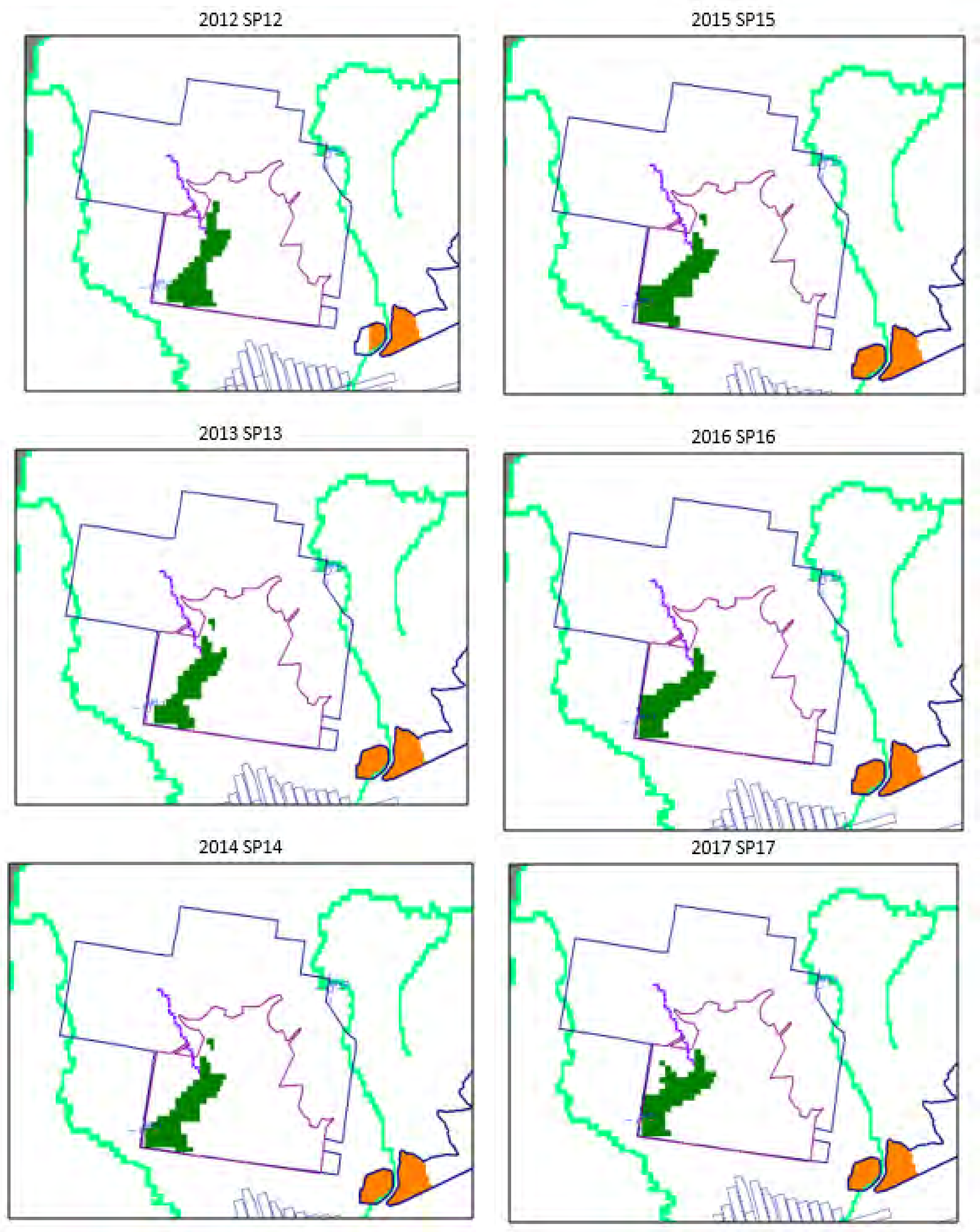


Figure A2. Mining Progression 2012 to 2017

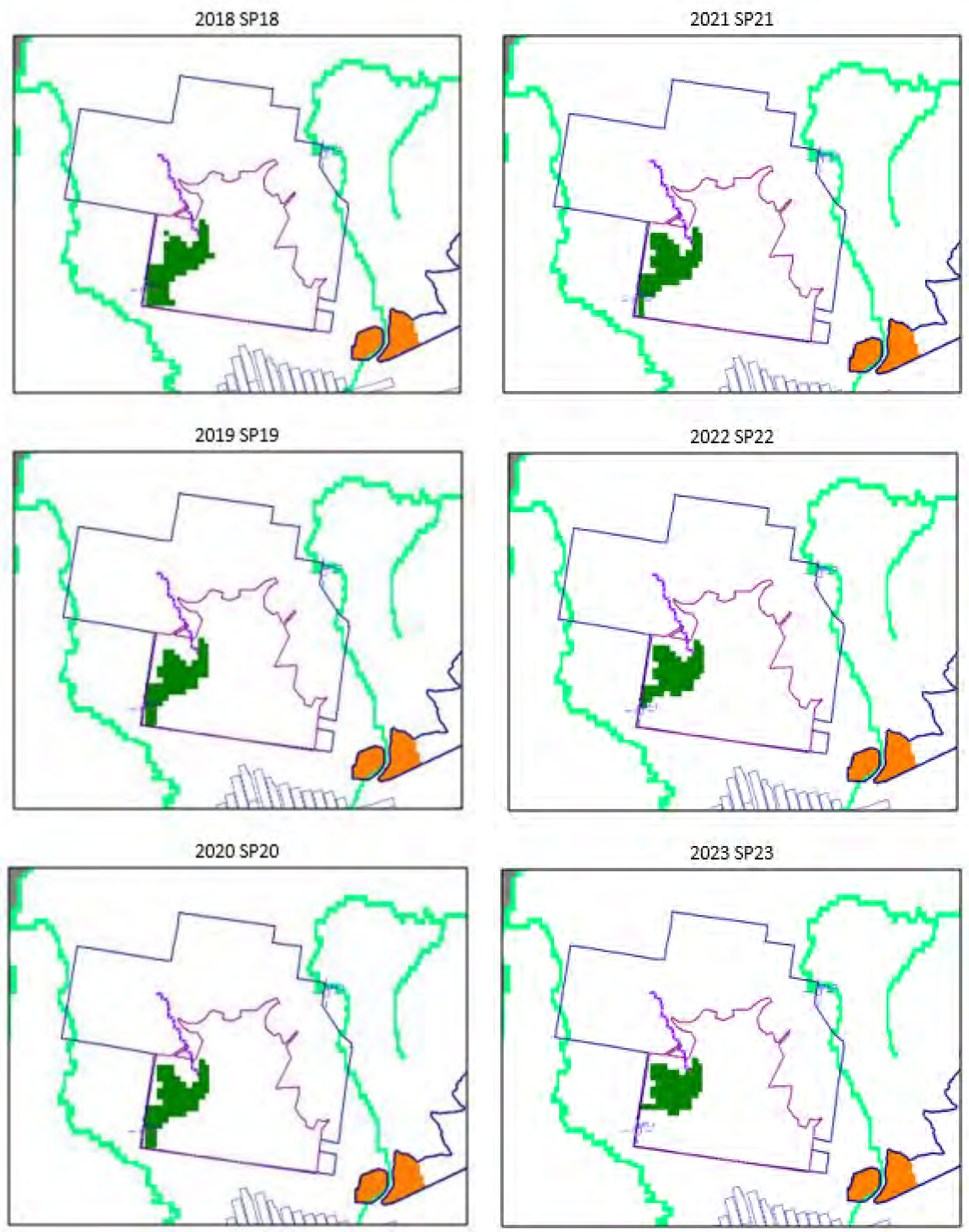


Figure A3. Mining Progression 2018 to 2023

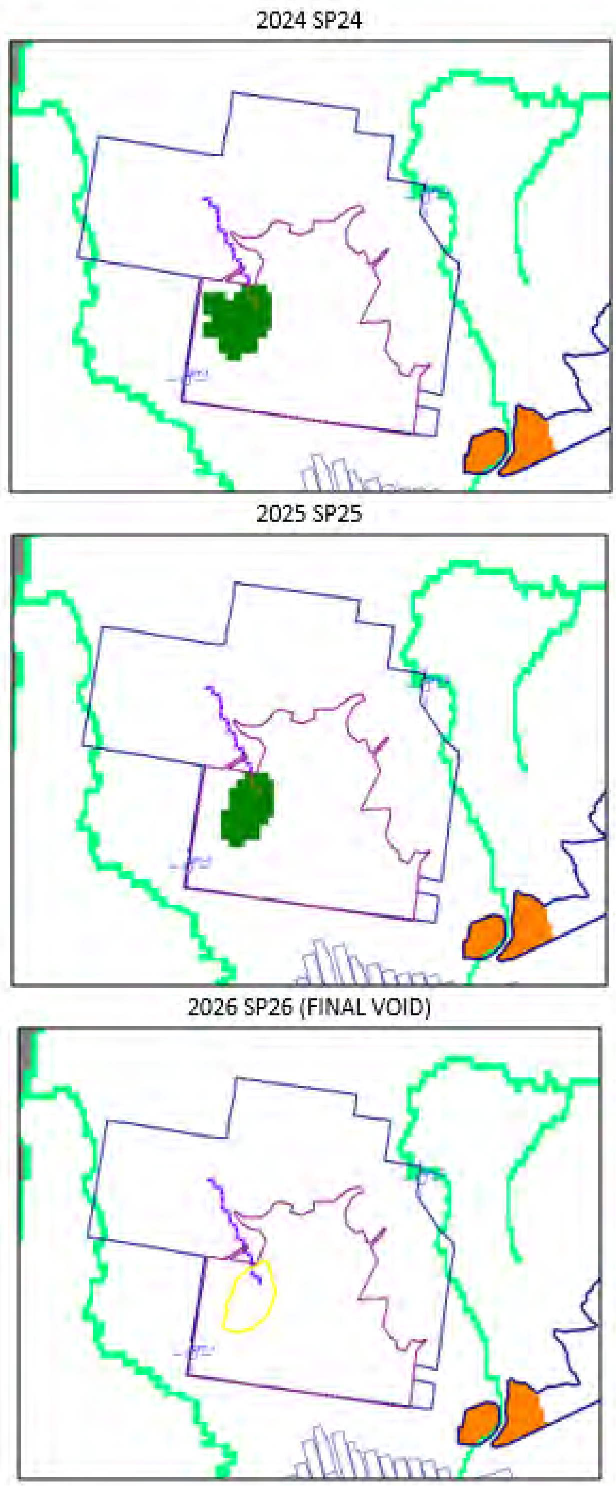
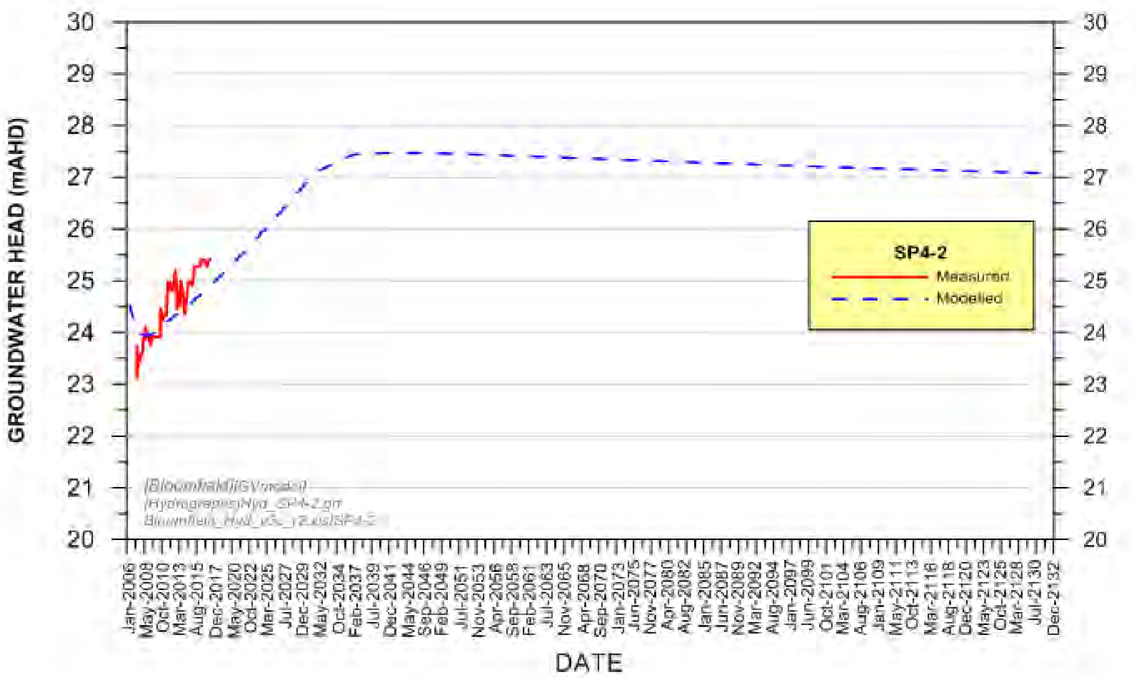


Figure A4. Mining Progression 2024 to 2025 and Final Void Location (SP26-SP32)

APPENDIX B

Groundwater Level Hydrographs



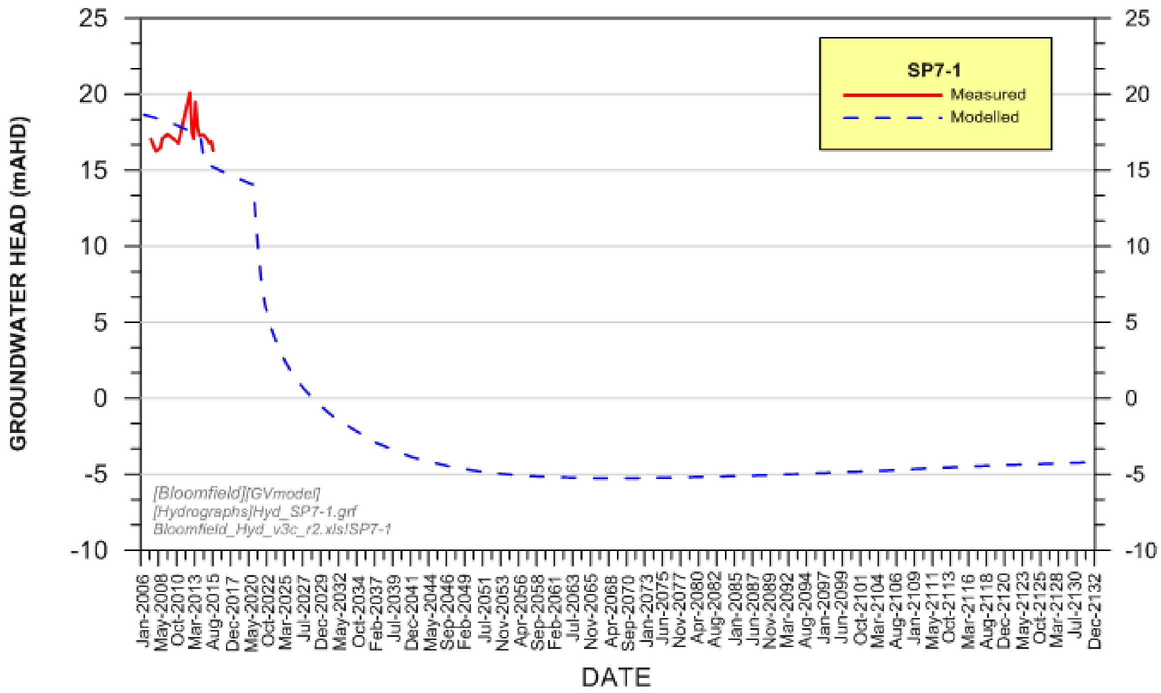


Figure B1. Measured and Simulated Hydrographs for Standpipes SP4-2 and SP7-1 in Alluvium and Regolith [Layer1]

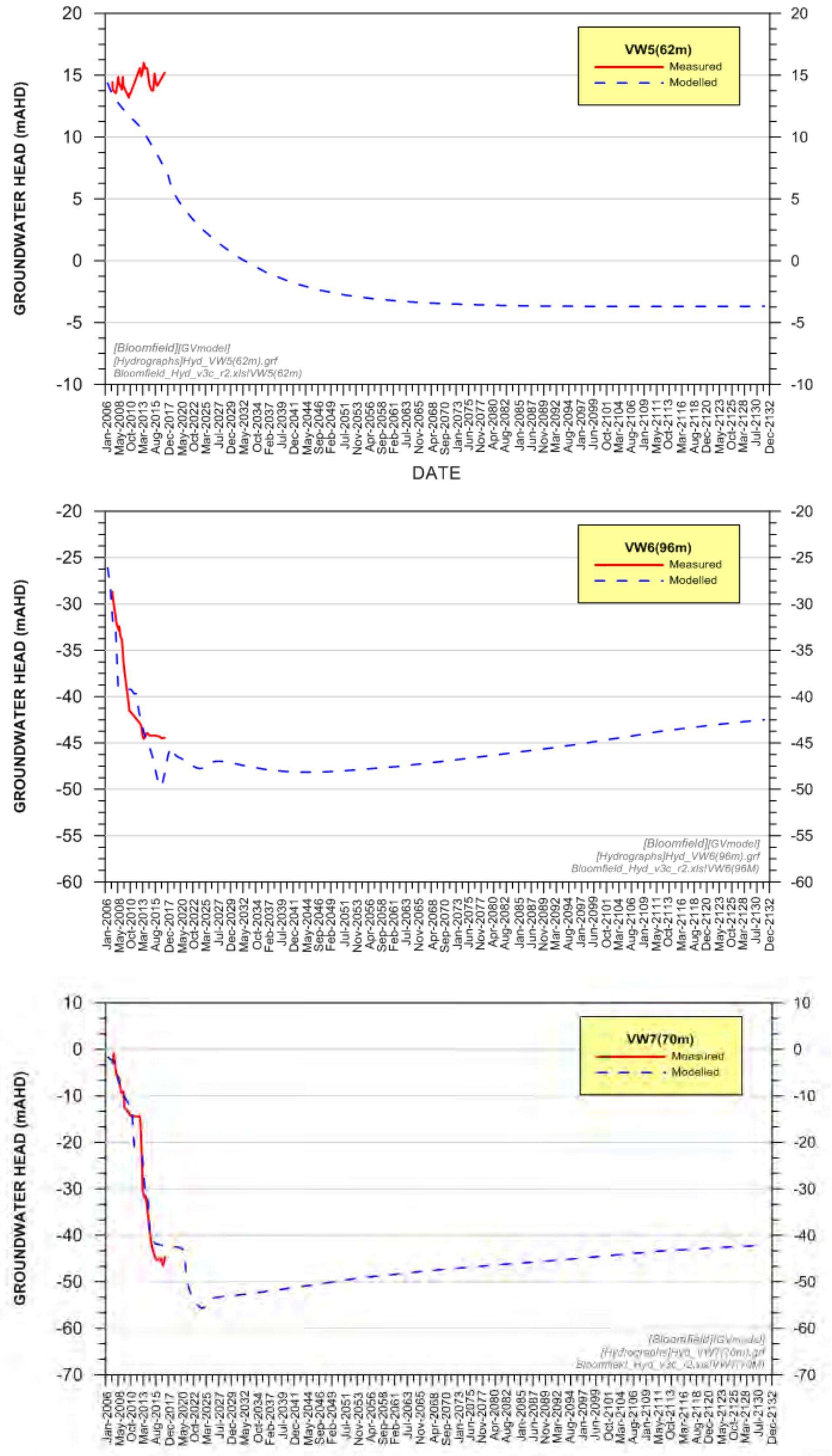


Figure B2. Measured and Simulated Hydrographs for VW5(62m), VW6(96m) and VW7(70m) at Whites Creek Seam [Layer13]

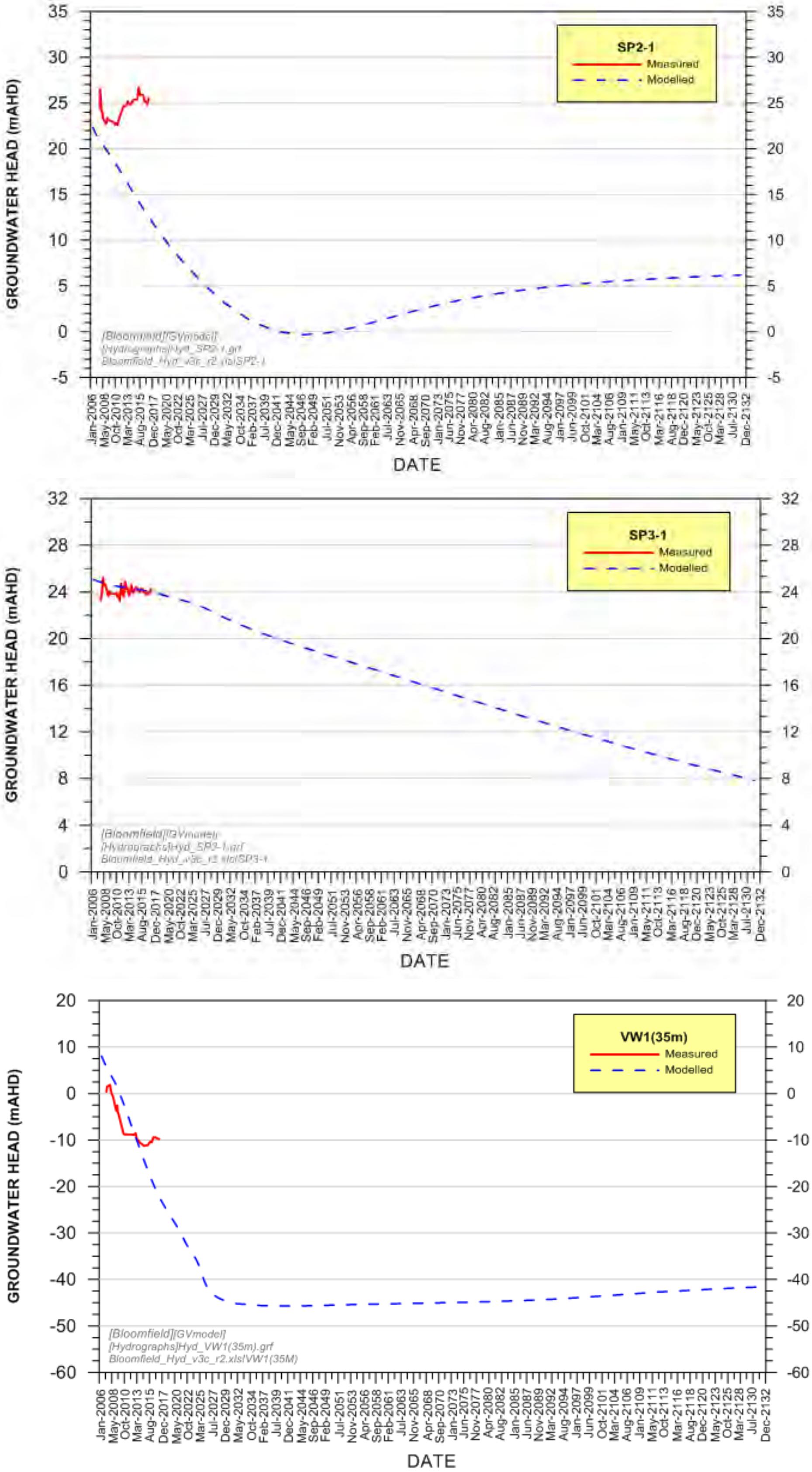
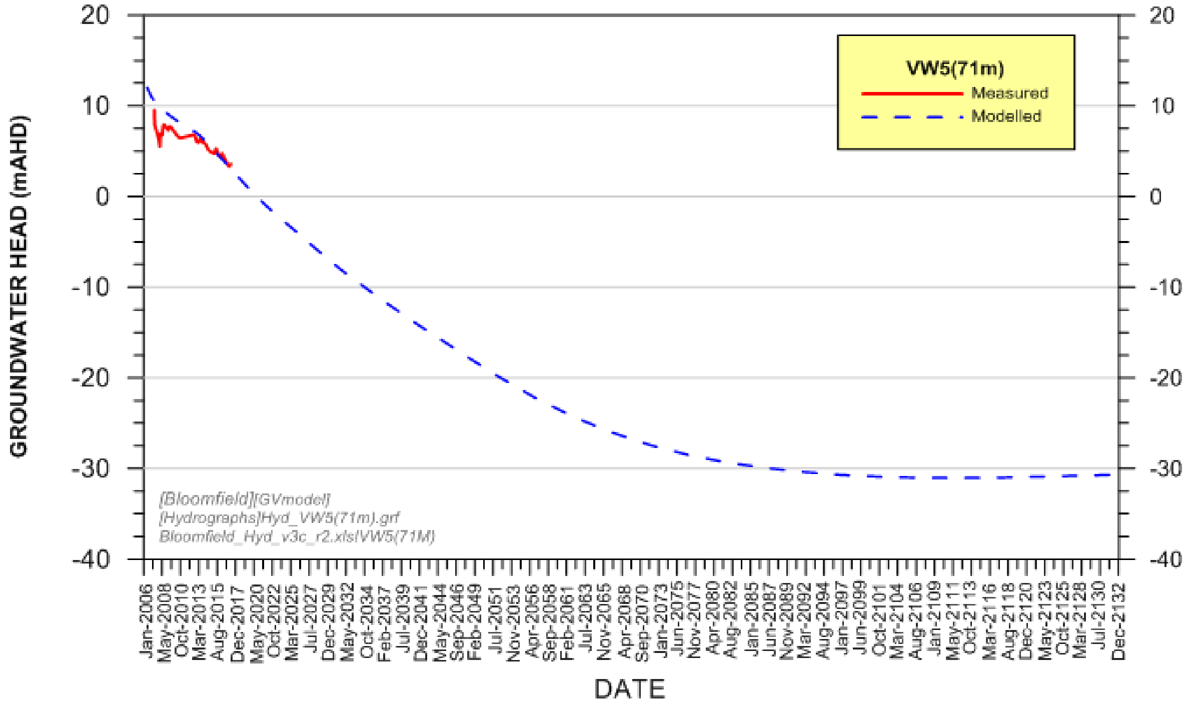


Figure B3. Measured and Simulated Hydrographs for Standpipes SP2-1 and SP3-1, and VW1(35m) at Donaldson Seam [Layer17]



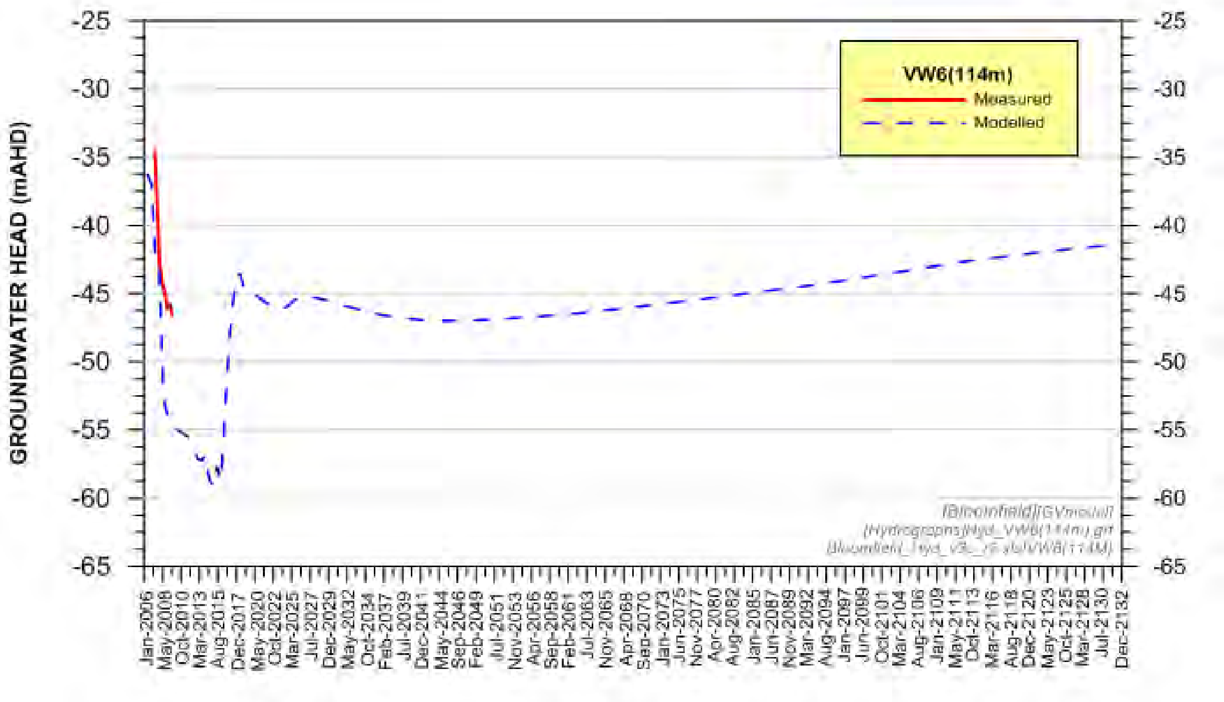
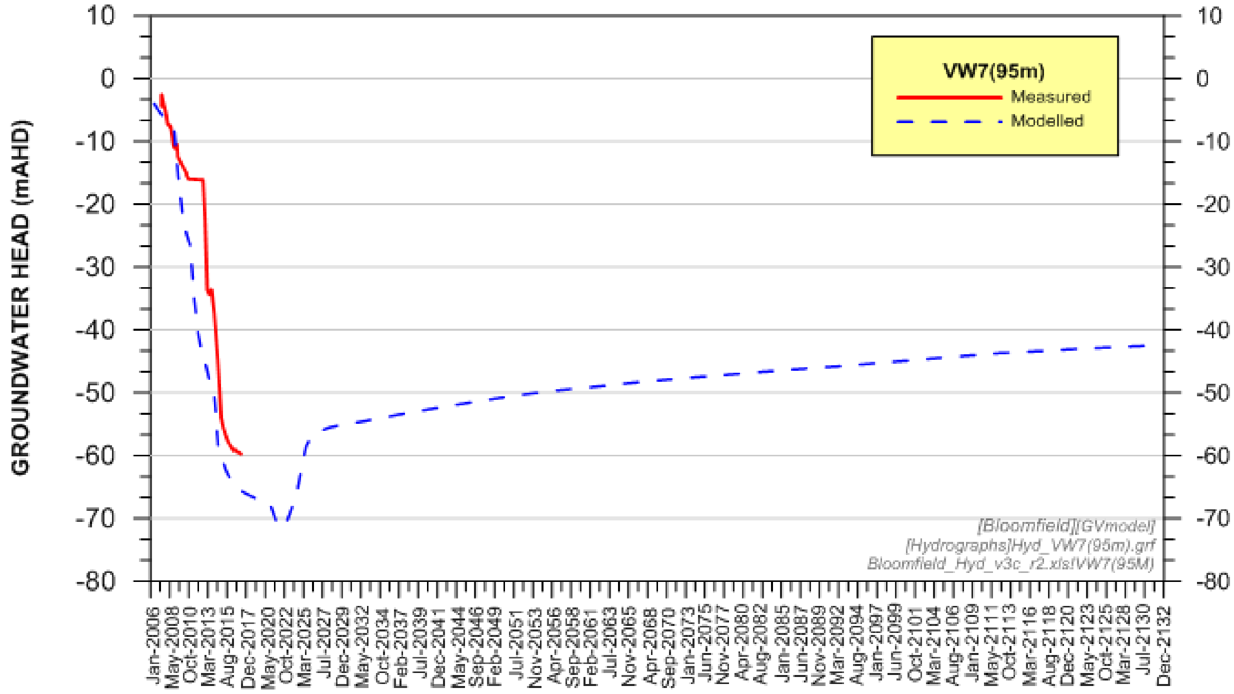


Figure B4. Measured and Simulated Hydrographs for VW5(71m) and VW6(114m) at Donaldson Seam [Layer17]



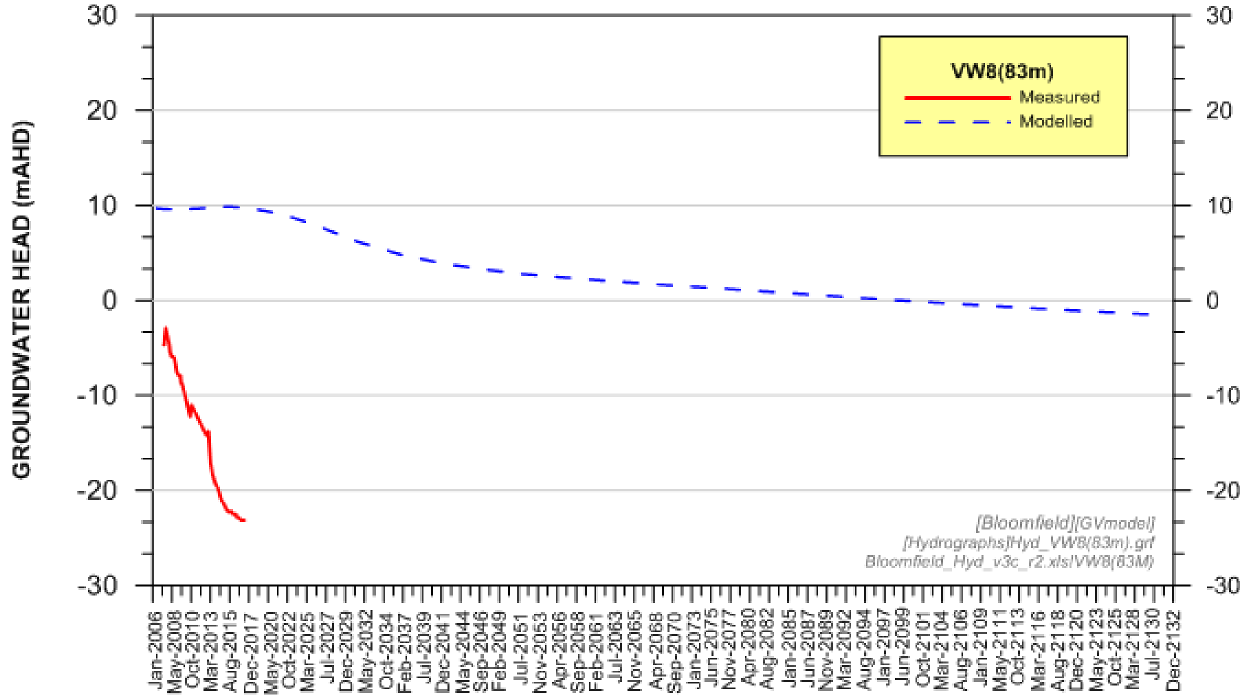


Figure B5. Measured and Simulated Hydrographs for VW7(95m) and VW8(83m) at Donaldson Seam [Layer17]

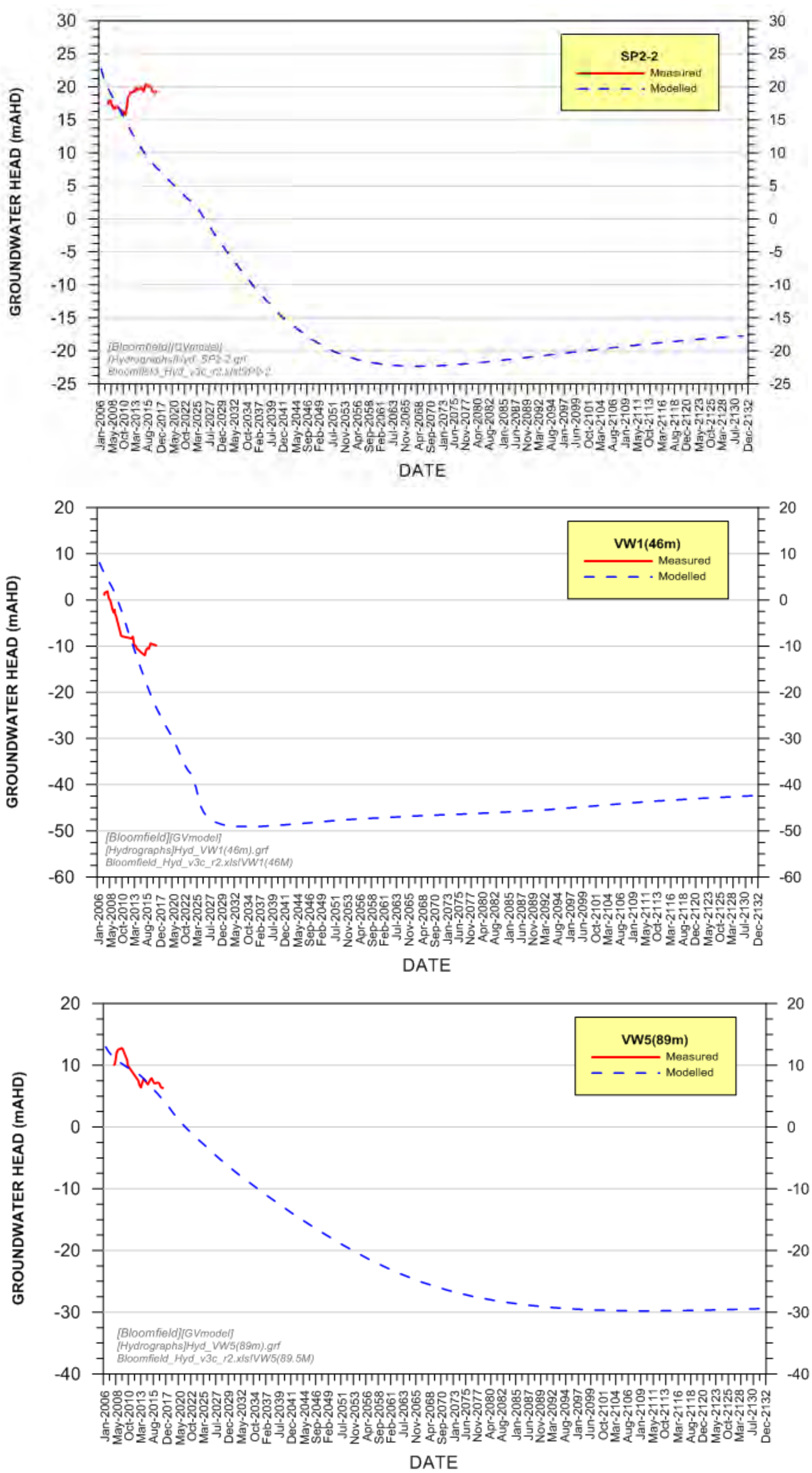


Figure B6. Measured and Simulated Hydrographs for Standpipe SP2-2, VW1(46m) and VW5(89m) at Big Ben Seam [Layer19]

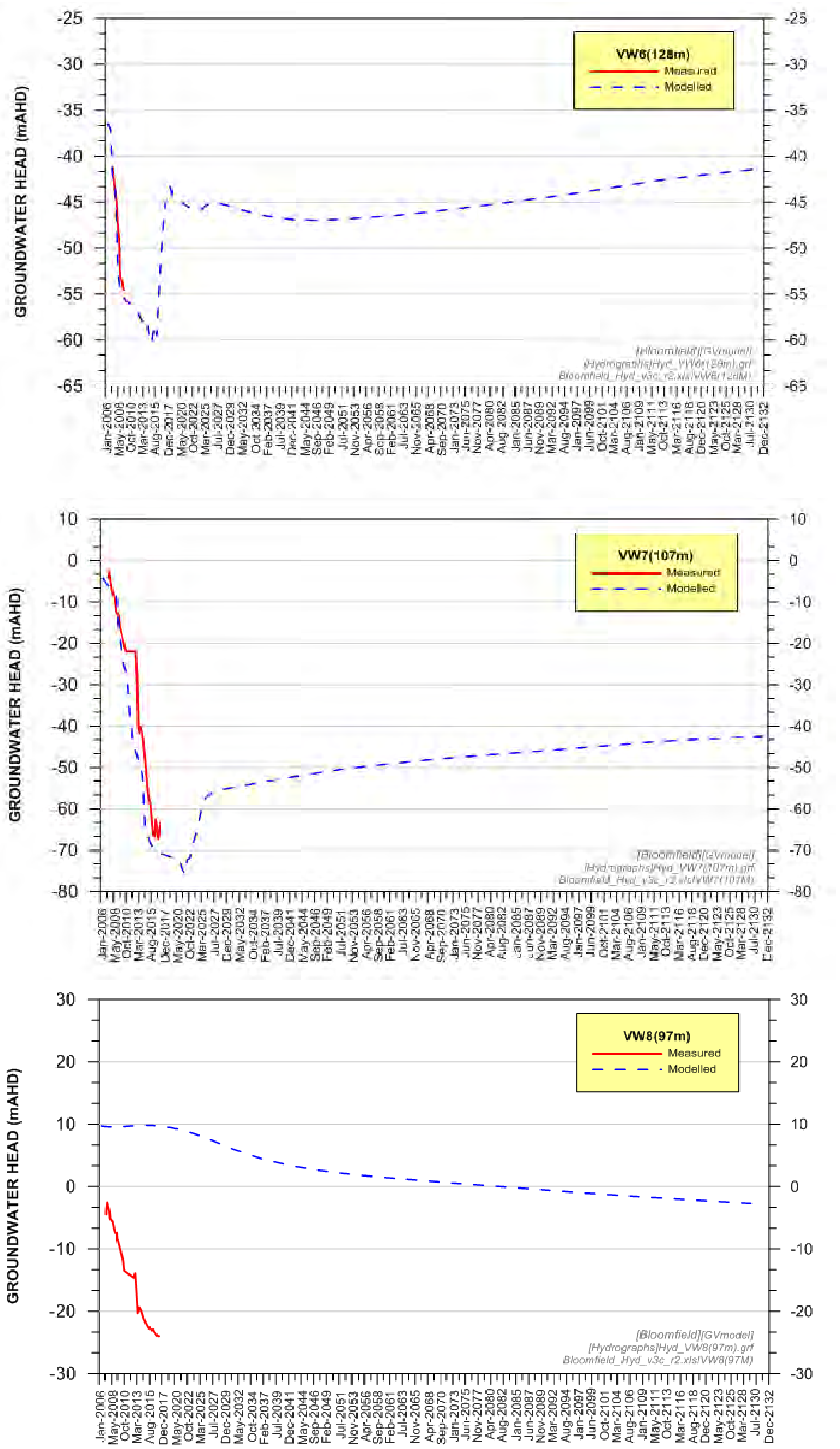


Figure B7. Measured and Simulated Hydrographs for VW6(128m), VW7(107m) and VW8(97m) at Big Ben Seam [Layer19]

APPENDIX C

Simulated Groundwater Level Maps

HYDRO SIMULATIONS

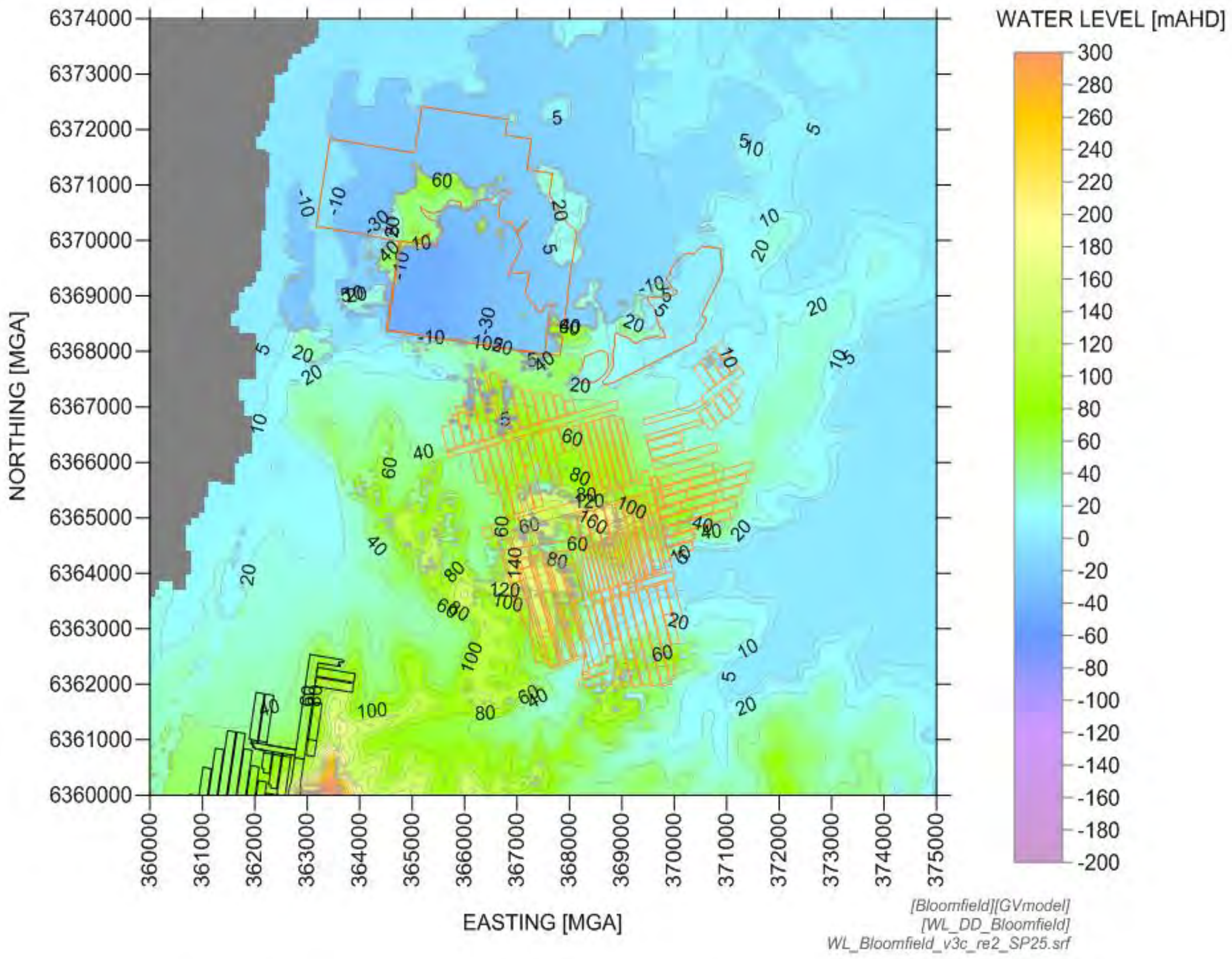


Figure C0. Predicted Water Table at the End of Mining (Year 2025)

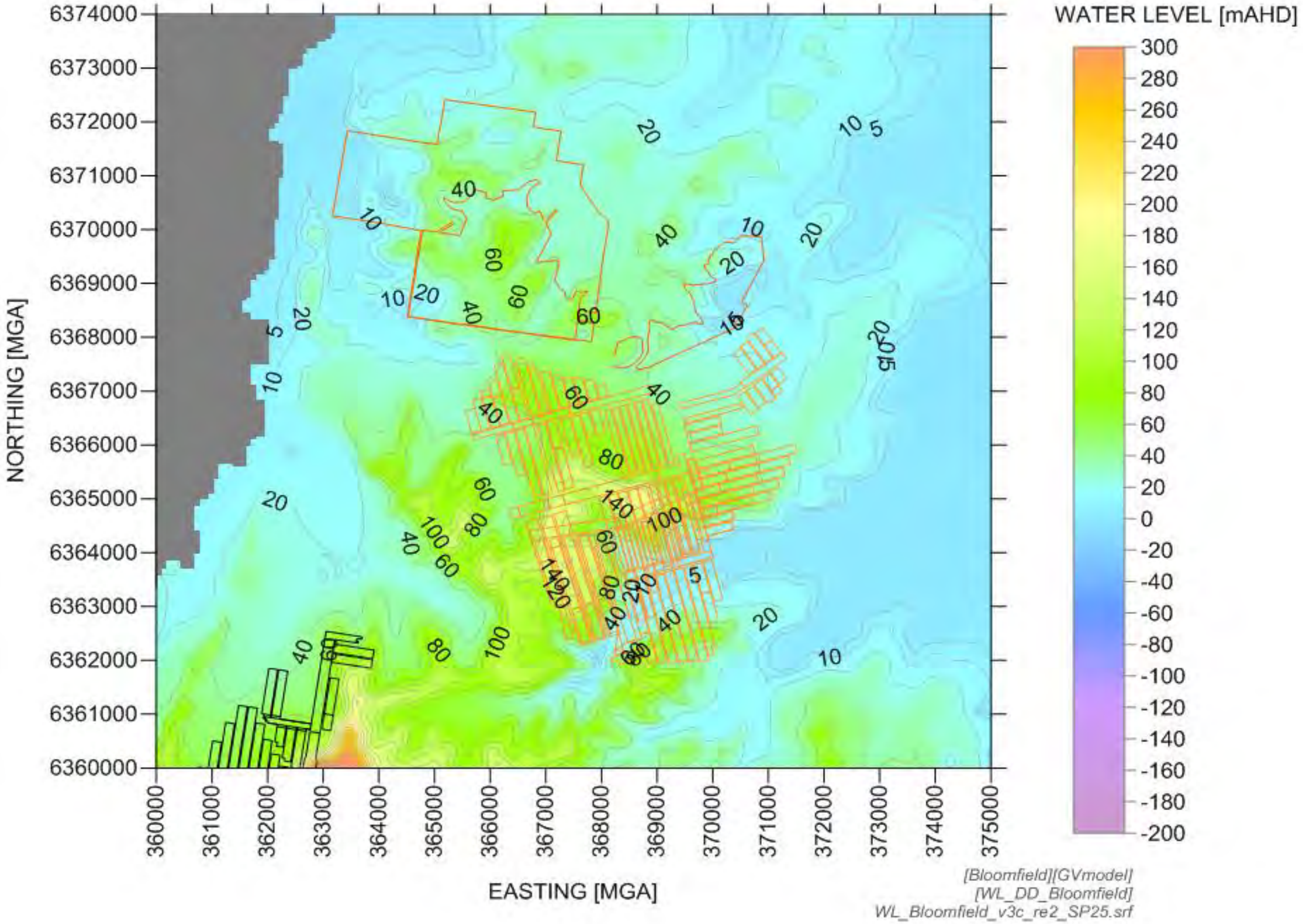


Figure C1. Predicted Water Levels in Alluvium and Regolith [Layer 1] at the End of Mining (Year 2025).

To account for a dry layer, the following definition is applied: Water Level = IF(C>B,C,B) where C = modelled water level; B = Layer 1 bottom elevation.

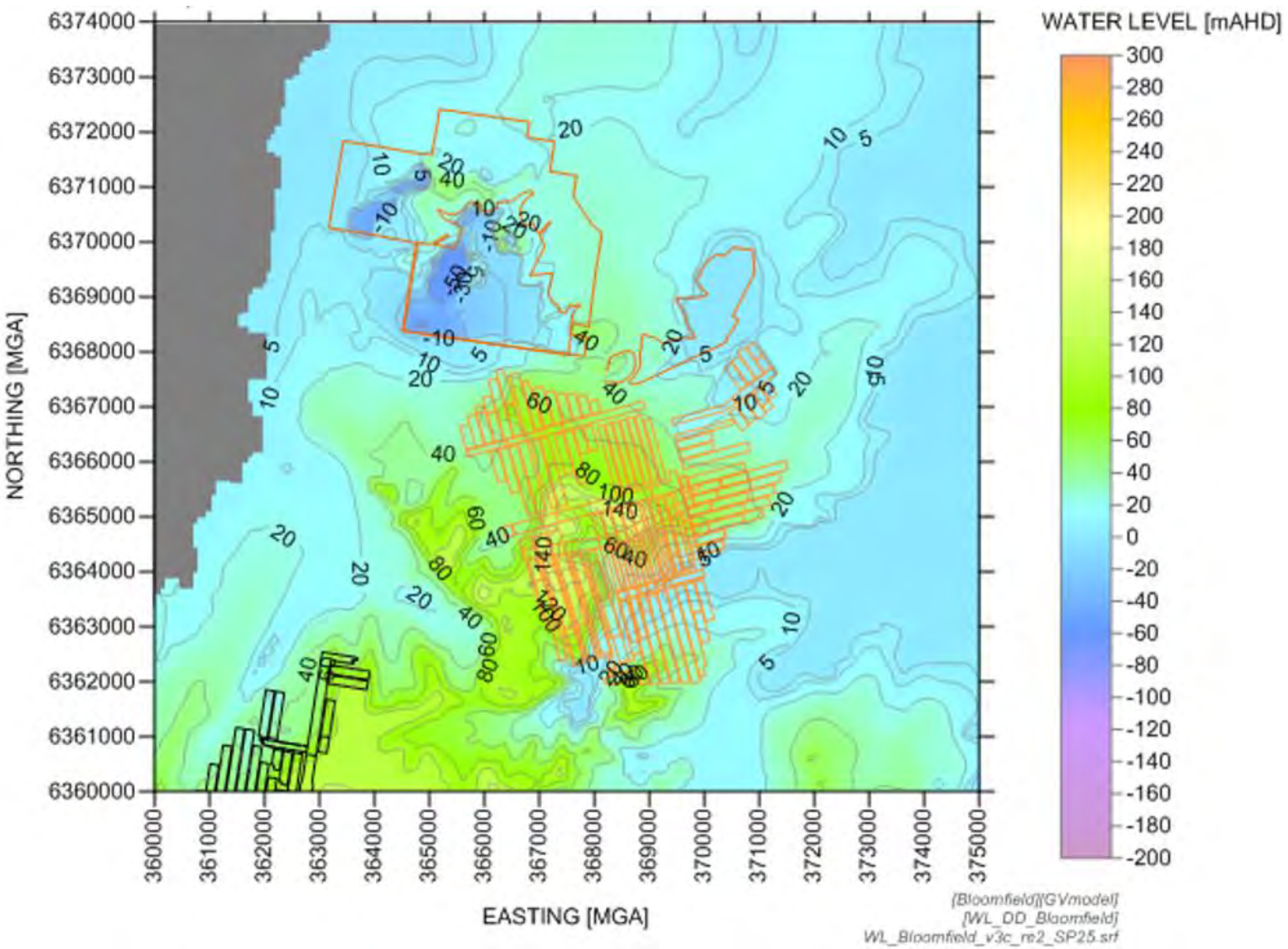


Figure C2. Predicted Water Levels in C Seam [Layer 3] at the End of Mining (Year 2025)

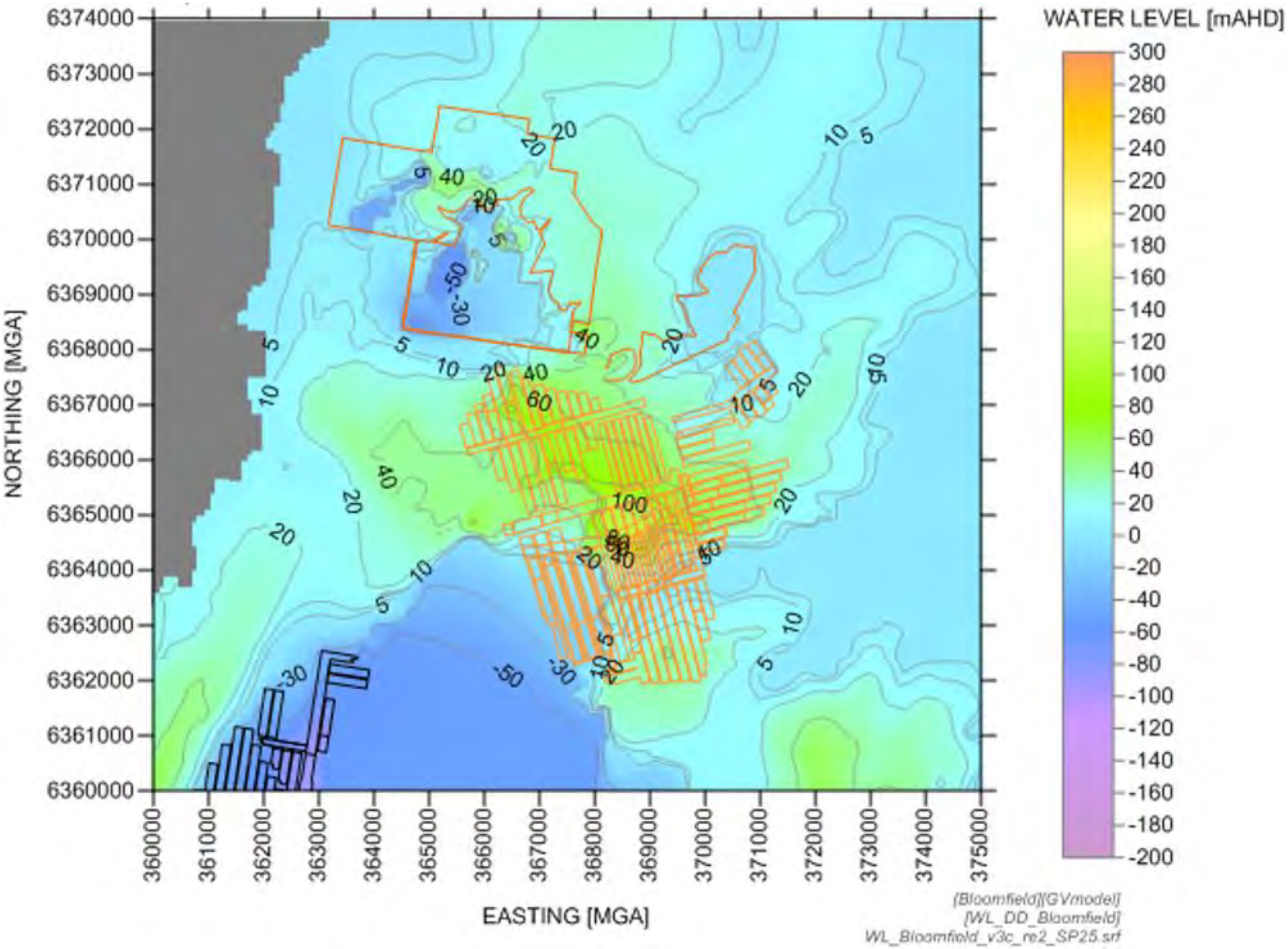


Figure C3. Predicted Water Levels in B Seam [Layer 7] at the End of Mining (Year 2025)

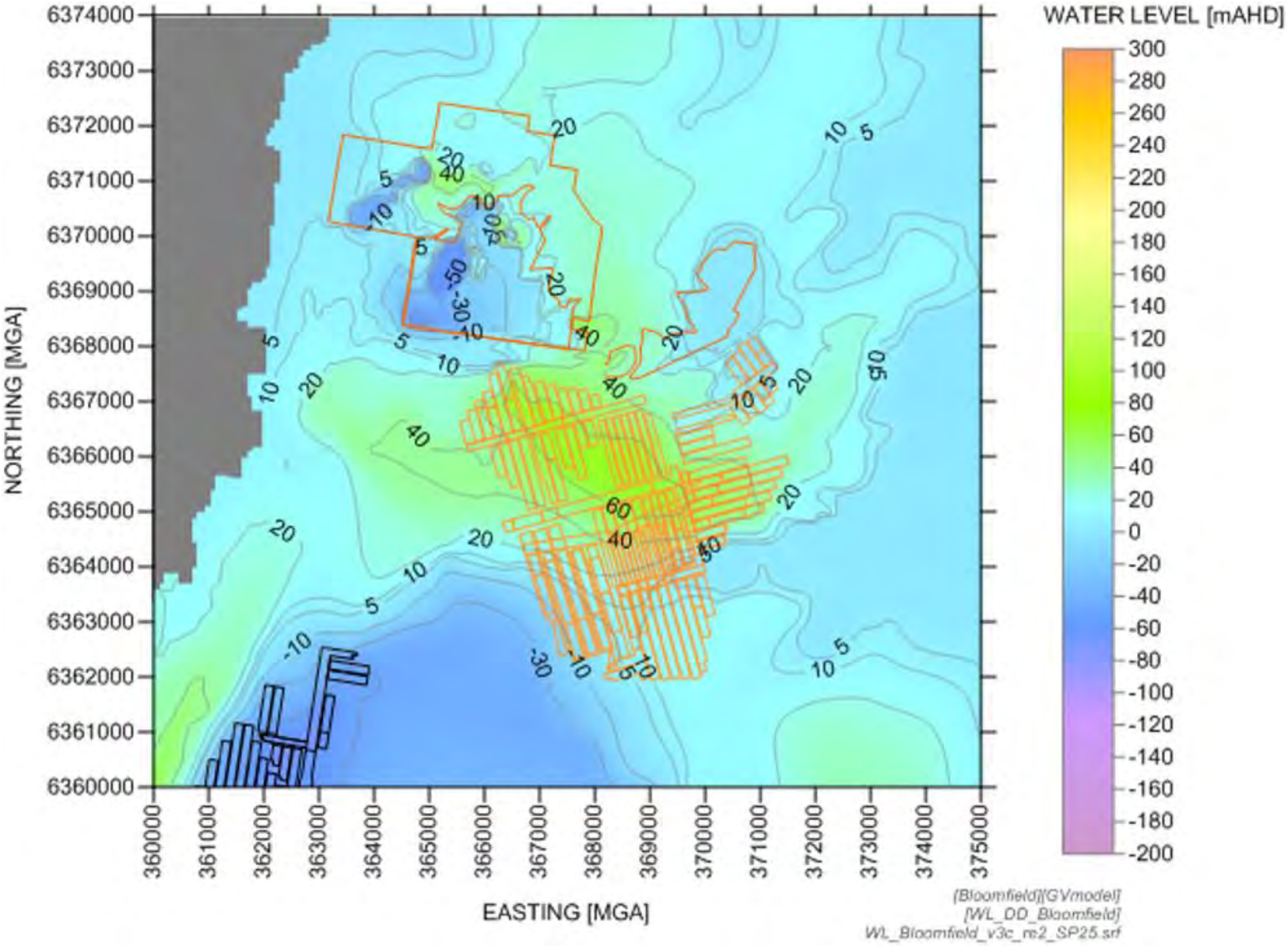


Figure C4. Predicted Water Levels in A Seam [Layer 9] at the End of Mining (Year 2025)

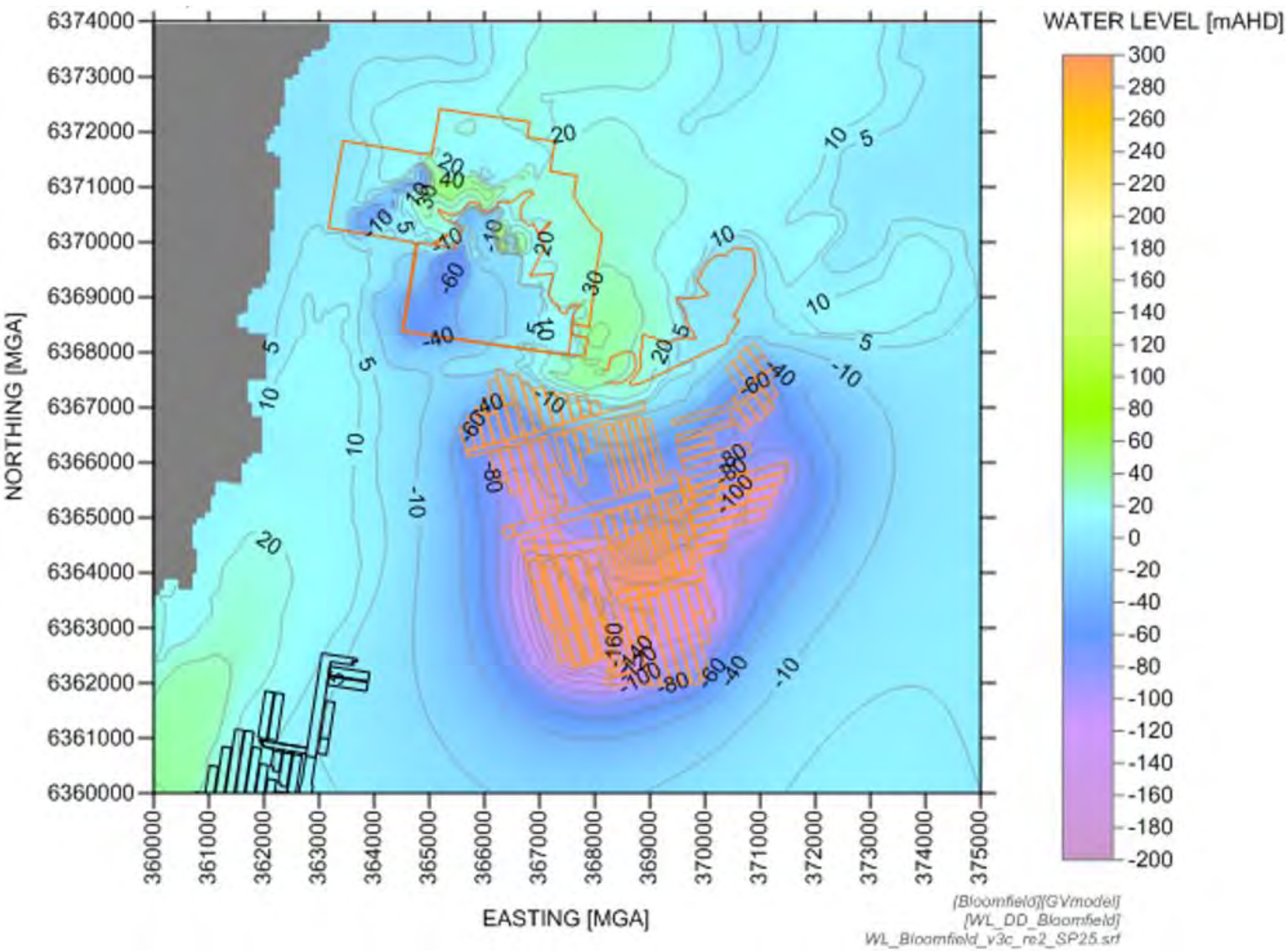


Figure C5. Predicted Water Levels in Whites Creek Seam [Layer 13] at the End of Mining (Year 2025)

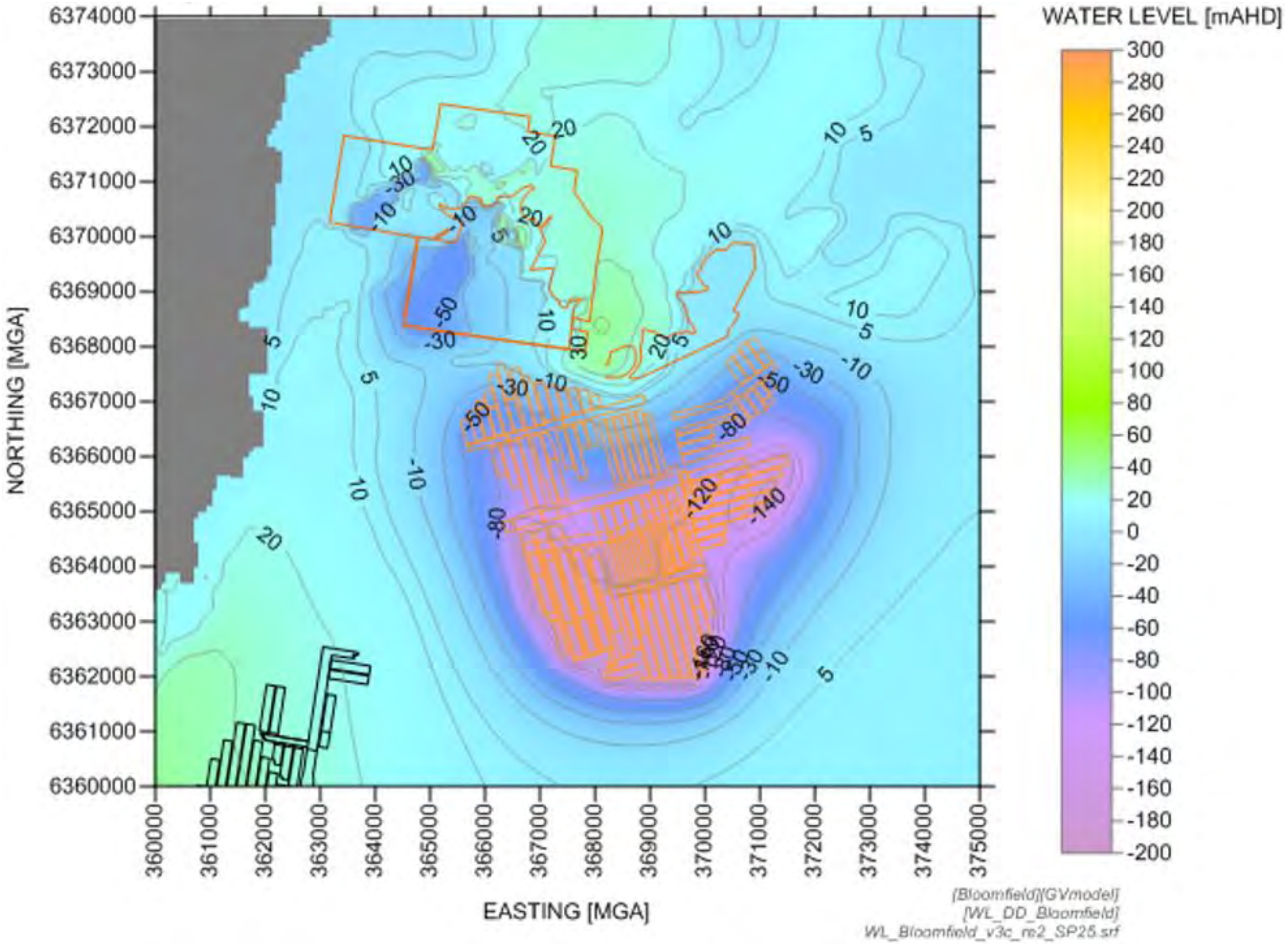


Figure C6. **Predicted Water Levels in EC Seam [Layer 15] at the End of Mining (Year 2025)**

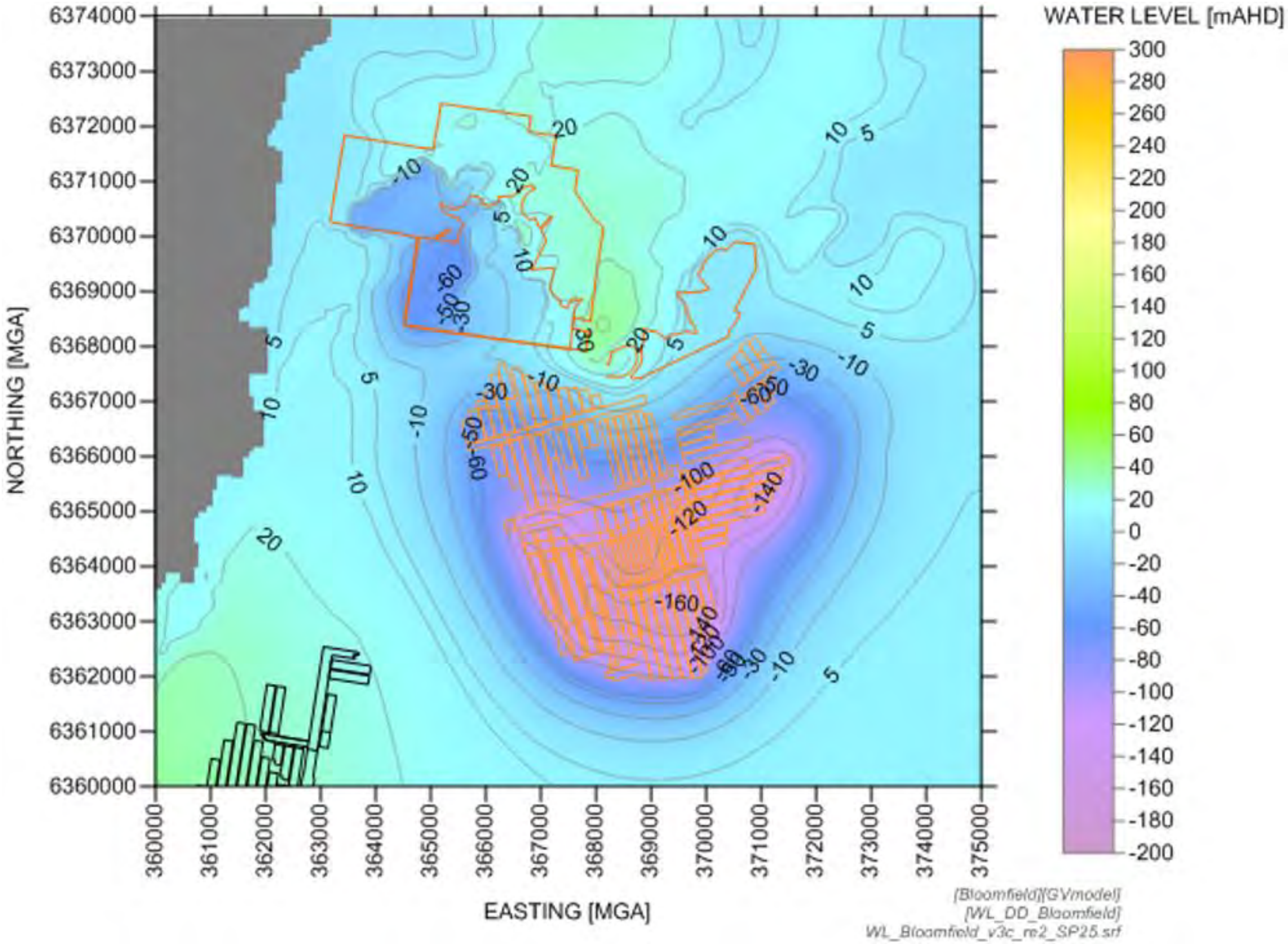


Figure C7. Predicted Water Levels in Donaldson Seam [Layer 17] at the End of Mining (Year 2025)

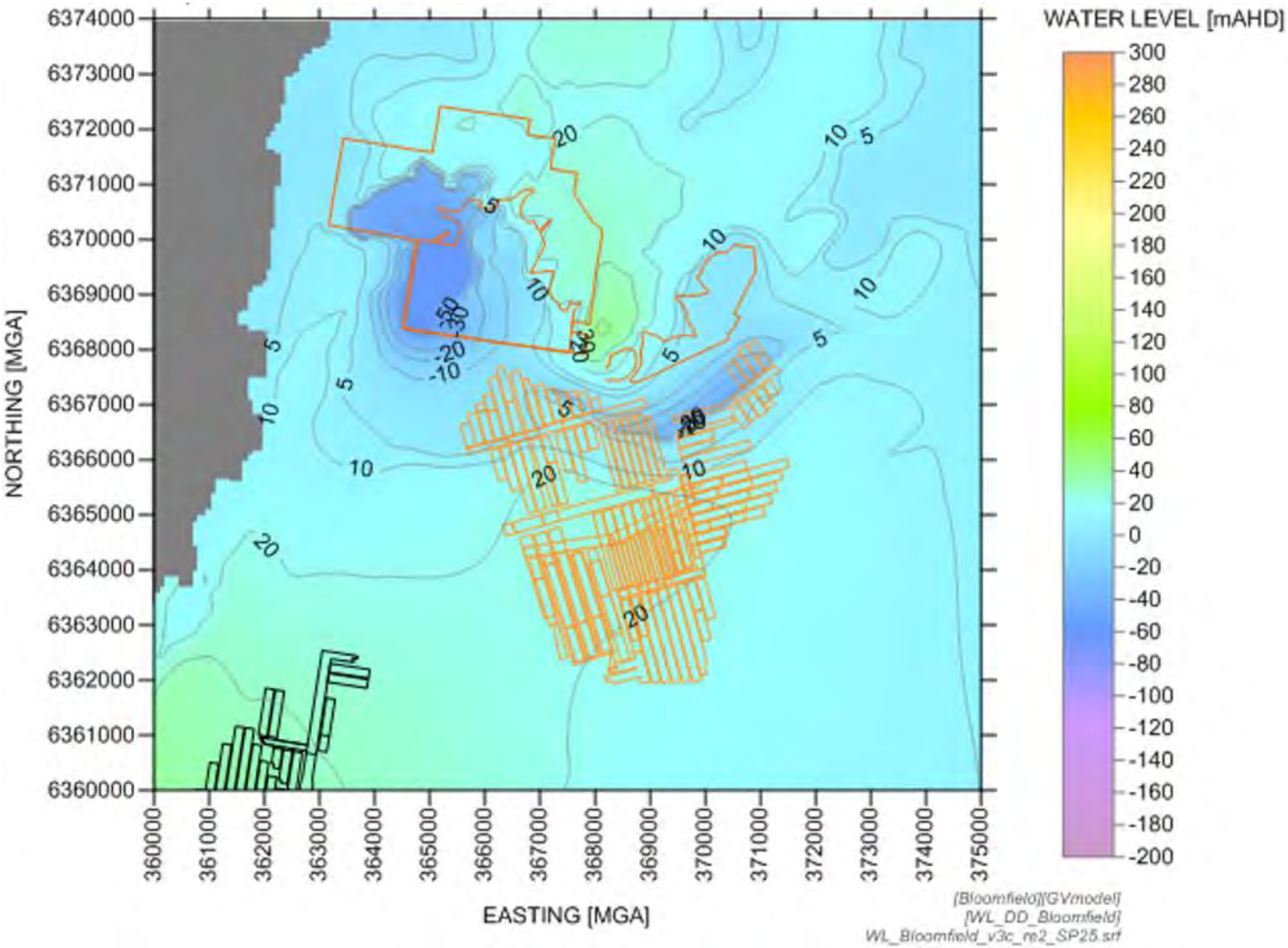


Figure C8. Predicted Water Levels in Big Ben Seam [Layer 19] at the End of Mining (Year 2025)

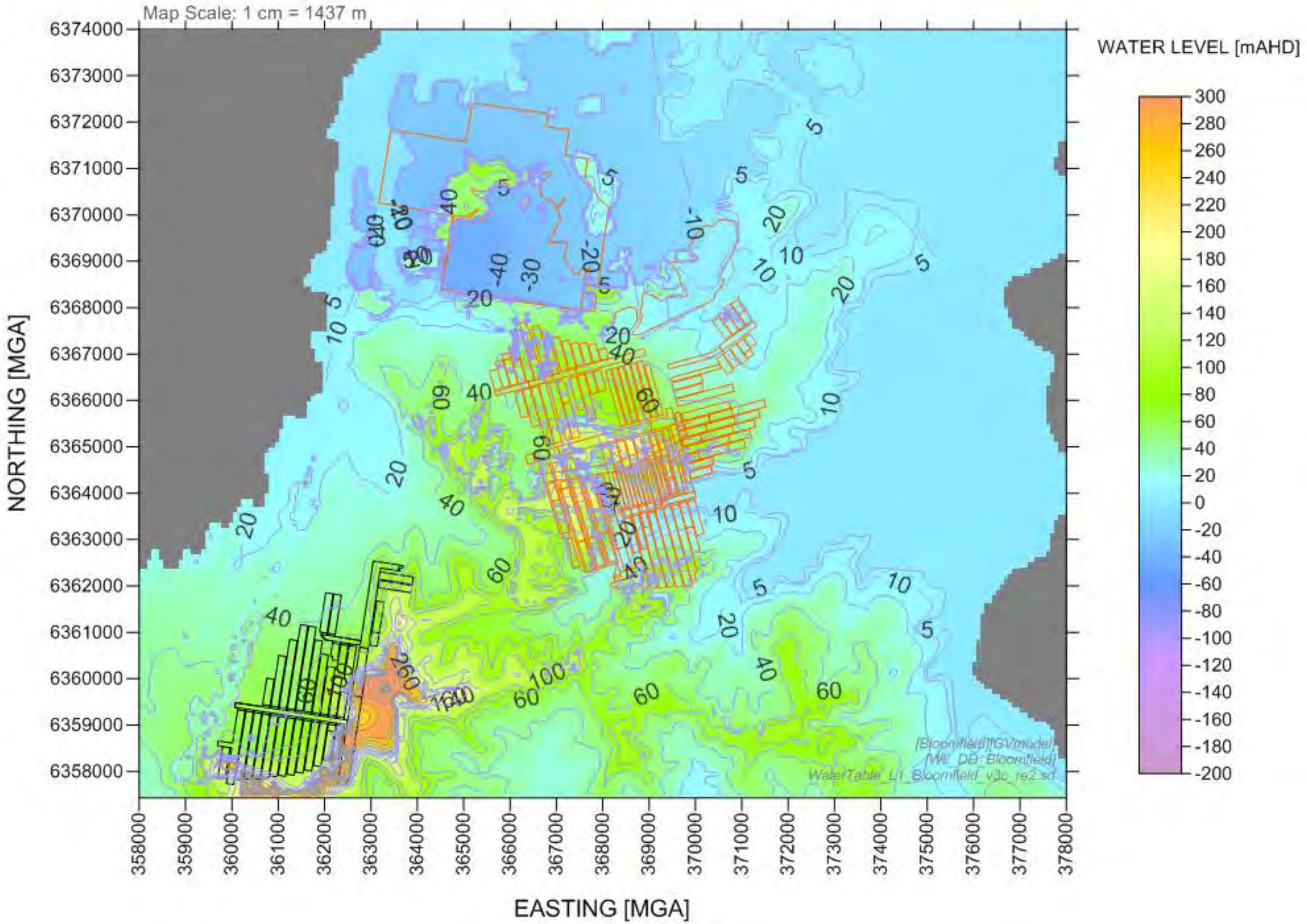


Figure C9. Predicted Water Table at the End of Recovery (100 years)

APPENDIX D

Predicted Groundwater Drawdown Maps

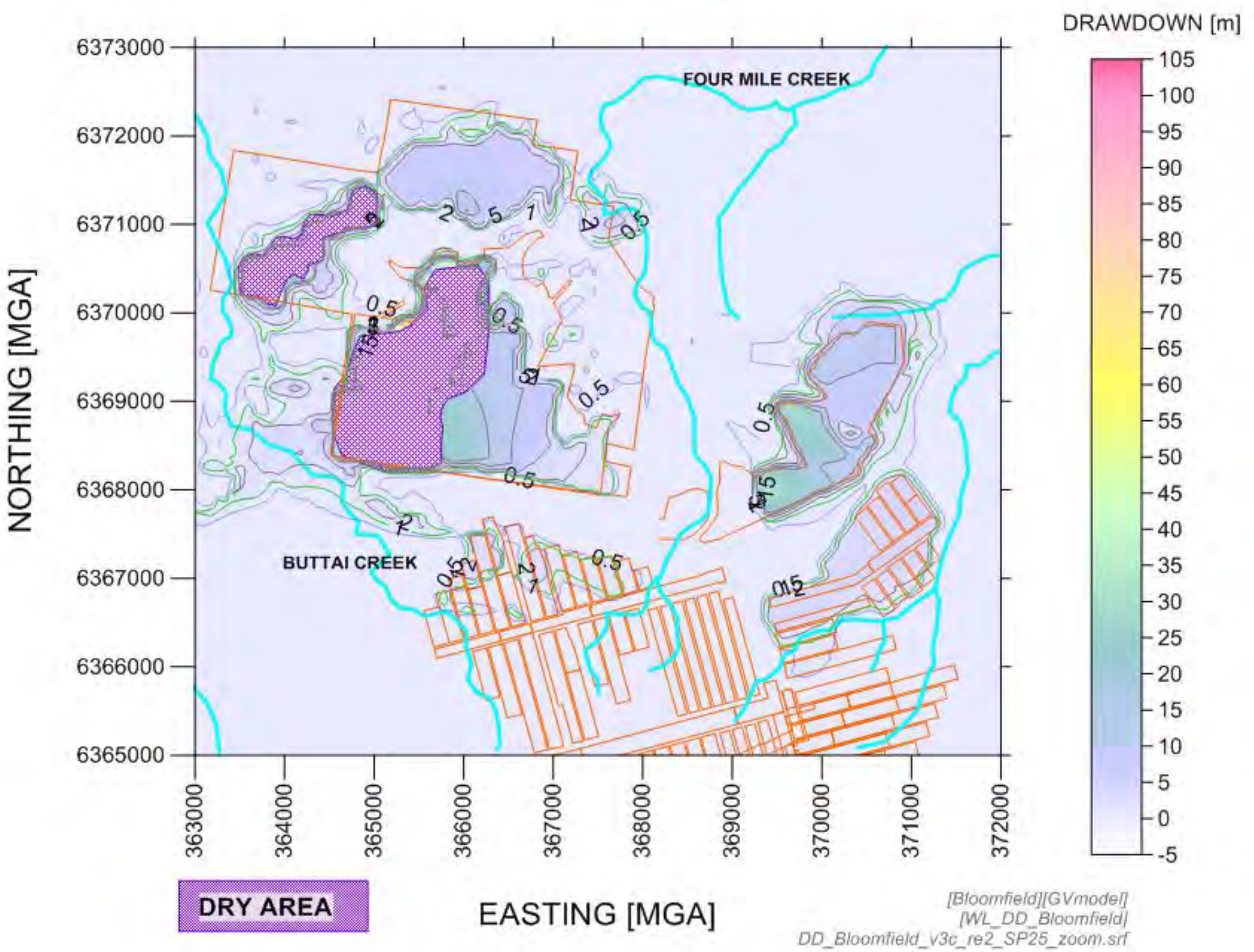


Figure D0. Predicted Water Table Drawdowns at the End of Mining (Year 2025) Showing where Layer 1 Becomes Dry

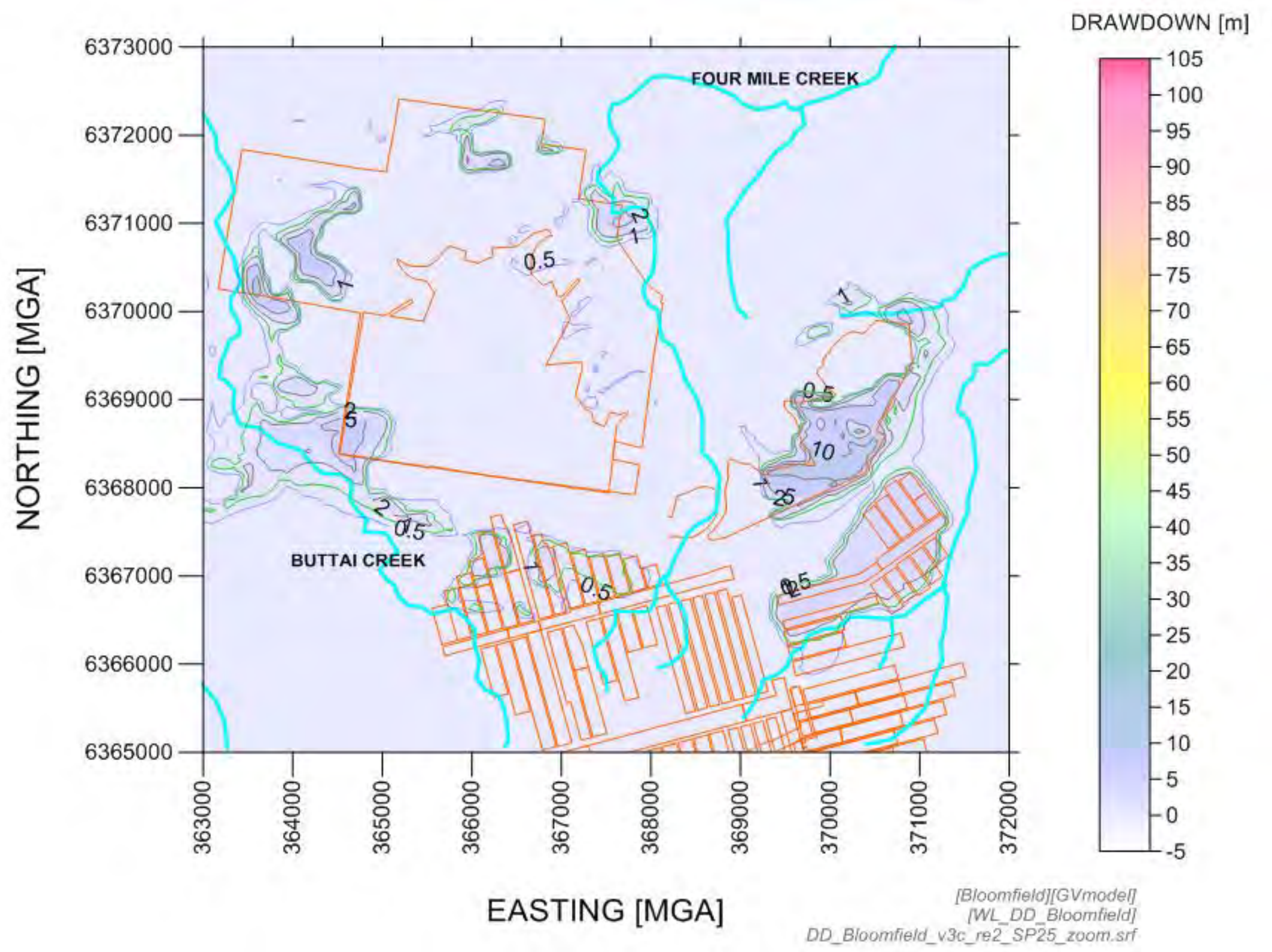


Figure D1. Predicted Drawdowns in Alluvium and Regolith [Layer 1] at the End of Mining (Year 2025).

To account for a dry layer, the following definition is applied: Drawdown = IF(A>B,A,B)- IF(C>B,C,B) where A = null model water level; C = modelled water level; B = Layer 1 bottom elevation.

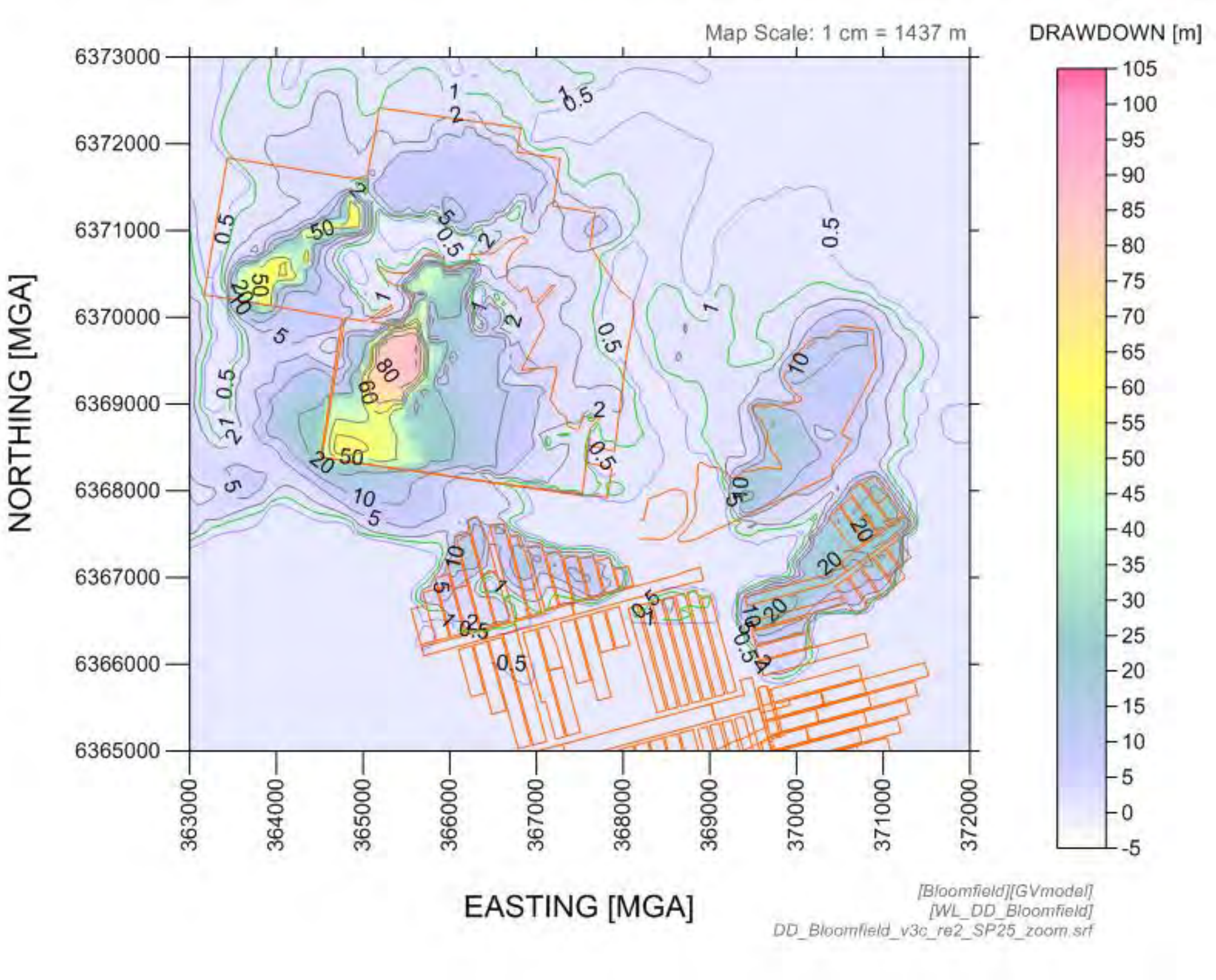


Figure D2. Predicted Drawdowns in C Seam [Layer 3] at the End of Mining (Year2025)

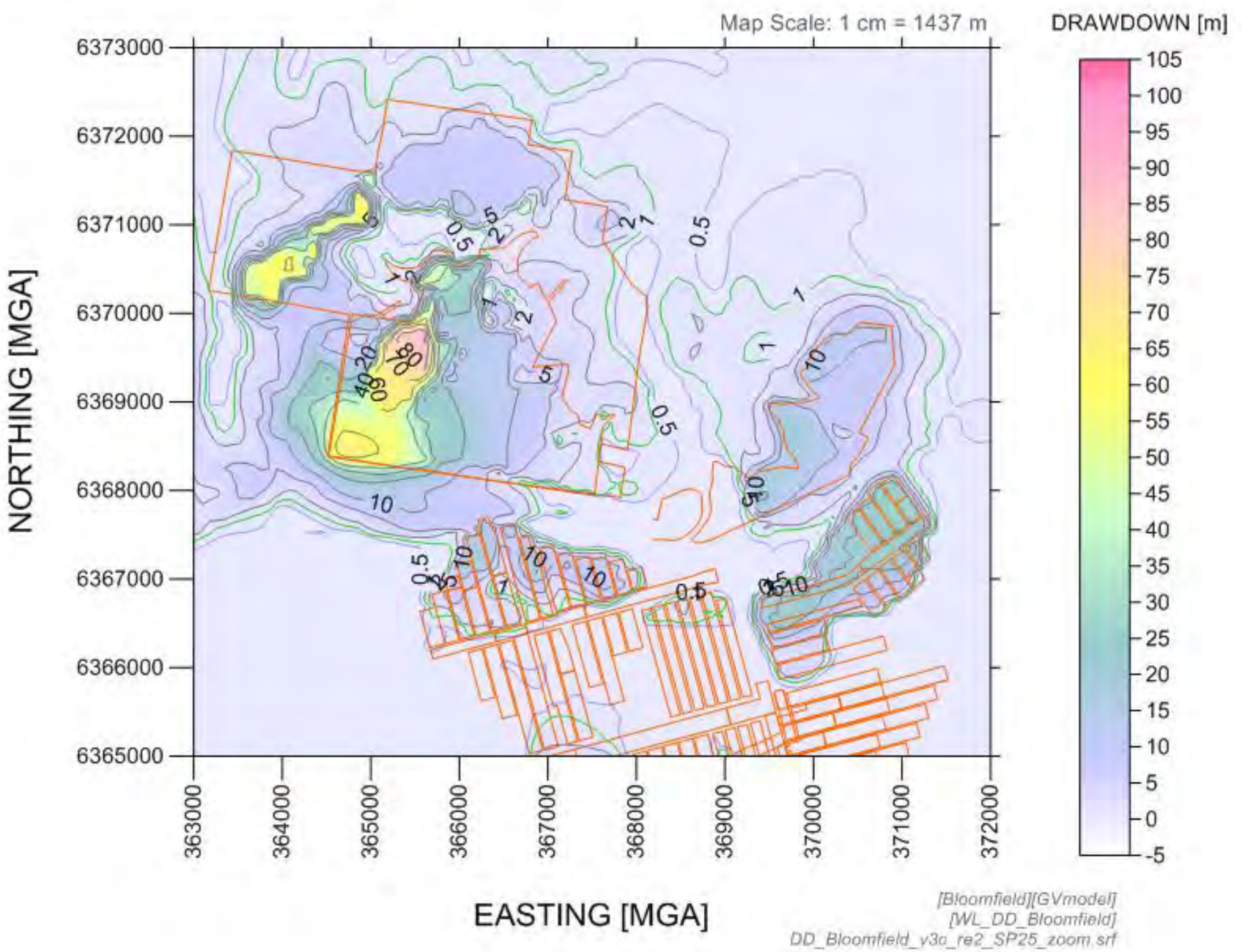


Figure D3. Predicted Drawdowns in B Seam [Layer 7] at the End of Mining (Year 2025)

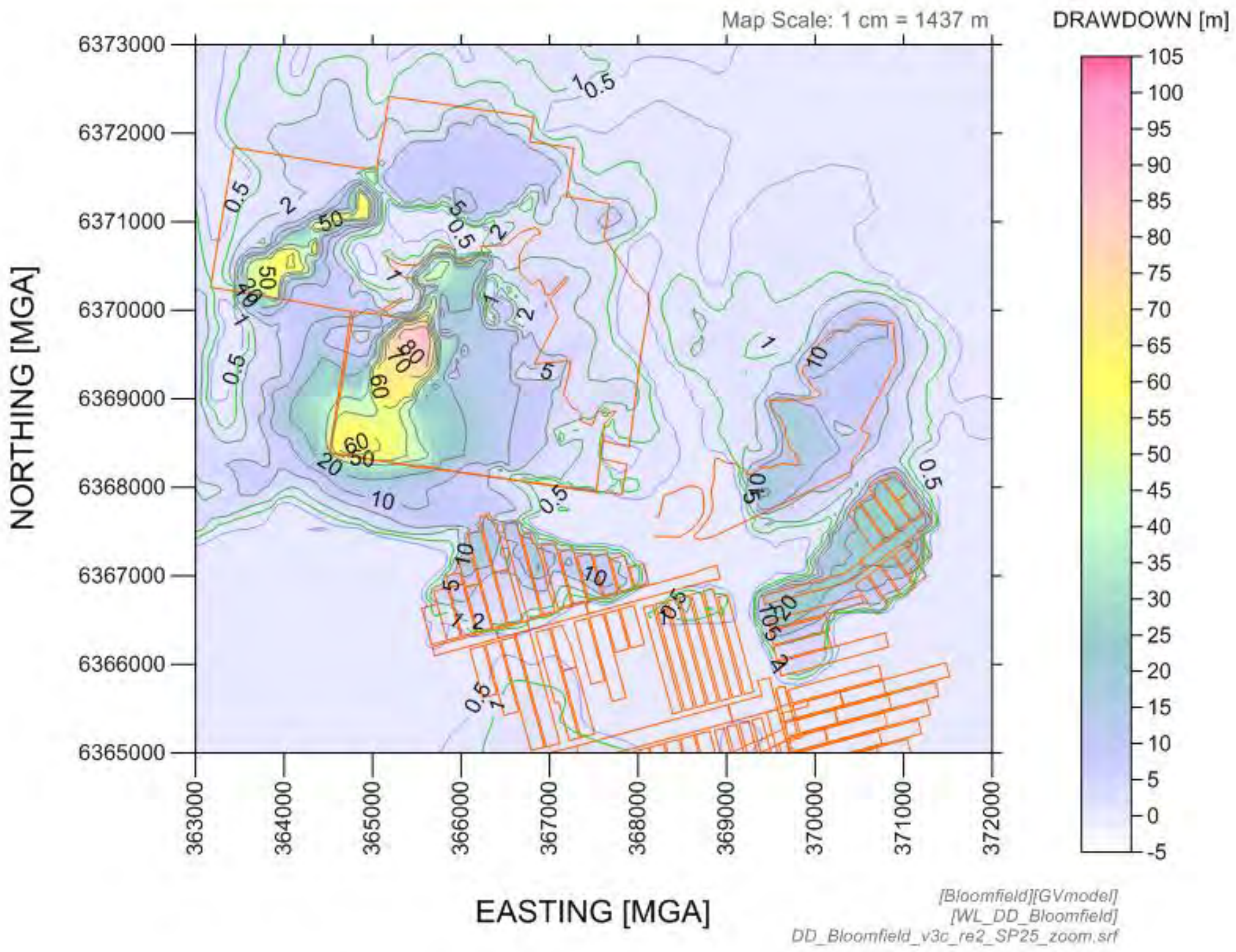


Figure D4. Predicted Drawdowns in A Seam [Layer 9] at the End of Mining (Year 2025)

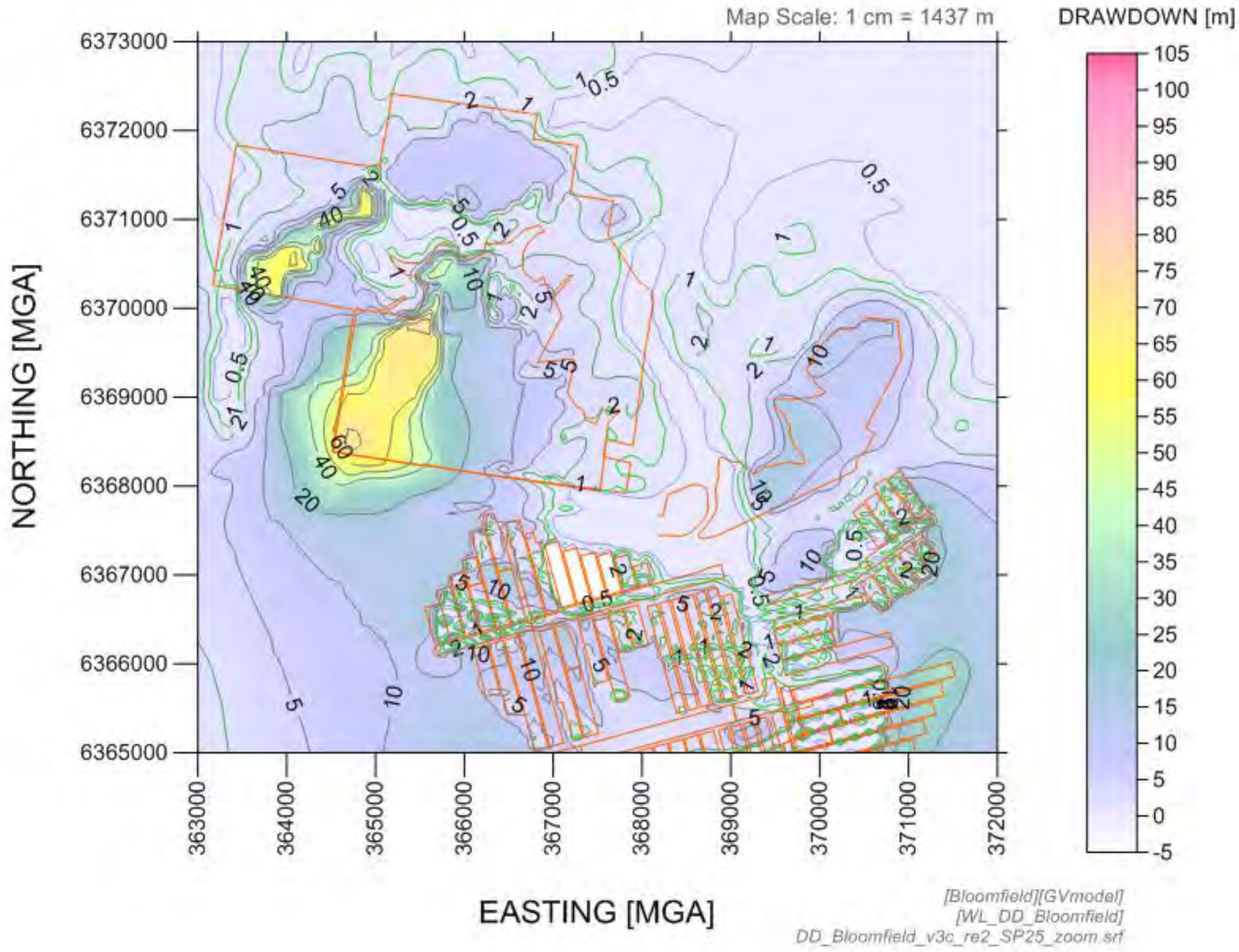


Figure D5. Predicted Drawdowns in Whites Creek Seam [Layer 13] at the End of Mining (Year 2025)

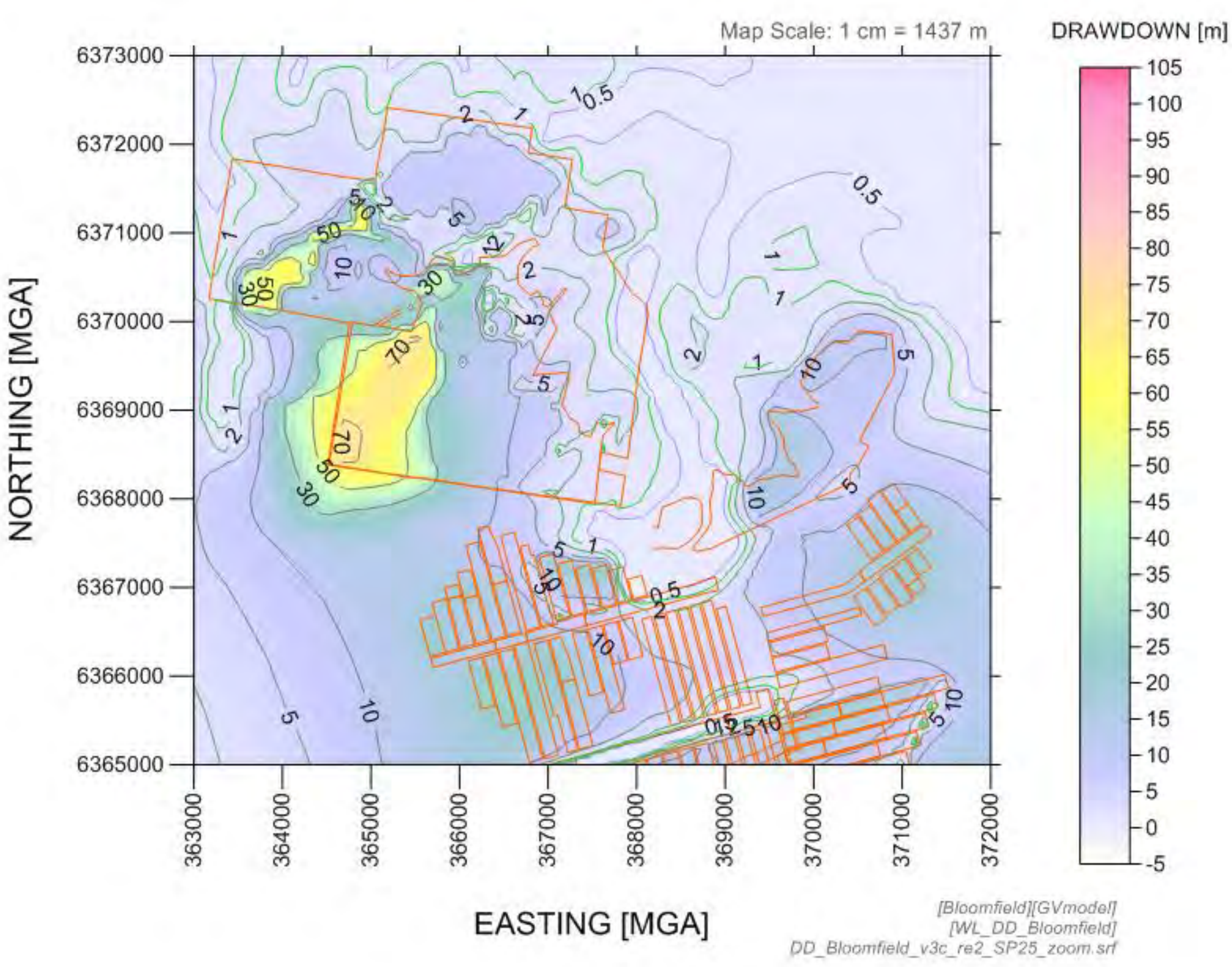


Figure D6. Predicted Drawdowns in EC Seam [Layer 15] at the End of Mining (Year 2025)

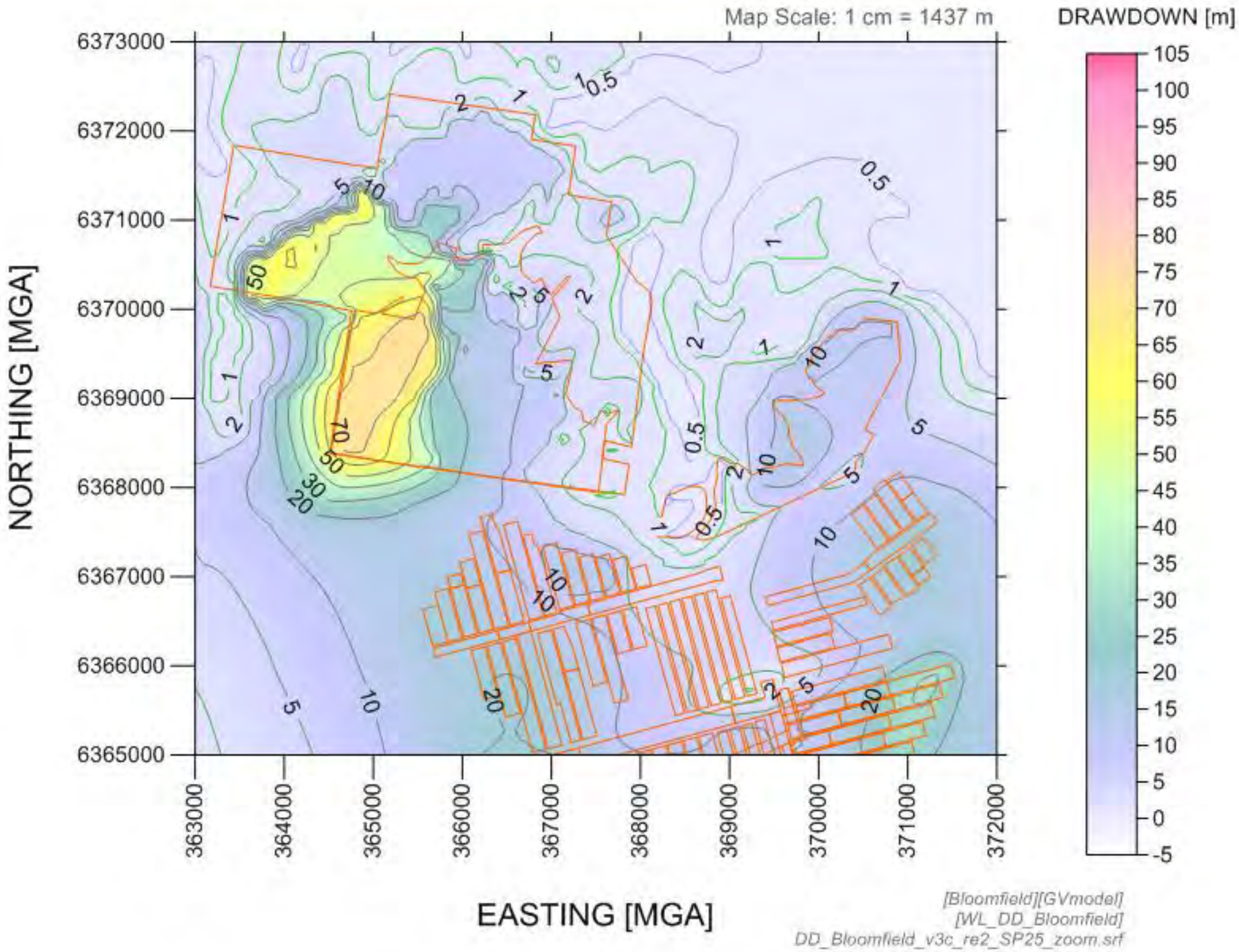


Figure D7. Predicted Drawdowns in Donaldson Seam [Layer 17] at the End of Mining (Year 2025)

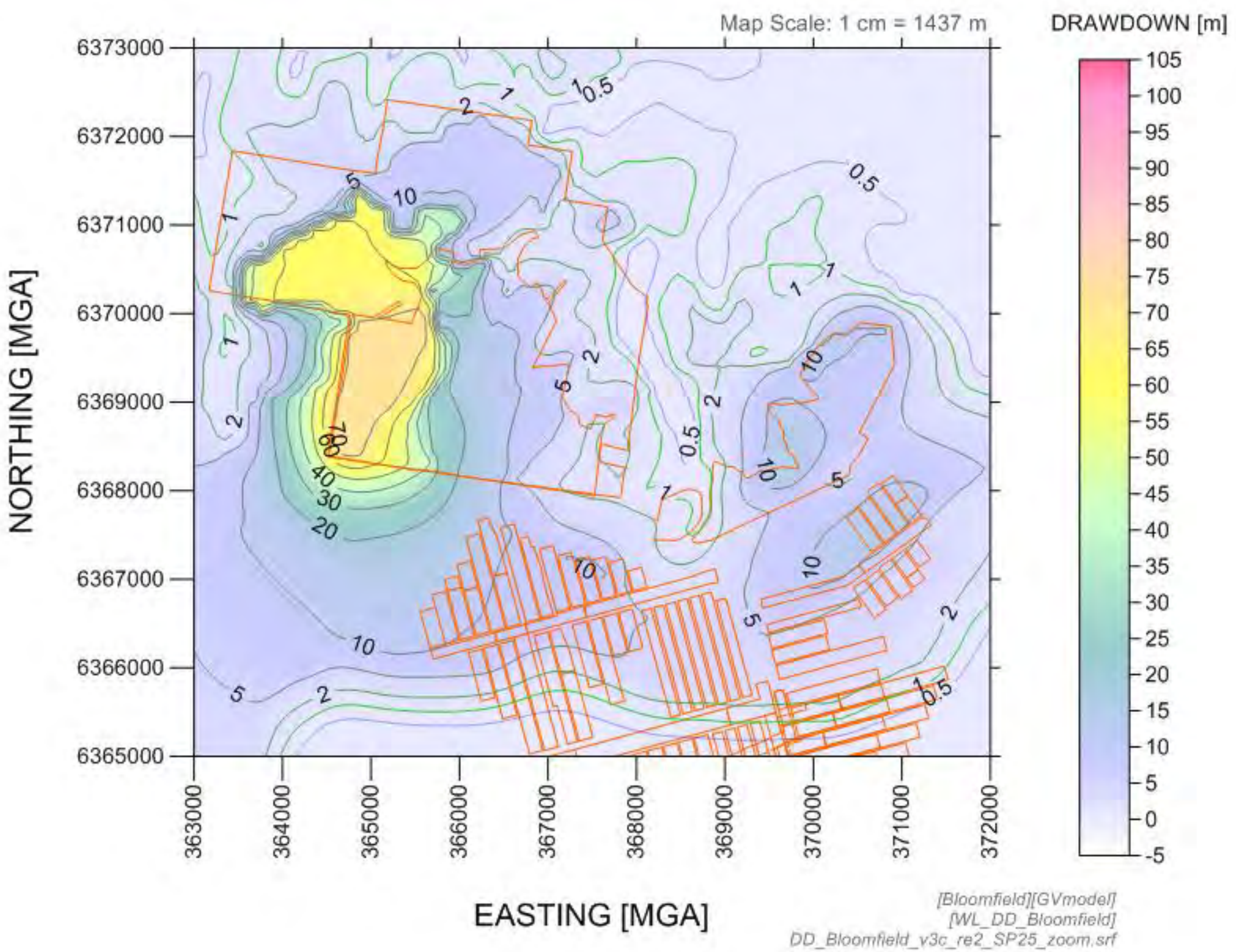


Figure D8. Predicted Drawdowns in Big Ben Seam [Layer 19] at the End of Mining (Year 2025)

Appendix B

EPL No. 396

Appendix B EPL No. 396

Environment Protection Licence

Licence - 396

Licence Details	
Number:	396
Anniversary Date:	31-December

Licensee
BLOOMFIELD COLLIERIES PTY LTD
PO BOX 4
EAST MAITLAND NSW 2323

Premises
BLOOMFIELD COLLIERY
FOUR MILE CREEK ROAD
ASHTONFIELD NSW 2323

Scheduled Activity
Coal works
Mining for coal

Fee Based Activity	Scale
Coal works	> 2000000-5000000 T annual handing capacity
Mining for coal	> 500000-2000000 T annual production capacity

Region
North - Hunter
Ground Floor, NSW Govt Offices, 117 Bull Street NEWCASTLE WEST NSW 2302
Phone: (02) 4908 6800
Fax: (02) 4908 6810
PO Box 488G NEWCASTLE
NSW 2300

Environment Protection Licence

Information about this licence

Dictionary

A definition of terms used in the licence can be found in the dictionary at the end of this licence.

Responsibilities of licensee

Separate to the requirements of this licence, general obligations of licensees are set out in the Protection of the Environment Operations Act 1997 (“the Act”) and the Regulations made under the Act. These include obligations to:

- ensure persons associated with you comply with this licence, as set out in section 64 of the Act;
- control the pollution of waters and the pollution of air (see for example sections 120 - 132 of the Act);
- report incidents causing or threatening material environmental harm to the environment, as set out in Part 5.7 of the Act.

Variation of licence conditions

The licence holder can apply to vary the conditions of this licence. An application form for this purpose is available from the EPA.

The EPA may also vary the conditions of the licence at any time by written notice without an application being made.

Where a licence has been granted in relation to development which was assessed under the Environmental Planning and Assessment Act 1979 in accordance with the procedures applying to integrated development, the EPA may not impose conditions which are inconsistent with the development consent conditions until the licence is first reviewed under Part 3.6 of the Act.

Duration of licence

This licence will remain in force until the licence is surrendered by the licence holder or until it is suspended or revoked by the EPA or the Minister. A licence may only be surrendered with the written approval of the EPA.

Licence review

The Act requires that the EPA review your licence at least every 5 years after the issue of the licence, as set out in Part 3.6 and Schedule 5 of the Act. You will receive advance notice of the licence review.

Fees and annual return to be sent to the EPA

For each licence fee period you must pay:

- an administrative fee; and
- a load-based fee (if applicable).

The EPA publication “A Guide to Licensing” contains information about how to calculate your licence fees. The licence requires that an Annual Return, comprising a Statement of Compliance and a summary of any monitoring required by the licence (including the recording of complaints), be submitted to the EPA. The Annual Return must be submitted within 60 days after the end of each reporting period. See condition R1 regarding the Annual Return reporting requirements.

Usually the licence fee period is the same as the reporting period.

Transfer of licence

The licence holder can apply to transfer the licence to another person. An application form for this purpose is available from the EPA.

Public register and access to monitoring data

Part 9.5 of the Act requires the EPA to keep a public register of details and decisions of the EPA in relation to, for example:

- licence applications;
- licence conditions and variations;
- statements of compliance;
- load based licensing information; and
- load reduction agreements.

Under s320 of the Act application can be made to the EPA for access to monitoring data which has been submitted to the EPA by licensees.

This licence is issued to:

BLOOMFIELD COLLIERIES PTY LTD
PO BOX 4
EAST MAITLAND NSW 2323

subject to the conditions which follow.

1 Administrative Conditions

A1 What the licence authorises and regulates

A1.1 This licence authorises the carrying out of the scheduled activities listed below at the premises specified in A2. The activities are listed according to their scheduled activity classification, fee-based activity classification and the scale of the operation.

Unless otherwise further restricted by a condition of this licence, the scale at which the activity is carried out must not exceed the maximum scale specified in this condition.

Scheduled Activity	Fee Based Activity	Scale
Coal works	Coal works	> 2000000 - 5000000 T annual handing capacity
Mining for coal	Mining for coal	> 500000 - 2000000 T annual production capacity

A2 Premises or plant to which this licence applies

A2.1 The licence applies to the following premises:

Premises Details
BLOOMFIELD COLLIERY
FOUR MILE CREEK ROAD
ASHTONFIELD
NSW 2323
AS DESCRIBED BY COORDINATES AND MAP ON DOCUMENT DATED DEC-14 AND REGISTERED IN THE EPA RECORDS SYSTEM AS DOC17/425999

A3 Information supplied to the EPA

A3.1 Works and activities must be carried out in accordance with the proposal contained in the licence application, except as expressly provided by a condition of this licence.

In this condition the reference to "the licence application" includes a reference to:
a) the applications for any licences (including former pollution control approvals) which this licence replaces under the Protection of the Environment Operations (Savings and Transitional) Regulation 1998; and
b) the licence information form provided by the licensee to the EPA to assist the EPA in connection with the issuing of this licence.

2 Discharges to Air and Water and Applications to Land

P1 Location of monitoring/discharge points and areas

P1.1 The following utilisation areas referred to in the table below are identified in this licence for the purposes of the monitoring and/or the setting of limits for any application of solids or liquids to the utilisation area.

P1.2 The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point.

Water and land

EPA Identi-fication no.	Type of Monitoring Point	Type of Discharge Point	Location Description
1	Discharge to waters under wet weather conditions Volume monitoring Discharge quality monitoring	Discharge to waters under wet weather conditions Volume monitoring Discharge quality monitoring	Lake Forster pipe labelled as EPA ID 1 on document dated Dec-14 and registered in the EPA Records System as DOC17/425999
2	Ambient water quality monitoring.		Four Mile Creek located 500m upstream of the current New England Highway culvert for Four Mile Creek and identified as EPA ID 2 on document dated Dec-14 and registered in the EPA Records System as DOC17/425999

P1.3 The following points referred to in the table below are identified in this licence for the purposes of weather and/or noise monitoring and/or setting limits for the emission of noise from the premises.

Noise/Weather

EPA identi-fication no.	Type of monitoring point	Location description
3	Air blast overpressure & ground vibration peak particle velocity monitoring	Monitoring location identified as "Mt Vincent Road" in the document titled "Bloomfield Collieries Pty Ltd, EPL 396, Blast Monitoring Site Location Plan, 12 January 2015"
4	Air blast overpressure & ground vibration peak particle velocity monitoring	Monitoring location identified as "McNaughtons" in the document titled "Bloomfield Collieries Pty Ltd, EPL 396, Blast Monitoring Site Location Plan, 12 January 2015"
5	Air blast overpressure & ground vibration peak particle velocity monitoring	Monitoring location identified as "Elliots" in the document titled "Bloomfield Collieries Pty Ltd, EPL 396, Blast Monitoring Site Location Plan, 12 January 2015"

6	Air blast overpressure & ground vibration peak particle velocity monitoring	Monitoring location identified as "Richards" in the document titled "Bloomfield Collieries Pty Ltd, EPL 396, Blast Monitoring Site Location Plan, 12 January 2015"

3 Limit Conditions

L1 Pollution of waters

L1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.

L2 Concentration limits

L2.1 For each monitoring/discharge point or utilisation area specified in the table\s below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table.

L2.2 Where a pH quality limit is specified in the table, the specified percentage of samples must be within the specified ranges.

L2.3 To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the table\s.

L2.4 Water and/or Land Concentration Limits

POINT 1

Pollutant	Units of Measure	50 percentile concentration limit	90 percentile concentration limit	3DGM concentration limit	100 percentile concentration limit
Conductivity	microsiemens per centimetre				6000
Filterable iron	milligrams per litre				1.0
pH	pH				6.5-8.5
Total suspended solids	milligrams per litre				30

L3 Volume and mass limits

L3.1 For each discharge point or utilisation area specified below (by a point number), the volume/mass of:
a) liquids discharged to water; or;
b) solids or liquids applied to the area;
must not exceed the volume/mass limit specified for that discharge point or area.

Point	Unit of Measure	Volume/Mass Limit
1	kilolitres per day	40000

L3.2 Discharge from Point 1 as referred to in Condition L3.1 is only permitted under the following conditions:

- in wet weather conditions following 10mm or greater 24 hours rainfall event in the catchment in the first 24 hour period following the rainfall event; and

- in wet weather conditions following a 15mm or greater 24 hours rainfall event in the catchment in the second 24 hour period following the rainfall event; and

- in wet weather conditions following a 20mm or greater 24 hours rainfall event in the catchment in the third 24 hour period following the rainfall event.

L4 Blasting

L4.1 Blasting in or on the premises must only be carried out between 9:00 hours and 17:00 hours, Monday to Saturday. Blasting in or on the premises must not take place on Sundays or Public Holidays without the prior approval of the EPA.

L4.2 The airblast overpressure level from blasting operations in or on the premises must not exceed:
115 dB (Lin Peak) for more than 5% of the total number of blasts during each reporting period;
at either monitoring point 3, 4, 5 or 6 in Condition P1.3.

L4.3 The airblast overpressure level from blasting operations in or on the premises must not exceed:
120 dB (Lin Peak) at any time;
at either monitoring point 3, 4, 5 or 6 in Condition P1.3.

L4.4 The ground vibration peak particle velocity from blasting operations carried out in or on the premises must not exceed:
5 mm/second for more than 5% of the total number of blasts during each reporting period;
at either monitoring point 3, 4, 5 or 6 in Condition P1.3.

L4.5 The ground vibration peak particle velocity from blasting operations carried out in or on the premises must not exceed:
10 mm/second at any time;
at either monitoring point 3, 4, 5 or 6 in Condition P1.3.

L4.6 Offensive blast fume must not be emitted from the premises.

Definition:

Offensive blast fume means post-blast gases from the detonation of explosives at the premises that by reason of their nature, duration, character or quality, or the time at which they are emitted, or any other circumstances:
1. *are harmful to (or likely to be harmful to) a person that is outside the premises from which it is emitted, or*
2. *interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted.*

4 Operating Conditions

O1 Activities must be carried out in a competent manner

O1.1 Licensed activities must be carried out in a competent manner.
This includes:
a) the processing, handling, movement and storage of materials and substances used to carry out the activity; and
b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity.

O2 Maintenance of plant and equipment

O2.1 All plant and equipment installed at the premises or used in connection with the licensed activity:
a) must be maintained in a proper and efficient condition; and
b) must be operated in a proper and efficient manner.

O3 Dust

O3.1 The premises must be maintained in a condition which minimises or prevents the emission of dust from the premises.

5 Monitoring and Recording Conditions

M1 Monitoring records

M1.1 The results of any monitoring required to be conducted by this licence or a load calculation protocol must be recorded and retained as set out in this condition.

M1.2 All records required to be kept by this licence must be:
a) in a legible form, or in a form that can readily be reduced to a legible form;

b) kept for at least 4 years after the monitoring or event to which they relate took place; and
c) produced in a legible form to any authorised officer of the EPA who asks to see them.

M1.3 The following records must be kept in respect of any samples required to be collected for the purposes of this licence:
a) the date(s) on which the sample was taken;
b) the time(s) at which the sample was collected;
c) the point at which the sample was taken; and
d) the name of the person who collected the sample.

M2 Requirement to monitor concentration of pollutants discharged

M2.1 For each monitoring/discharge point or utilisation area specified below (by a point number), the licensee must monitor (by sampling and obtaining results by analysis) the concentration of each pollutant specified in Column 1. The licensee must use the sampling method, units of measure, and sample at the frequency, specified opposite in the other columns:

M2.2 Water and/ or Land Monitoring Requirements

POINT 1

Pollutant	Units of measure	Frequency	Sampling Method
Conductivity	microsiemens per centimetre	Daily during any discharge	Grab sample
Filterable iron	milligrams per litre	Daily during any discharge	Grab sample
pH	pH	Daily during any discharge	Grab sample
Total suspended solids	milligrams per litre	Daily during any discharge	Grab sample

POINT 2

Pollutant	Units of measure	Frequency	Sampling Method
Conductivity	microsiemens per centimetre	Continuous during discharge	In line instrumentation
pH	pH	Daily during any discharge	Grab sample
Total suspended solids	milligrams per litre	Daily during any discharge	Grab sample

M3 Testing methods - concentration limits

M3.1 Subject to any express provision to the contrary in this licence, monitoring for the concentration of a pollutant discharged to waters or applied to a utilisation area must be done in accordance with the Approved Methods Publication unless another method has been approved by the EPA in writing before any tests are conducted.

M4 Recording of pollution complaints

M4.1 The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this licence applies.

M4.2 The record must include details of the following:
a) the date and time of the complaint;
b) the method by which the complaint was made;
c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
d) the nature of the complaint;
e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and
f) if no action was taken by the licensee, the reasons why no action was taken.

M4.3 The record of a complaint must be kept for at least 4 years after the complaint was made.

M4.4 The record must be produced to any authorised officer of the EPA who asks to see them.

M5 Telephone complaints line

M5.1 The licensee must operate during its operating hours a telephone complaints line for the purpose of receiving any complaints from members of the public in relation to activities conducted at the premises or by the vehicle or mobile plant, unless otherwise specified in the licence.

M5.2 The licensee must notify the public of the complaints line telephone number and the fact that it is a complaints line so that the impacted community knows how to make a complaint.

M5.3 The preceding two conditions do not apply until 3 months after: the date of the issue of this licence.

M6 Requirement to monitor volume or mass

M6.1 For each discharge point or utilisation area specified below, the licensee must monitor:
a) the volume of liquids discharged to water or applied to the area;
b) the mass of solids applied to the area;
c) the mass of pollutants emitted to the air;
at the frequency and using the method and units of measure, specified below.

POINT 1

Frequency	Unit of Measure	Sampling Method

Daily during any discharge	kilolitres per day	By Calculation (volume flow rate or pump capacity multiplied by operating time)

POINT 2

Frequency	Unit of Measure	Sampling Method
Daily during any discharge	kilolitres per day	In line instrumentation

M7 Blasting

M7.1 To determine compliance with conditions L4.2 and L4.3:
a) Airblast overpressure and ground vibration levels must be measured and electronically recorded for monitoring points 3, 4, 5 and 6 for the parameters specified in Column 1 of the table below; and
b) The licensee must use the units of measure, sampling method, and sample at the frequency specified opposite in the other columns.

Parameter	Units of Measure	Frequency	Sampling Method
Airblast Overpressure	Decibels (Linear Peak)	All blasts	Australian Standard AS 2187.2-2006
Ground Vibration Peak Particle Velocity	millimetres/second	All blasts	Australian Standard AS 2187.2-2006

6 Reporting Conditions

R1 Annual return documents

R1.1 The licensee must complete and supply to the EPA an Annual Return in the approved form comprising:
1. a Statement of Compliance,
2. a Monitoring and Complaints Summary,
3. a Statement of Compliance - Licence Conditions,
4. a Statement of Compliance - Load based Fee,
5. a Statement of Compliance - Requirement to Prepare Pollution Incident Response Management Plan,
6. a Statement of Compliance - Requirement to Publish Pollution Monitoring Data; and
7. a Statement of Compliance - Environmental Management Systems and Practices.

At the end of each reporting period, the EPA will provide to the licensee a copy of the form that must be completed and returned to the EPA.

R1.2 An Annual Return must be prepared in respect of each reporting period, except as provided below.

Note: The term "reporting period" is defined in the dictionary at the end of this licence. Do not complete the Annual Return until after the end of the reporting period.

R1.3 Where this licence is transferred from the licensee to a new licensee:
a) the transferring licensee must prepare an Annual Return for the period commencing on the first day of

the reporting period and ending on the date the application for the transfer of the licence to the new licensee is granted; and
b) the new licensee must prepare an Annual Return for the period commencing on the date the application for the transfer of the licence is granted and ending on the last day of the reporting period.

Note: An application to transfer a licence must be made in the approved form for this purpose.

R1.4 Where this licence is surrendered by the licensee or revoked by the EPA or Minister, the licensee must prepare an Annual Return in respect of the period commencing on the first day of the reporting period and ending on:
a) in relation to the surrender of a licence - the date when notice in writing of approval of the surrender is given; or
b) in relation to the revocation of the licence - the date from which notice revoking the licence operates.

R1.5 The Annual Return for the reporting period must be supplied to the EPA via eConnect *EPA* or by registered post not later than 60 days after the end of each reporting period or in the case of a transferring licence not later than 60 days after the date the transfer was granted (the 'due date').

R1.6 The licensee must retain a copy of the Annual Return supplied to the EPA for a period of at least 4 years after the Annual Return was due to be supplied to the EPA.

R1.7 Within the Annual Return, the Statements of Compliance must be certified and the Monitoring and Complaints Summary must be signed by:
a) the licence holder; or
b) by a person approved in writing by the EPA to sign on behalf of the licence holder.

R2 Notification of environmental harm

R2.1 Notifications must be made by telephoning the Environment Line service on 131 555.

R2.2 The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred.

Note: The licensee or its employees must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.

R3 Written report

R3.1 Where an authorised officer of the EPA suspects on reasonable grounds that:
a) where this licence applies to premises, an event has occurred at the premises; or
b) where this licence applies to vehicles or mobile plant, an event has occurred in connection with the carrying out of the activities authorised by this licence,
and the event has caused, is causing or is likely to cause material harm to the environment (whether the harm occurs on or off premises to which the licence applies), the authorised officer may request a written report of the event.

R3.2 The licensee must make all reasonable inquiries in relation to the event and supply the report to the EPA within such time as may be specified in the request.

R3.3 The request may require a report which includes any or all of the following information:
a) the cause, time and duration of the event;
b) the type, volume and concentration of every pollutant discharged as a result of the event;
c) the name, address and business hours telephone number of employees or agents of the licensee, or a specified class of them, who witnessed the event;
d) the name, address and business hours telephone number of every other person (of whom the licensee is aware) who witnessed the event, unless the licensee has been unable to obtain that information after making reasonable effort;
e) action taken by the licensee in relation to the event, including any follow-up contact with any complainants;
f) details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of such an event; and
g) any other relevant matters.

R3.4 The EPA may make a written request for further details in relation to any of the above matters if it is not satisfied with the report provided by the licensee. The licensee must provide such further details to the EPA within the time specified in the request.

R4 Other reporting conditions

R4.1 Reporting blasting limit exceedence

The licensee must report any exceedence of the licence blasting limits to the regional office of the EPA as soon as practicable after the exceedence becomes known to the licensee or to one of the licensee’s employees or agents.

7 General Conditions

G1 Copy of licence kept at the premises or plant

G1.1 A copy of this licence must be kept at the premises to which the licence applies.

G1.2 The licence must be produced to any authorised officer of the EPA who asks to see it.

G1.3 The licence must be available for inspection by any employee or agent of the licensee working at the premises.

8 Pollution Studies and Reduction Programs

U1 Coal Mine Wind Erosion of Exposed Land Assessment

U1.1 The licensee must undertake the following steps:

1. Calculate the wind erosion exposed surface area (in hectares) within the premises as of 31 December 2014.
2. Determine the wind erosion exposed surface area (in hectares) predicted as at 31 December 2014 within the licensee's Environmental Assessment for the premises.
3. Compare the areas calculated in steps 1 and 2.
4. Submit a written report to the EPA at hunter.region@epa.nsw.gov.au containing the analysis required in steps 1 to 3, by 29 May 2015.

The report submitted to the EPA must be accompanied by spatial data to confirm the wind erosion exposed surface area calculations. The following data is required:

- Shapefiles showing the premises boundary.
- Shapefiles showing the wind erosion exposed area within the premises as of 31 December 2014.
- Shapefiles showing areas classified as stabilised surface as of 31 December 2014.
- Details of any studies undertaken to verify that the areas of stabilised surface meet the definition.

Note: *Environmental Assessment* means any environmental assessment document prepared in order to gain approval or consent under the Environmental Planning and Assessment Act (1979) under which the licensee currently operates at the premises. If the predictions made in this document do not correspond to the current year of mine operation, the licensee should extrapolate between predictions.

Stabilised Surface means any previously disturbed surface area which shows visual or other evidence of surface crusting and is resistant to wind-driven fugitive dust and is demonstrated to be stabilised. Stabilisation can be determined in accordance with one or more of the applicable test methods contained in the Rule 403 Implementation Handbook located at:
www.capcoa.org/Docs/SCAQMD%20r403%20handbook.doc.

Wind Erosion Exposed Surface Area means the portion of the premises surface which has been physically moved, uncovered, destabilised or otherwise modified from its natural state, thereby increasing the potential for fugitive particulate matter emissions, but excluding areas which have been:

- paved or covered by a permanent building or structure;
- maintained with a vegetative ground cover of at least 50% of ground cover for particular areas.

Vegetative ground cover can be determined in accordance with the standardised procedure for revegetation assessment contained in Atyeo C. & Thackway R. (2009) located at:
http://data.daff.gov.au/data/warehouse/pe_brs90000004196/revegetationManual200906_20100410_ap14.pdf or

- classified as a stabilised surface.

Dictionary

General Dictionary

3DGM [in relation to a concentration limit]	Means the three day geometric mean, which is calculated by multiplying the results of the analysis of three samples collected on consecutive days and then taking the cubed root of that amount. Where one or more of the samples is zero or below the detection limit for the analysis, then 1 or the detection limit respectively should be used in place of those samples
Act	Means the Protection of the Environment Operations Act 1997
activity	Means a scheduled or non-scheduled activity within the meaning of the Protection of the Environment Operations Act 1997
actual load	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
AM	Together with a number, means an ambient air monitoring method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.
AMG	Australian Map Grid
anniversary date	The anniversary date is the anniversary each year of the date of issue of the licence. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
annual return	Is defined in R1.1
Approved Methods Publication	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
assessable pollutants	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
BOD	Means biochemical oxygen demand
CEM	Together with a number, means a continuous emission monitoring method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.
COD	Means chemical oxygen demand
composite sample	Unless otherwise specifically approved in writing by the EPA, a sample consisting of 24 individual samples collected at hourly intervals and each having an equivalent volume.
cond.	Means conductivity
environment	Has the same meaning as in the Protection of the Environment Operations Act 1997
environment protection legislation	Has the same meaning as in the Protection of the Environment Administration Act 1991
EPA	Means Environment Protection Authority of New South Wales.
fee-based activity classification	Means the numbered short descriptions in Schedule 1 of the Protection of the Environment Operations (General) Regulation 2009.
general solid waste (non-putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997

Environment Protection Licence

flow weighted composite sample	Means a sample whose composites are sized in proportion to the flow at each composites time of collection.
general solid waste (putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environmen t Operations Act 1997
grab sample	Means a single sample taken at a point at a single time
hazardous waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
licensee	Means the licence holder described at the front of this licence
load calculation protocol	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
local authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
material harm	Has the same meaning as in section 147 Protection of the Environment Operations Act 1997
MBAS	Means methylene blue active substances
Minister	Means the Minister administering the Protection of the Environment Operations Act 1997
mobile plant	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
motor vehicle	Has the same meaning as in the Protection of the Environment Operations Act 1997
O&G	Means oil and grease
percentile [in relation to a concentration limit of a sample]	Means that percentage [eg.50%] of the number of samples taken that must meet the concentration limit specified in the licence for that pollutant over a specified period of time. In this licence, the specified period of time is the Reporting Period unless otherwise stated in this licence.
plant	Includes all plant within the meaning of the Protection of the Environment Operations Act 1997 as well as motor vehicles.
pollution of waters [or water pollution]	Has the same meaning as in the Protection of the Environment Operations Act 1997
premises	Means the premises described in condition A2.1
public authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
regional office	Means the relevant EPA office referred to in the Contacting the EPA document accompanying this licence
reporting period	For the purposes of this licence, the reporting period means the period of 12 months after the issue of the licence, and each subsequent period of 12 mo nths. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
restricted solid waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
scheduled activity	Means an activity listed in Schedule 1 of the Protection of the Environment Operations Act 1997
special waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
TM	Together with a number, means a test method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.

TSP	Means total suspended particles
TSS	Means total suspended solids
Type 1 substance	Means the elements antimony, arsenic, cadmium, lead or mercury or any compound containing one or more of those elements
Type 2 substance	Means the elements beryllium, chromium, cobalt, manganese, nickel, selenium, tin or vanadium or any compound containing one or more of those elements
utilisation area	Means any area shown as a utilisation area on a map submitted with the application for this licence
waste	Has the same meaning as in the Protection of the Environment Operations Act 1997
waste type	Means liquid, restricted solid waste, general solid waste (putrescible), general solid waste (non - putrescible), special waste or hazardous waste

Ms Debbie Maddison

Environment Protection Authority

(By Delegation)

Date of this edition: 05-April-2000

End Notes

1	Licence varied by notice V/M upgrade, issued on 07-Jul-2000, which came into effect on 07-Jul-2000.
2	Licence varied by notice 1005836, issued on 21-Nov-2001, which came into effect on 21-Nov-2001.
3	Licence varied by notice 1032965, issued on 09-Dec-2003, which came into effect on 03-Jan-2004.
4	Licence varied by notice 1042169, issued on 22-Dec-2004, which came into effect on 16-Jan-2005.
5	Condition A1.3 Not applicable varied by notice issued on <issue date> which came into effect on <effective date>
6	Licence varied by notice 1104182, issued on 18-Nov-2009, which came into effect on 18-Nov-2009.
7	Licence varied by notice 1501185 issued on 02-Dec-2011
8	Licence varied by notice 1506512 issued on 21-Mar-2013
9	Licence varied by notice 1516491 issued on 08-Oct-2013
10	Licence varied by notice 1522189 issued on 16-Oct-2014
11	Licence varied by notice 1527795 issued on 05-Feb-2015
12	Licence varied by notice 1530063 issued on 27-Apr-2015
13	Licence varied by notice 1547417 issued on 17-Aug-2017

Appendix C

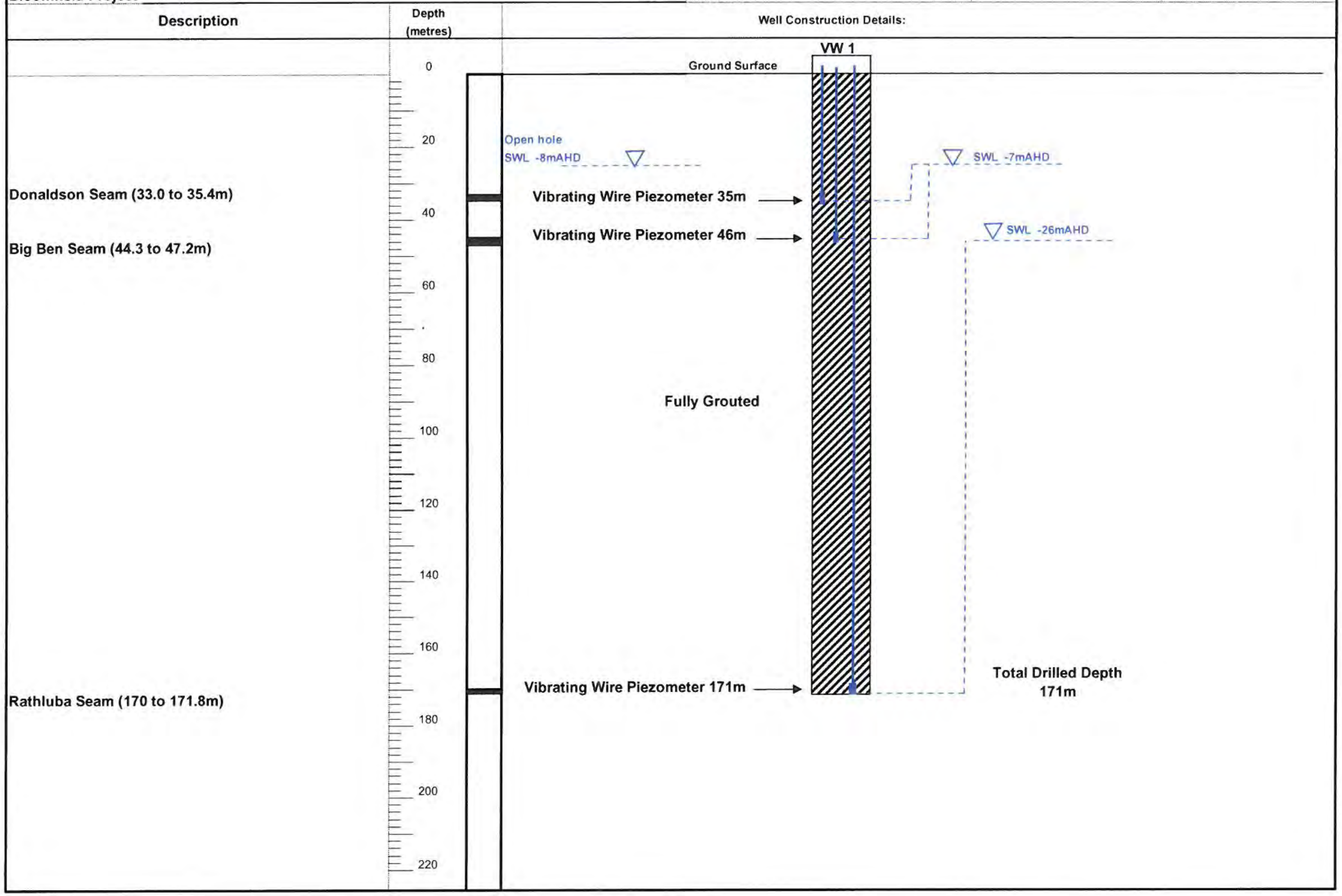
Bloomfield Piezometer Logs

Appendix C Bloomfield Piezometer Logs

Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 1

						Project No:	S05
Client: Bloomfield Collieries Pty Ltd	Bore: VW 1	Elevation (GL): 17.4 mAHD	Elevation (TOC):	Stickup:	Drilling Contractor: Hunter Drilling Services	Date Started: 27-Mar-07	Date Finished: 12-Apr-07
Location: Bloomfield Project			Hole depths: As shown			Supervised By: R McCallum	

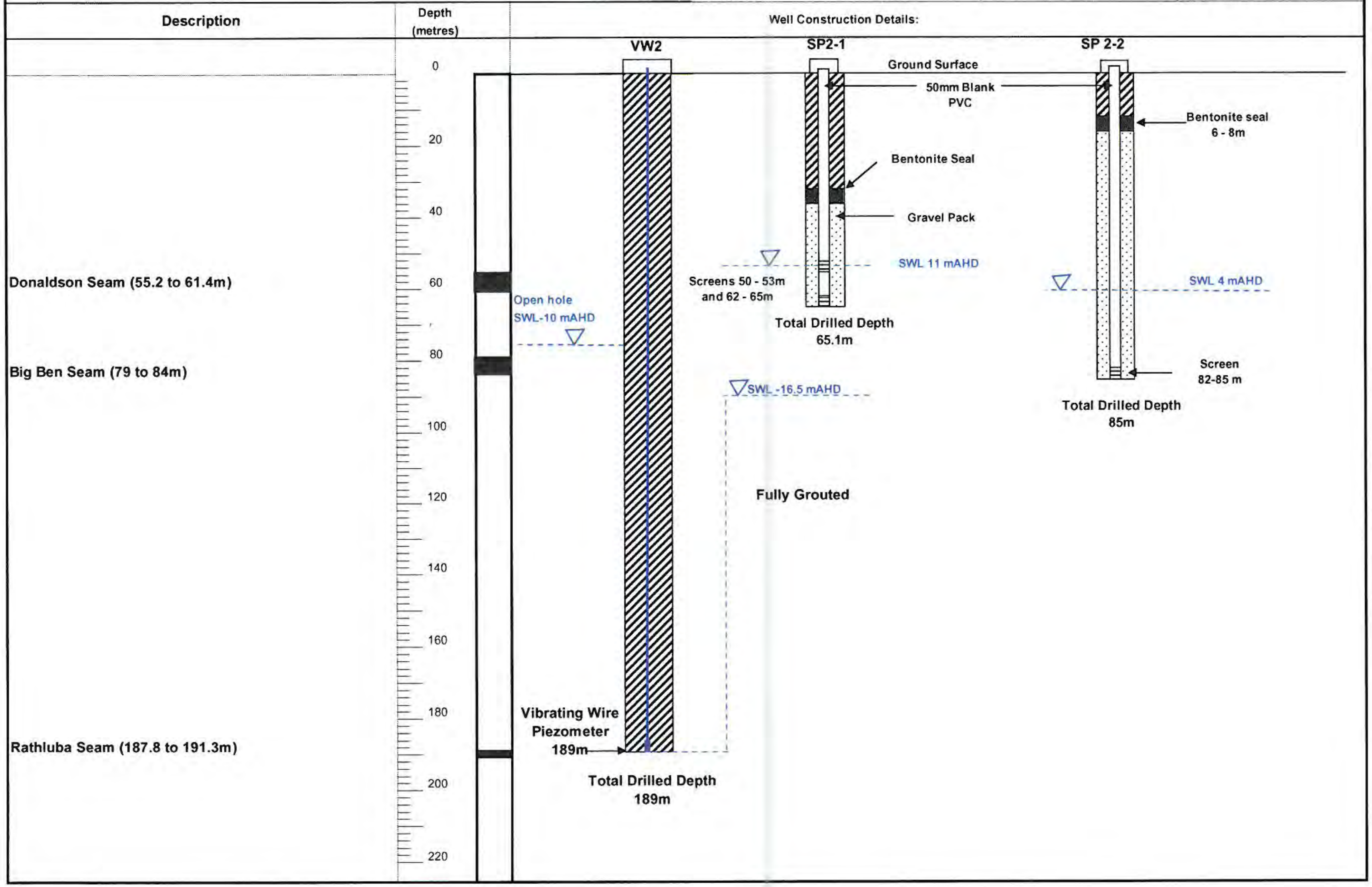


Appendix B-1: Bore Logs - Site 1

Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 2

						Project No:	S05
Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	VW2	65.2 mAHD			Hunter Drilling Services	20-Mar-07	27-Mar-07
Location:	SP2-1	65.2 mAHD			Hunter Drilling Services	20-Mar-07	27-Mar-07
Bloomfield Project	SP2-2	65.2 mAHD			Hunter Drilling Services	20-Mar-07	27-Mar-07
			Hole depths: As shown			Supervised By: R McCallum	



Appendix B-2: Bore Logs - Site 2

Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 3

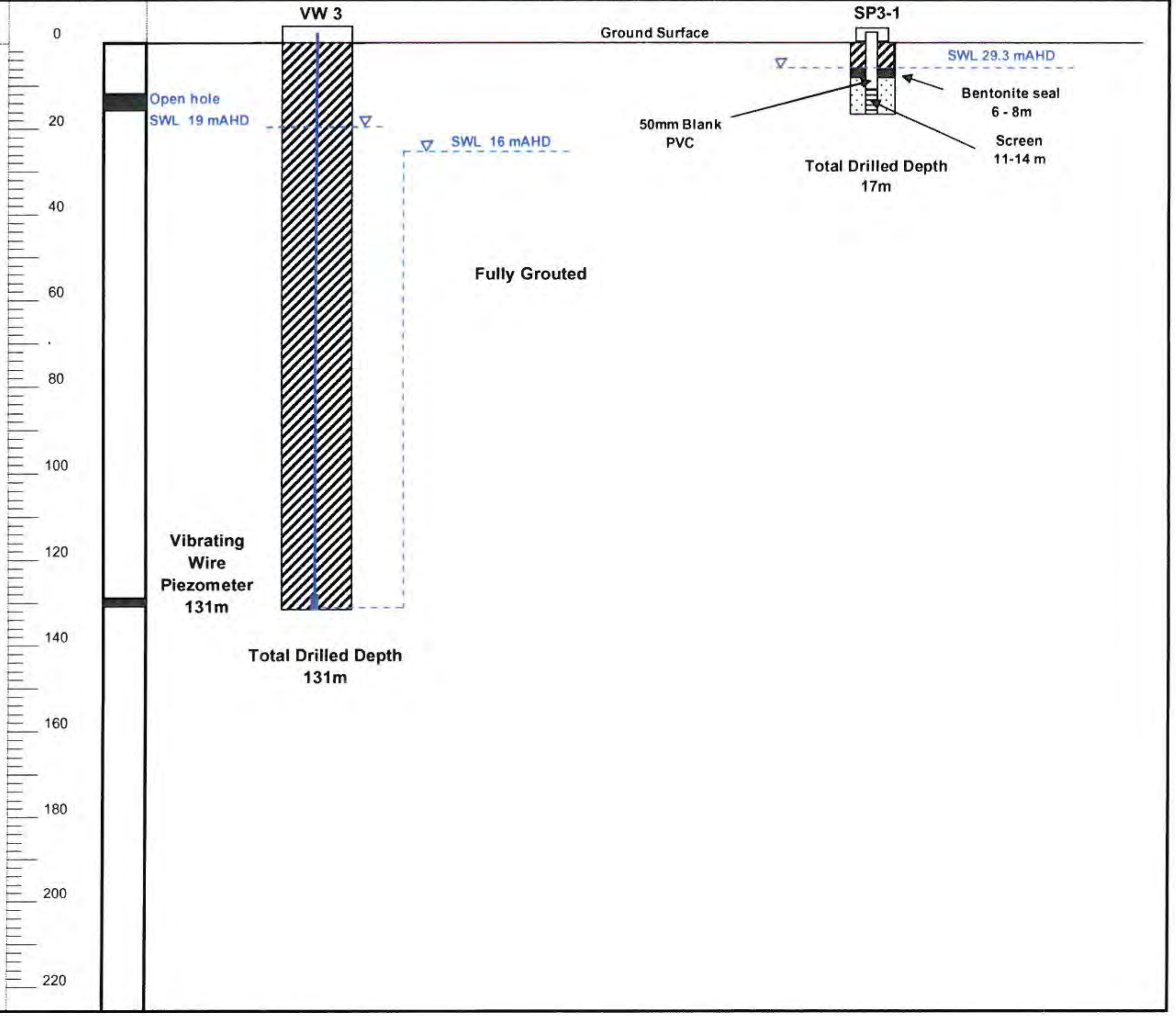
Project No:	S05

Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	VW3	38.8 mAHD			Hunter Drilling Services	11-May-07	14-May-07
Location:	SP3-1	38.8 mAHD			Hunter Drilling Services	11-May-07	14-May-07
Bloomfield Project							

Hole depths: As shown

Supervised By: R McCallum

Description	Depth (metres)	Well Construction Details:
Donaldson Seam (12 to 15.2m)		
Rathluba Seam (129.7 to 131.5m)		



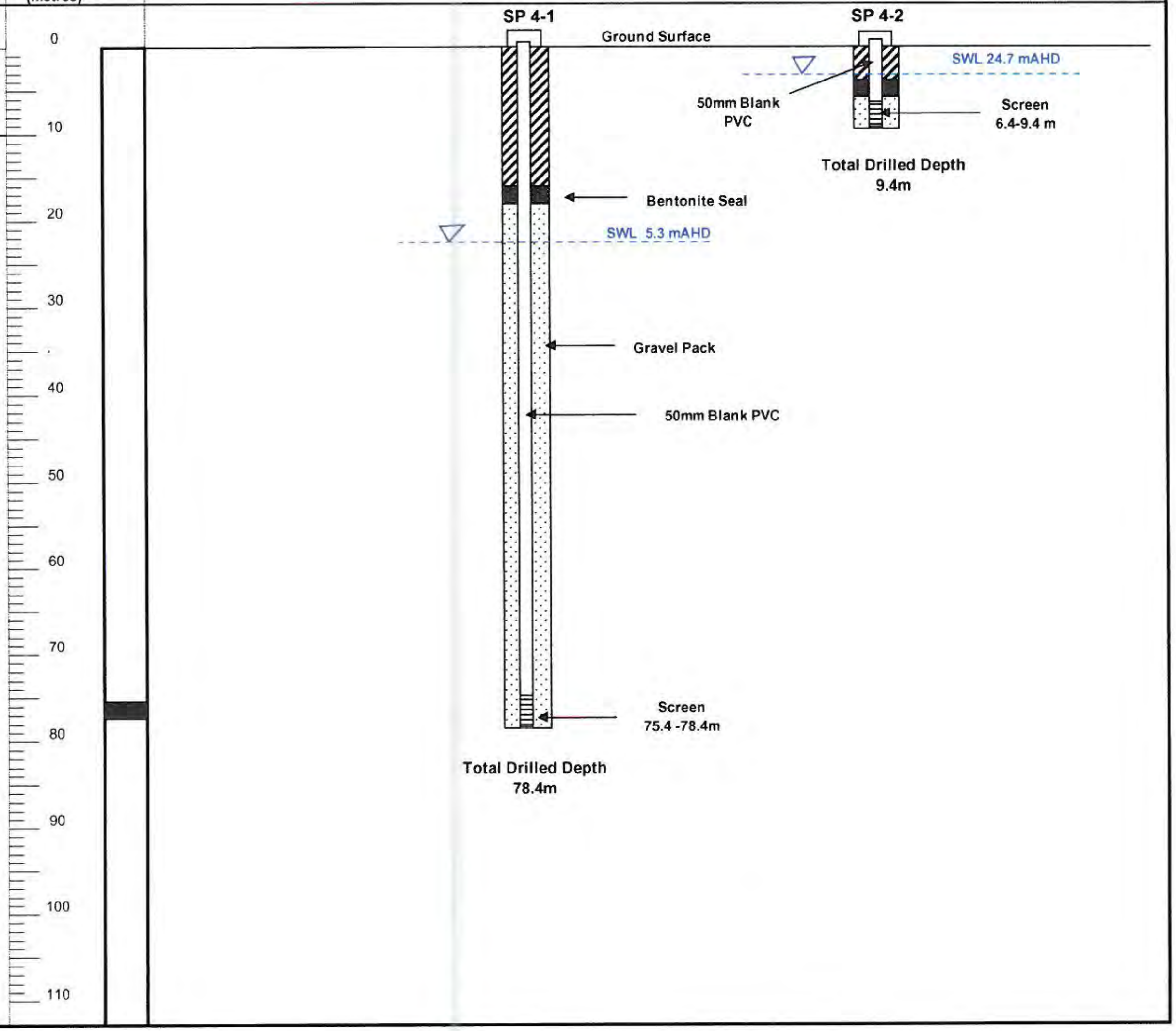
Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 4

Project No: **S05**

Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	SP4-1	27.8 mAHD			Hunter Drilling Services	16-Mar-07	17-Mar-07
Location:	SP4-2	27.8 mAHD		0.25 m	Hunter Drilling Services	16-Mar-07	17-Mar-07
Bloomfield Project							
			Hole depths: As shown			Supervised By: R McCallum	

Description	Depth (metres)	Well Construction Details:
Alluvium / weathered Permian	0–10	
Rathluba Seam (75.4 to 77.4m)	75.4–77.4	



Appendix B-4: Bore Logs - Site 4

Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 5

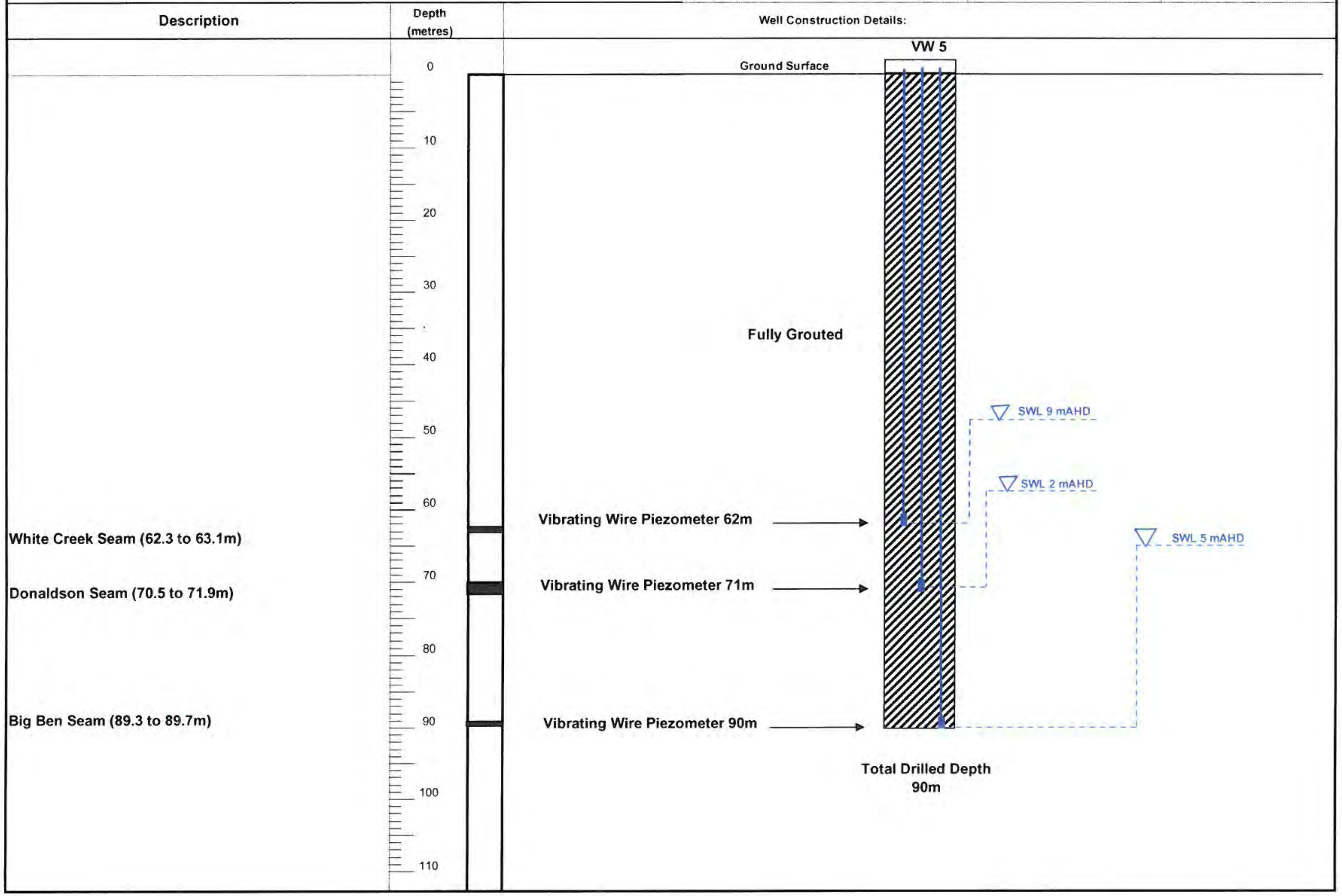
Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	VW5	55.7 mAHD			Hunter Drilling Services	05-Apr-07	27-Apr-07

Project No: S05

Location: Bloomfield Project

As shown

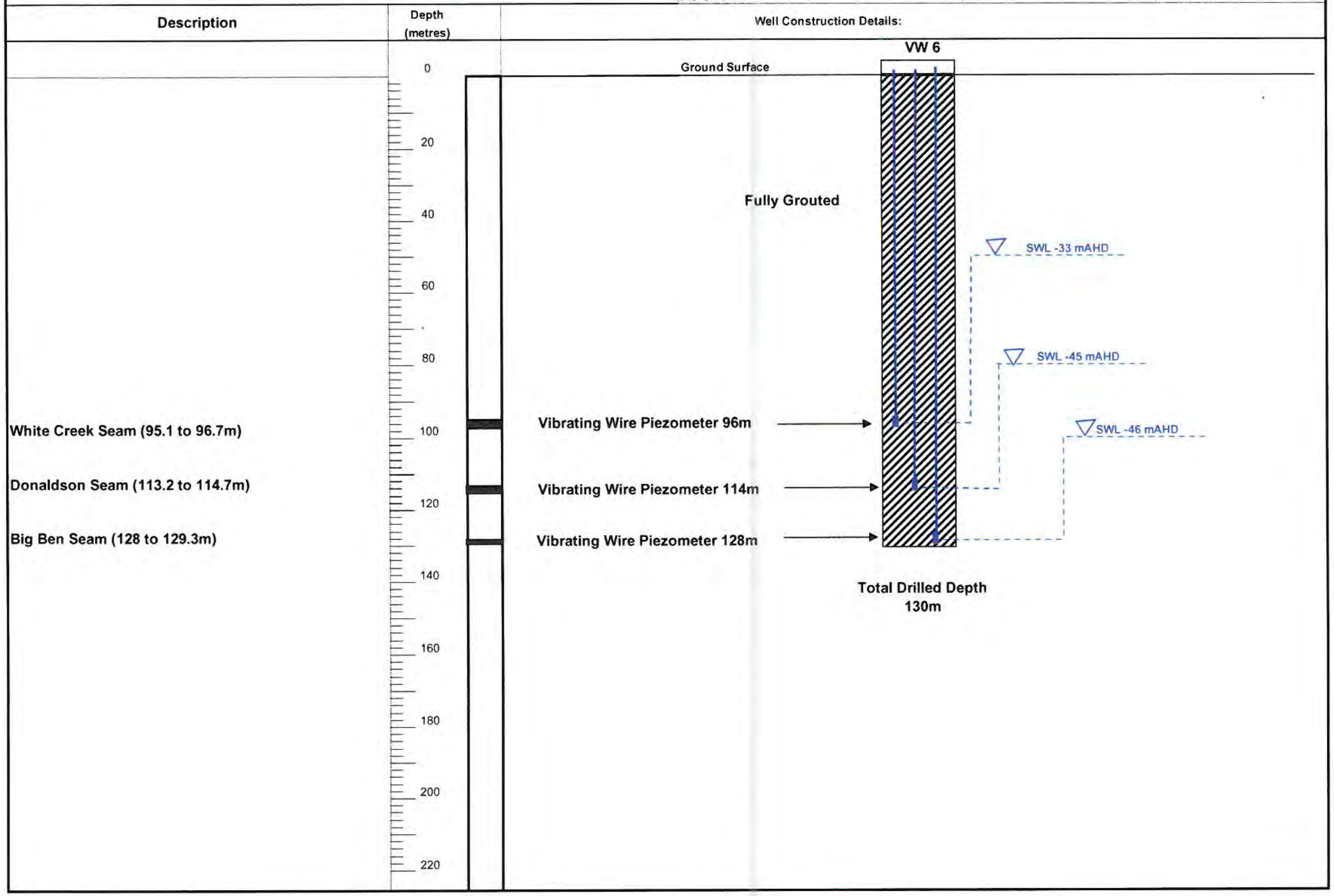
Supervised By: R McCallum



Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 6

						Project No:	S05
Client: Bloomfield Collieries Pty Ltd	Bore: VW6	Elevation (GL): 52.5 mAHD	Elevation (TOC): 52.75 mAHD	Stickup: 0.25 m	Drilling Contractor: Hunter Drilling Services	Date Started: 24-Apr-07	Date Finished: 27-Apr-07
Location: Bloomfield Project			Hole depths: As shown			Supervised By: R McCallum	

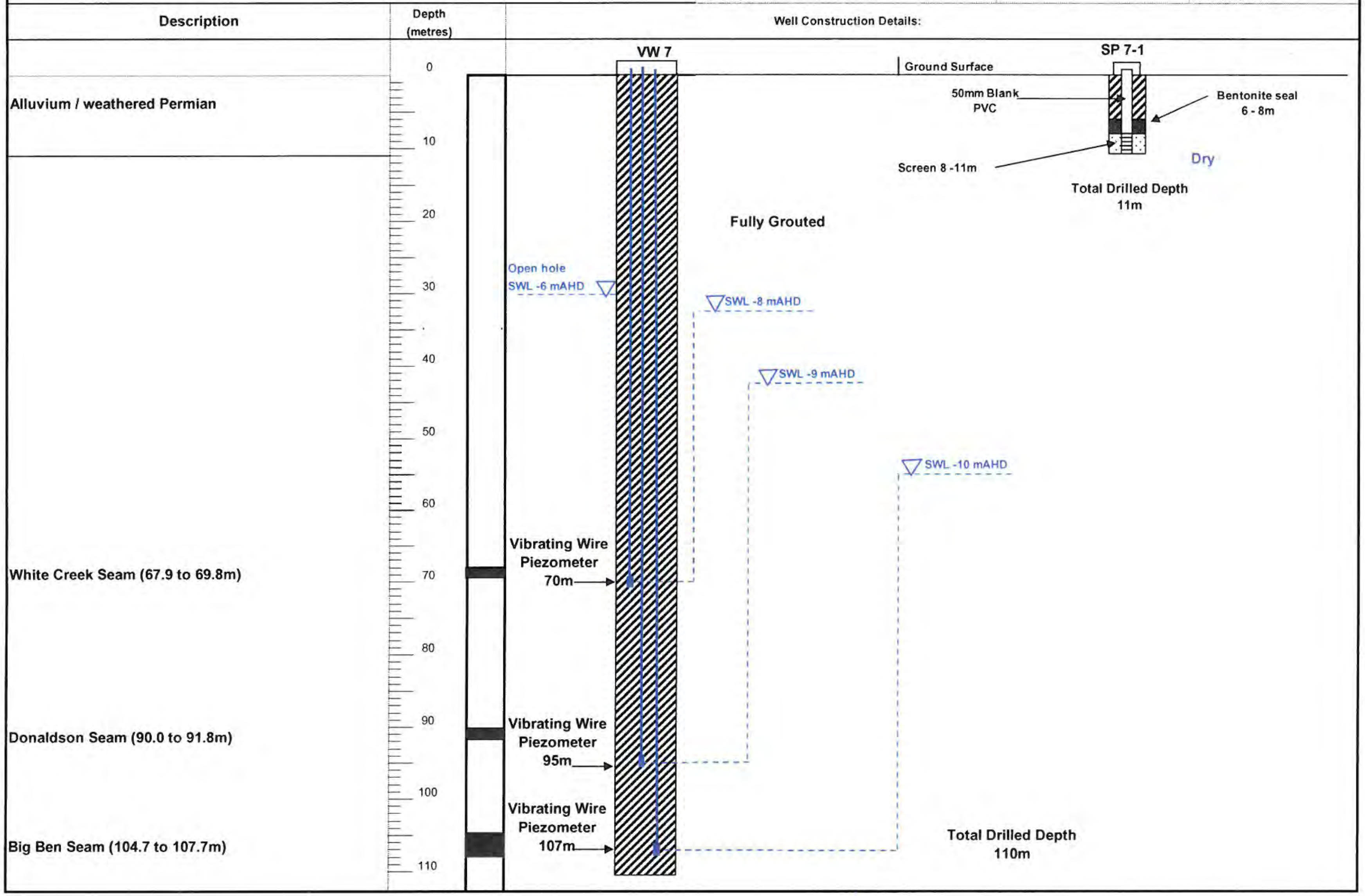


Appendix B-6: Bore Logs - Site 6

Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 7

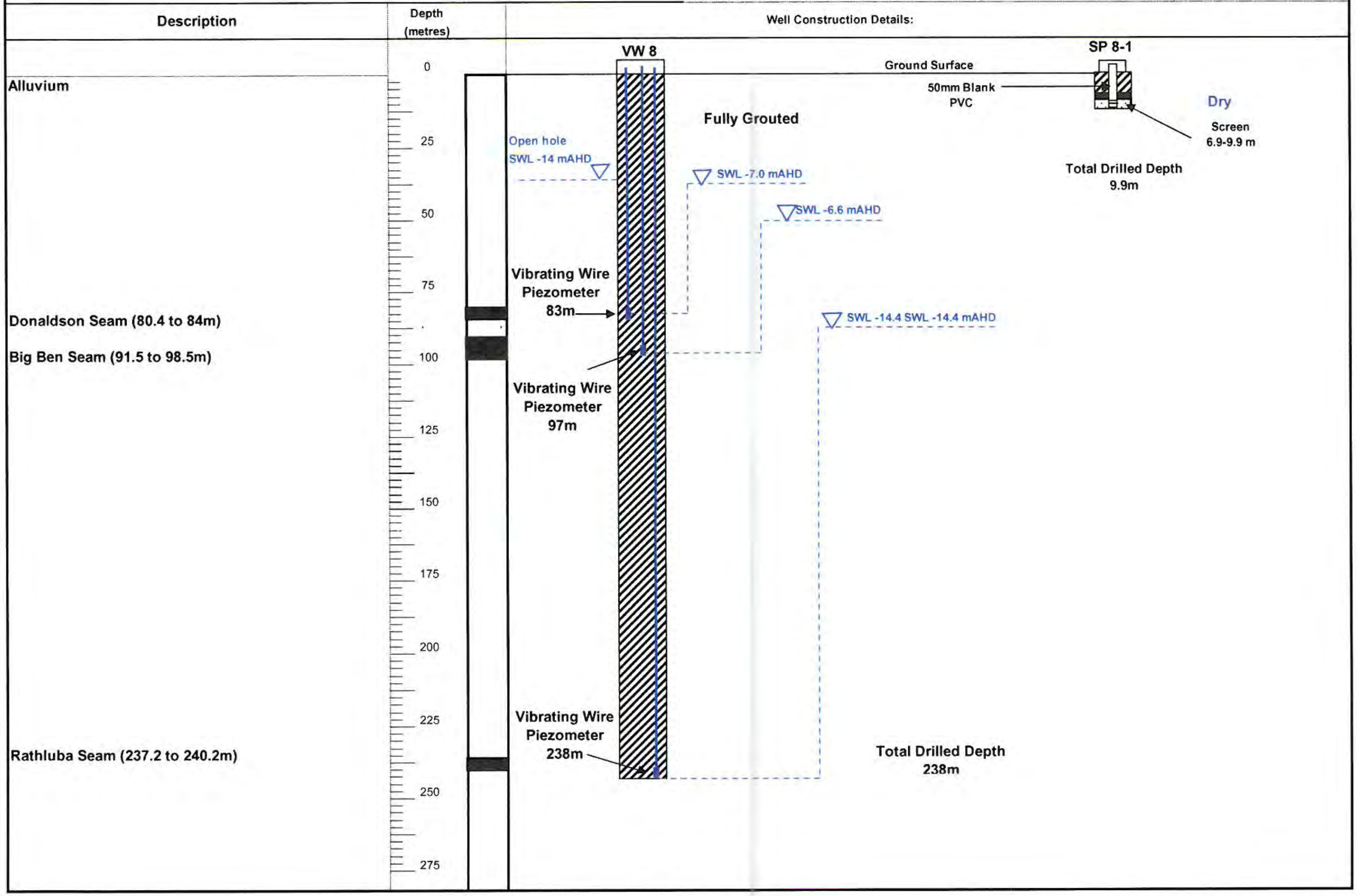
Client:	Bore:	Depth:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Project No:	S05
Bloomfield Collieries Pty Ltd	VW7		24.9 mAHD			Hunter Drilling Services	Date Started: 18-Apr-07	Date Finished: 24-Apr-07
Location: Bloomfield Project	SP7-1		24.9 mAHD	As shown		Hunter Drilling Services	Supervised By: R McCallum	



Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 8

Client:	Bore:	Depth:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Project No:	S05
Bloomfield Collieries Pty Ltd	VW8		22.5 mAHD			Hunter Drilling Services	Date Started: 29-Mar-07	Date Finished: 18-Apr-07
Location:	SP8-1		22.5 mAHD					
Bloomfield Project				As shown			Supervised By: R McCallum	



Appendix B-8: Bore Logs - Site 8

Appendix D

DPI-Water Registered Bores

Appendix D DPI-Water Registered Bores

NSW Office of Water
Work Summary

GW051353

Licence: 20BL114994 **Licence Status:** ACTIVE

Authorised Purpose (s): STOCK,DOMESTIC
Intended Purpose(s): STOCK, DOMESTIC

Work Type: Bore open thru rock
Work Status:
Construct.Method: Rotary
Owner Type: Private

Commenced Date: **Final Depth:** 49.70 m
Completion Date: 01/11/1980 **Drilled Depth:** 49.70 m

Contractor Name:
Driller:
Assistant Driller:

Property: ROBIN HILL **Standing Water Level (m):**
GWMA: - **Salinity Description:** 3001-7000 ppm
GW Zone: - **Yield (L/s):**

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.057	99
Licensed:	NORTHUMBERLAND	STOCKRINGTON	Whole Lot //

Region: 20 - Hunter **CMA Map:** 9232-3N
River Basin: 210 - HUNTER RIVER **Grid Zone:** **Scale:**
Area/District:

Elevation: 0.00 m (A.H.D.) **Northing:** 6365810.0 **Latitude:** 32°50'15.3"S
Elevation Source: (Unknown) **Easting:** 365986.0 **Longitude:** 151°34'05.1"E

GS Map: - **MGA Zone:** 0 **Coordinate Source:** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	P.V.C.	-0.30	1.50	114			Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.60	23.10	0.50	Fractured	15.20		0.12			
24.90	25.20	0.30	Fractured	15.20		0.20			

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.50	0.50	Soil Clay	Soil	
0.50	3.60	3.10	Sandstone Yellow	Sandstone	
3.60	3.90	0.30	Ironstone Shale	Ironstone	
3.90	10.70	6.80	Sandstone White	Sandstone	
10.70	11.90	1.20	Coal	Coal	
11.90	14.00	2.10	Sandstone Hard	Sandstone	
14.00	15.80	1.80	Shale	Shale	
15.80	22.60	6.80	Sandstone White	Sandstone	
22.60	25.60	3.00	Shale Water Supply	Shale	
25.60	49.70	24.10	Shale Black	Shale	
3.90	10.70	6.80	Shale Seams	Shale	

Remarks

***** End of GW051353 *****

NSW Office of Water
Work Summary

GW051647

Licence: 20BL112319

Licence Status: ACTIVE

Authorised Purpose (s): STOCK
Intended Purpose(s): STOCK

Work Type: Bore
Work Status:
Construct.Method: Rotary
Owner Type: Private

Commenced Date:
Completion Date: 01/09/1980

Final Depth:
Drilled Depth:

Contractor Name:
Driller: Alan Francis Ryan
Assistant Driller:

Property: KARINYA
GWMA: -
GW Zone: -

Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.034	L9 (1)
Licensed:	NORTHUMBERLAND	MAITLAND	Whole Lot //

Region: 20 - Hunter
CMA Map: 9232-3N
River Basin: 210 - HUNTER RIVER
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6373006.0
Easting: 362896.0
Latitude: 32°46'20.3"S
Longitude: 151°32'10.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log
Drillers Log

			Drillers Description	Geological Material	Comments

From (m)	To (m)	Thickness (m)			
0.00	0.15	0.15	Topsoil	Topsoil	
0.15	3.00	2.85	Clay	Clay	
3.00	3.81	0.81	Sand Yellow	Sand	
3.81	4.57	0.76	Sand White	Sand	
4.57	6.10	1.53	Clay Sand	Clay	
6.10	12.00	5.90	Sandstone Hard	Sandstone	

Remarks

***** End of GW051647 *****

NSW Office of Water
Work Summary

GW058760

Licence: 20BL130469

Licence Status: ACTIVE

Authorised Purpose (s): FARMING
Intended Purpose(s): FARMING

Work Type: Bore
Work Status:
Construct.Method: Rotary
Owner Type: Private

Commenced Date:
Completion Date: 01/10/1983

Final Depth: 33.00 m
Drilled Depth:

Contractor Name:
Driller:
Assistant Driller:

Property: N/A NSW

GWMA: -
GW Zone: -

Standing Water Level (m):
Salinity Description: 0-500 ppm
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.003	L13 DP225727 (46)
Licensed:	NORTHUMBERLAND	ALNWICK	Whole Lot 13//225727

Region: 20 - Hunter
CMA Map: 9232-3N

River Basin Area/District: 210 - HUNTER RIVER
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6371207.0
Easting: 371142.0
Latitude: 32°47'22.3"S
Longitude: 151°37'26.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	P.V.C.	0.00	33.00	900			Seated on Bottom
1	1	Opening	Slots - Horizontal	27.00	33.00	900		1	Mechanically Slotted, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
27.00	33.00	6.00	(Unknown)	27.00		0.10			

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments

Remarks

17/01/1985: TDS = 162 MG/L

***** End of GW058760 *****

NSW Office of Water
Work Summary

GW061307

Licence: 20BL133448

Licence Status: ACTIVE

Authorised Purpose (s): DOMESTIC
Intended Purpose(s): DOMESTIC

Work Type: Bore
Work Status:
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date: 01/10/1984

Final Depth: 30.00 m
Drilled Depth: 30.00 m

Contractor Name:
Driller:
Assistant Driller:

Property: N/A NSW
GWMA: -
GW Zone: -

Standing Water Level (m):
Salinity Description: 501-1000 ppm
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.003	L10 DP225727 (46)
Licensed:	NORTHUMBERLAND	ALNWICK	Whole Lot 10//225727

Region: 20 - Hunter
CMA Map: 9232-3N

River Basin: 210 - HUNTER RIVER
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6371148.0
Easting: 371299.0
Latitude: 32°47'24.3"S
Longitude: 151°37'32.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.20	30.00	150			Seated on Bottom
1	1	Opening	Slots - Vertical	25.00	30.00	150		1	Mechanically Slotted, A: 6.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
25.00	25.50	0.50	(Unknown)						

28.00	28.50	0.50	(Unknown)	25.00		0.40			

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.80	1.80	Clay	Clay	
1.80	30.00	28.20	Rock White Shale, Sandstone Water Bearing	Rock	

Remarks

***** End of GW061307 *****

NSW Office of Water
Work Summary

GW078044

Licence: 20BL166662

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status:
Construct.Method: Backhoe
Owner Type:

Commenced Date:
Completion Date: 14/11/1997

Final Depth: 30.10 m
Drilled Depth: 30.10 m

Contractor Name: MCDERMOTT DRILLING PTY LTD
Driller:
Assistant Driller:

Property: NOT KNOWN
GWMA: 017 - HUNTER
GW Zone: -

Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.003	LOT 102 DP 616161
Licensed:	NORTHUMBERLAND	ALNWICK	Whole Lot 12//1007491

Region: 20 - Hunter
CMA Map:

River Basin: Area/District: - Unknown
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6370151.0
Easting: 370428.0

Latitude: 32°47'56.3"S
Longitude: 151°36'58.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	30.10	96			Other
1		Annulus	Waterworn/Rounded	8.40	30.10				Ungraded
1	1	Opening	Screen	16.50	26.90			1	
1	1	Opening	Slots - Horizontal	16.50	26.90	55		1	PVC, SL: 10.4mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)		Duration (hr)	Salinity (mg/L)

							Hole Depth (m)		
13.70	30.10	16.40	Unknown	13.70			30.10		

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	6.00	6.00	SILTSTONE	Siltstone	
6.00	8.70	2.70	SANDSTONE	Sandstone	
8.70	10.60	1.90	COAL	Invalid Code	
10.60	12.00	1.40	MUDSTONE	Unknown	
12.00	14.80	2.80	SILTSTONE/SANDSTONE	Siltstone	
14.80	15.50	0.70	COAL	Invalid Code	
15.50	17.90	2.40	SILTSTONE	Siltstone	
17.90	18.30	0.40	COAL	Invalid Code	
18.30	19.50	1.20	SILTSTONE	Siltstone	
19.50	20.30	0.80	COAL	Invalid Code	
20.30	21.50	1.20	CLAYSTONE	Claystone	
21.50	26.60	5.10	COAL	Invalid Code	
26.60	30.10	3.50	SILTSTONE	Siltstone	

Remarks

***** End of GW078044 *****

NSW Office of Water
Work Summary

GW078045

Licence: 20BL166663

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status:
Construct.Method: Backhoe
Owner Type:

Commenced Date:
Completion Date: 14/11/1997

Final Depth: 30.50 m
Drilled Depth: 30.50 m

Contractor Name: MCDERMOTT DRILLING PTY LTD
Driller:
Assistant Driller:

Property: N/A
GWMA: 017 - HUNTER
GW Zone: -

Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.003	LOT 23 DP 532814
Licensed:	NORTHUMBERLAND	ALNWICK	Whole Lot 23//532814

Region: 20 - Hunter
CMA Map:
River Basin: - Unknown
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6369892.0
Easting: 371836.0
Latitude: 32°48'05.3"S
Longitude: 151°37'52.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	30.50	96			Open Hole - Water
1		Annulus	Waterworn/Rounded	5.00	30.50				Ungraded
1	1	Opening	Screen	15.80	27.80			1	
1	1	Opening	Slots - Horizontal	15.80	27.80	55		1	PVC, SL: 12.0mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)		Duration (hr)	Salinity (mg/L)

							Hole Depth (m)		
17.30	30.50	13.20	Unknown	17.30			30.50		

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	2.00	2.00	SANDSTONE	Sandstone	
2.00	16.00	14.00	SILTSTONE/MUDSTONE	Siltstone	
16.00	16.50	0.50	COAL	Invalid Code	
16.50	20.40	3.90	SILTSTONE/MUDSTONE	Siltstone	
20.40	20.90	0.50	COAL	Invalid Code	
20.90	25.00	4.10	MUDSTONE	Mudstone	
25.00	30.50	5.50	SILTSTONE	Siltstone	

Remarks

***** End of GW078045 *****

NSW Office of Water
Work Summary

GW078046

Licence: 20BL166664

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status:
Construct.Method: Backhoe
Owner Type:

Commenced Date:
Completion Date: 14/11/1997

Final Depth: 30.40 m
Drilled Depth: 30.40 m

Contractor Name: MCDERMOTT DRILLING PTY LTD
Driller:
Assistant Driller:

Property: N/A
GWMA: 017 - HUNTER
GW Zone: -

Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.057	LOT 92 DP 755260
Licensed:	NORTHUMBERLAND	STOCKRINGTON	Whole Lot 92//755260

Region: 20 - Hunter

CMA Map:

River Basin: - Unknown
Area/District:

Grid Zone:

Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6368741.0
Easting: 368651.0

Latitude: 32°48'41.3"S
Longitude: 151°35'49.1"E

GS Map: -

MGA Zone: 0

Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	30.40	96			Open Hole - Water
1		Annulus	Waterworn/Rounded	6.00	30.40				Ungraded
1	1	Opening	Screen	6.80	18.80			1	
1	1	Opening	Slots - Horizontal	6.80	18.80	55		1	PVC, SL: 12.0mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

13.60	30.40	16.80	Unknown	13.60			30.40		

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	9.20	9.20	SILTSTONE/MUDSTONE	Siltstone	
9.20	9.40	0.20	COAL	Invalid Code	
9.40	11.20	1.80	SILTSTONE	Siltstone	
11.20	11.60	0.40	COAL	Invalid Code	
11.60	30.40	18.80	SILTSTONE/SANDSTONE	Siltstone	

Remarks

***** End of GW078046 *****

NSW Office of Water
Work Summary

GW078047

Licence: 20BL166665

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 14/11/1997

Final Depth: 54.30 m
Drilled Depth: 54.30 m

Contractor Name: MCDERMOTT DRILLING PTY LTD
Driller:
Assistant Driller:

Property: N/A
GWMA: 017 - HUNTER
GW Zone: -

Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.057	PT LOT 13 DP 755260
Licensed:	NORTHUMBERLAND	STOCKRINGTON	PART LOT 13//755260

Region: 20 - Hunter
CMA Map:
River Basin: - Unknown
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6368800.0
Easting: 370784.0
Latitude: 32°48'40.3"S
Longitude: 151°37'11.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	54.30	96			Unknown
1		Annulus	Waterworn/Rounded	24.90	49.20				Ungraded
1	1	Opening	Screen	25.20	49.20			1	
1	1	Opening	Slots - Horizontal	25.20	49.20	55		1	PVC, SL: 24.0mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

22.80	54.30	31.50	Unknown	22.80			54.30		

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	6.50	6.50	SILTSTONE	Siltstone	
6.50	12.00	5.50	SANDSTONE	Sandstone	
12.00	14.60	2.60	SILTSTONE/MUDSTONE	Siltstone	
14.60	15.40	0.80	COAL	Invalid Code	
15.40	24.90	9.50	SILTSTONE	Siltstone	
24.90	27.70	2.80	COAL	Invalid Code	
27.70	32.30	4.60	SILTSTONE/SANDSTONE	Siltstone	
32.30	33.40	1.10	COAL	Invalid Code	
33.40	39.30	5.90	SANDSTONE	Sandstone	
39.30	39.90	0.60	COAL	Invalid Code	
39.90	41.10	1.20	SILTSTONE/SANDSTONE	Siltstone	
41.10	43.50	2.40	COAL	Invalid Code	
43.50	45.10	1.60	CLAYSTONE	Claystone	
45.10	49.40	4.30	COAL	Invalid Code	
49.40	54.30	4.90	SILTSTONE	Siltstone	

Remarks

***** End of GW078047 *****

NSW Office of Water
Work Summary

GW078120

Licence: 20BL166666

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 14/11/1997

Final Depth: 24.00 m
Drilled Depth: 24.00 m

Contractor Name: MCDERMOTT DRILLING PTY LTD
Driller:
Assistant Driller:

Property: N/A
GWMA: 017 - HUNTER
GW Zone: -

Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.029	LOT 115 DP 240782
Licensed:	NORTHUMBERLAND	HEXHAM	Whole Lot 115//240782

Region: 20 - Hunter
CMA Map:
River Basin: - Unknown
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6368590.0
Easting: 371176.0
Latitude: 32°48'47.3"S
Longitude: 151°37'26.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	24.00	96			Open Hole - Water
1		Annulus	Waterworn/Rounded	2.00	24.00				Ungraded
1	1	Opening	Screen	6.00	18.00			1	
1	1	Opening	Slots - Horizontal	6.00	18.00	55		1	PVC, SL: 12.0mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)		Duration (hr)	Salinity (mg/L)

							Hole Depth (m)		
6.10	24.00	17.90	Unknown	6.10			24.00		

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	14.00	14.00	SILTSTONE/MUDSTONE	Siltstone	
14.00	16.00	2.00	SANDSTONE	Sandstone	
16.00	24.00	8.00	MUDSTONE/SHALE	Mudstone	

Remarks

***** End of GW078120 *****

NSW Office of Water
Work Summary

GW078121

Licence: 20BL166667

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 14/11/1997

Final Depth: 43.00 m
Drilled Depth: 43.00 m

Contractor Name: MCDERMOTT DRILLING PTY LTD
Driller:
Assistant Driller:

Property: N/A
GWMA: 017 - HUNTER
GW Zone: -

Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.057	LOT 10 DP 11875
Licensed:	NORTHUMBERLAND	STOCKRINGTON	Whole Lot 10//11875

Region: 20 - Hunter
CMA Map:
River Basin: - Unknown
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6367262.0
Easting: 368619.0
Latitude: 32°49'29.3"S
Longitude: 151°35'47.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	43.00	96			Open Hole - Water
1		Annulus	Waterworn/Rounded	2.00	43.00				Ungraded
1	1	Opening	Screen	26.70	42.50			1	
1	1	Opening	Slots	26.70	42.50	55		1	PVC, SL: 15.8mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.30	43.00	20.70	Unknown	22.30			43.00		

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	14.00	14.00	SILTSTONE/SHALE	Siltstone	
14.00	16.00	2.00	SANDSTONE	Sandstone	
16.00	20.00	4.00	SILTSTONE/SHALE	Siltstone	
20.00	22.00	2.00	SANDSTONE	Sandstone	
22.00	25.40	3.40	SILTSTONE/SHALE	Siltstone	
25.40	25.90	0.50	COAL	Invalid Code	
25.90	32.10	6.20	SANDSTONE	Sandstone	
32.10	32.60	0.50	COAL	Invalid Code	
32.60	33.90	1.30	SANDSTONE	Sandstone	
33.90	35.60	1.70	COAL	Invalid Code	
35.60	36.20	0.60	SANDSTONE	Sandstone	
36.20	37.00	0.80	COAL	Invalid Code	
37.00	38.20	1.20	SANDSTONE/SILTSTONE	Sandstone	
38.20	38.60	0.40	COAL	Invalid Code	
38.60	43.00	4.40	SILTSTONE	Siltstone	

Remarks

***** End of GW078121 *****

NSW Office of Water
Work Summary

GW078122

Licence: 20BL166668

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 14/11/1997

Final Depth: 35.40 m
Drilled Depth: 35.40 m

Contractor Name: MCDERMOTT DRILLING PTY LTD
Driller:
Assistant Driller:

Property: N/A
GWMA: 017 - HUNTER
GW Zone: -

Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.057	LOT 10 DP 11875
Licensed:	NORTHUMBERLAND	STOCKRINGTON	Whole Lot 10//11875

Region: 20 - Hunter
CMA Map:

River Basin: - Unknown
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6367663.0
Easting: 368666.0

Latitude: 32°49'16.3"S
Longitude: 151°35'49.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	35.40	96			Open Hole - Water
1		Annulus	Waterworn/Rounded	19.20	35.40				Ungraded
1	1	Opening	Screen	19.50	35.00			1	
1	1	Opening	Slots - Horizontal	19.50	35.00	55		1	PVC, SL: 15.5mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
23.10	51.30	28.20	Unknown	23.10			35.40		

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	12.00	12.00	SANDSTONE/SILTSTONE	Sandstone	
12.00	12.40	0.40	COAL	Invalid Code	
12.40	16.00	3.60	SILTSTONE	Siltstone	
16.00	19.50	3.50	SANDSTONE	Sandstone	
19.50	20.90	1.40	COAL	Invalid Code	
20.90	22.00	1.10	SANDSTONE	Sandstone	
22.00	23.60	1.60	COAL	Invalid Code	
23.60	24.40	0.80	SANDSTONE	Sandstone	
24.40	26.60	2.20	COAL	Invalid Code	
26.60	28.00	1.40	SILTSTONE/CLAYSTONE	Siltstone	
28.00	31.70	3.70	COAL	Invalid Code	
31.70	35.40	3.70	SANDSTONE	Sandstone	

Remarks

***** End of GW078122 *****

NSW Office of Water
Work Summary

GW078123

Licence: 20BL166669

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE

Intended Purpose(s):

Work Type: Bore

Work Status:

Construct.Method:

Owner Type:

Commenced Date:

Completion Date: 14/11/1997

Final Depth: 33.00 m

Drilled Depth: 33.00 m

Contractor Name: MCDERMOTT DRILLING PTY LTD

Driller:

Assistant Driller:

Property: N/A

GWMA: 017 - HUNTER

GW Zone: -

Standing Water Level (m):

Salinity Description:

Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.057	LOT 92 DP 755260
Licensed:	NORTHUMBERLAND	STOCKRINGTON	Whole Lot 92//755260

Region: 20 - Hunter

CMA Map:

River Basin: - Unknown

Area/District:

Grid Zone:

Scale:

Elevation: 0.00 m (A.H.D.)

Elevation Source: Unknown

Northing: 6368165.0

Easting: 369309.0

Latitude: 32°49'00.3"S

Longitude: 151°36'14.1"E

GS Map: -

MGA Zone: 0

Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	33.00	96			Other
1		Annulus	Waterworn/Rounded	12.50	32.20				Ungraded
1	1	Opening	Screen	20.20	32.20			1	
1	1	Opening	Slots - Horizontal	20.20	32.20	55		1	PVC, SL: 12.0mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

24.40	33.00	8.60	Unknown	24.40			33.00		

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	13.20	13.20	SANDSTONE/SILTSTONE	Sandstone	
13.20	15.30	2.10	COAL	Invalid Code	
15.30	17.00	1.70	SILTSTONE	Siltstone	
17.00	17.90	0.90	COAL/SANDSTONE	Invalid Code	
17.90	19.00	1.10	SILTSTONE	Siltstone	
19.00	19.70	0.70	COAL/SANDSTONE	Invalid Code	
19.70	20.80	1.10	SANDSTONE	Sandstone	
20.80	23.20	2.40	COAL	Invalid Code	
23.20	25.50	2.30	SANDSTONE/CLAYSTONE	Sandstone	
25.50	29.70	4.20	COAL	Invalid Code	
29.70	33.00	3.30	SANDSTONE/SILTSTONE	Sandstone	

Remarks

***** End of GW078123 *****

NSW Office of Water
Work Summary

GW078124

Licence: 20BL166670

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE

Intended Purpose(s): MONITORING BORE

Work Type: Bore

Work Status:

Construct.Method:

Owner Type:

Commenced Date:

Completion Date: 14/11/1997

Final Depth: 40.00 m

Drilled Depth: 40.00 m

Contractor Name: MCDERMOTT DRILLING PTY LTD

Driller:

Assistant Driller:

Property: N/A

GWMA: 017 - HUNTER

GW Zone: -

Standing Water Level (m):

Salinity Description:

Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.057	PT LOT 13 DP755260
Licensed:	NORTHUMBERLAND	STOCKRINGTON	PART LOT 13//755260

Region: 20 - Hunter

CMA Map:

River Basin: Area/District: - Unknown

Grid Zone:

Scale:

Elevation: 0.00 m (A.H.D.)

Elevation Source: Unknown

Northing: 6368018.0

Easting: 369883.0

Latitude: 32°49'05.3"S

Longitude: 151°36'36.1"E

GS Map: -

MGA Zone: 0

Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	40.00	96			Open Hole - Water
1		Annulus	Waterworn/Rounded	11.10	40.00				Ungraded
1	1	Opening	Screen	12.50	36.50			1	
1	1	Opening	Slots - Horizontal	12.50	36.50	55		1	PVC, SL: 30.0mm, A: 2.40mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

18.60	40.00	21.40	Unknown	18.60			40.00		

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	8.10	8.10	sandstone	Sandstone	
8.10	8.60	0.50	coal	Invalid Code	
8.60	10.00	1.40	siltstone	Siltstone	
10.00	15.50	5.50	sandstone	Sandstone	
15.50	17.20	1.70	coal	Invalid Code	
17.20	18.30	1.10	sandstone	Sandstone	
18.30	19.20	0.90	coal	Invalid Code	
19.20	20.00	0.80	mudstone	Mudstone	
20.00	24.50	4.50	siltstone	Siltstone	
24.50	27.70	3.20	coal	Invalid Code	
27.70	29.90	2.20	sandstone/claystone	Sandstone	
29.90	33.30	3.40	coal	Invalid Code	
33.30	37.00	3.70	mudstone	Mudstone	

Remarks

23/09/2011: Slot Length and Width adjusted due to data entry errors with advice from Madhwan Keshwan. GDS Data Cleanup project 2011.

***** End of GW078124 *****

NSW Office of Water
Work Summary

GW078125

Licence: 20BL166671

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE

Intended Purpose(s): MONITORING BORE

Work Type: Bore

Work Status:

Construct.Method:

Owner Type:

Commenced Date:

Completion Date: 14/11/1997

Final Depth: 30.00 m

Drilled Depth: 30.00 m

Contractor Name: MCDERMOTT DRILLING PTY LTD

Driller:

Assistant Driller:

Property: N/A

GWMA: 017 - HUNTER

GW Zone: -

Standing Water Level (m):

Salinity Description:

Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.057	PT LOT 13 DP755260
Licensed:	NORTHUMBERLAND	STOCKRINGTON	PART LOT 13//755260

Region: 20 - Hunter

CMA Map:

River Basin: - Unknown

Area/District:

Grid Zone:

Scale:

Elevation: 0.00 m (A.H.D.)

Elevation Source: Unknown

Northing: 6368464.0

Easting: 370970.0

Latitude: 32°48'51.3"S

Longitude: 151°37'18.1"E

GS Map: -

MGA Zone: 0

Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	30.00	96			Open Hole - Water
1		Annulus	Waterworn/Rounded	5.00	30.00				Ungraded
1	1	Opening	Screen	11.80	29.80			1	
1	1	Opening	Slots - Horizontal	11.80	29.80	55		1	PVC, SL: 18.0mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

10.20	30.00	19.80	Unknown	10.20			30.00		

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	19.00	19.00	siltstone/sandstone	Siltstone	
19.00	24.00	5.00	sandstone	Sandstone	
24.00	26.50	2.50	siltstone/sandstone	Siltstone	
26.50	26.90	0.40	coal	Invalid Code	
26.90	30.00	3.10	siltstone/sandstone	Siltstone	

Remarks

***** End of GW078125 *****

NSW Office of Water
Work Summary

GW078126

Licence: 20BL166672

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 14/11/1997

Final Depth: 30.00 m
Drilled Depth: 30.00 m

Contractor Name: MCDERMOTT DRILLING PTY LTD
Driller:
Assistant Driller:

Property: BERESFIELD BORAL-BERESFIELD
GWMA: 017 - HUNTER
GW Zone: -

Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.029	LOT 117 DP 568625
Licensed:	NORTHUMBERLAND	HEXHAM	Whole Lot 30//870411

Region: 20 - Hunter

CMA Map:

River Basin: - Unknown
Area/District:

Grid Zone:

Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6367736.0
Easting: 371890.0

Latitude: 32°49'15.3"S
Longitude: 151°37'53.1"E

GS Map: -

MGA Zone: 0

Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	30.00	96			Open Hole - Water
1		Annulus	Waterworn/Rounded	2.00	30.00				Ungraded
1	1	Opening	Screen	17.50	29.50			1	
1	1	Opening	Slots - Horizontal	17.50	29.50	55		1	PVC, SL: 12.0mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)		Duration (hr)	Salinity (mg/L)

							Hole Depth (m)		
9.00	30.00	21.00	Unknown	9.00			30.00		

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	7.00	7.00	sandstone	Sandstone	
7.00	17.10	10.10	siltstone/mudstone	Siltstone	
17.10	17.80	0.70	coal	Invalid Code	
17.80	19.50	1.70	siltstone/claystone	Siltstone	
19.50	19.90	0.40	coal	Invalid Code	
19.90	30.00	10.10	siltstone/mudstone	Siltstone	

Remarks

***** End of GW078126 *****

NSW Office of Water
Work Summary

GW078127

Licence: 20BL166673

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE

Intended Purpose(s): MONITORING BORE

Work Type: Bore

Work Status:

Construct.Method:

Owner Type:

Commenced Date:

Completion Date: 14/11/1997

Final Depth: 30.00 m

Drilled Depth: 30.00 m

Contractor Name: MCDERMOTT DRILLING PTY LTD

Driller:

Assistant Driller:

Property: NOT KNOWN

GWMA: 017 - HUNTER

GW Zone: -

Standing Water Level (m):

Salinity Description:

Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.057	LOT 82 DP 627798
Licensed:	NORTHUMBERLAND	STOCKRINGTON	Whole Lot 82//627799

Region: 20 - Hunter

CMA Map:

River Basin: - Unknown

Area/District:

Grid Zone:

Scale:

Elevation: 0.00 m (A.H.D.)

Elevation Source: Unknown

Northing: 6366406.0

Easting: 369073.0

Latitude: 32°49'57.3"S

Longitude: 151°36'04.1"E

GS Map: -

MGA Zone: 0

Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	30.00	96			Open Hole - Water
1		Annulus	Waterworn/Rounded	1.00	30.00				Ungraded
1	1	Opening	Screen	14.30	26.30			1	
1	1	Opening	Slots - Horizontal	14.30	26.30	55		1	PVC, SL: 12.0mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

16.60	30.00	13.40	Unknown	16.60			30.00		

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	13.00	13.00	siltstone/mudstone	Siltstone	
13.00	17.00	4.00	mudstone	Mudstone	
17.00	30.00	13.00	siltstone/mudstone	Siltstone	

Remarks

***** End of GW078127 *****

NSW Office of Water
Work Summary

GW078128

Licence: 20BL166674
Licence Status: ACTIVE

Authorised Purpose(s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 14/11/1997
Final Depth: 30.00 m
Drilled Depth: 30.00 m

Contractor Name: MCDERMOTT DRILLING PTY LTD
Driller:
Assistant Driller:

Property: BERESFIELD BORAL BERESFIELD
GWMA: 017 - HUNTER
GW Zone: -
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.029	LOT 117 DP 568625
Licensed:	NORTHUMBERLAND	HEXHAM	Whole Lot 30//870411

Region: 20 - Hunter
CMA Map:
River Basin: - Unknown
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6366923.0
Easting: 370912.0
Latitude: 32°49'41.3"S
Longitude: 151°37'15.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	30.00	96			Open Hole - Water
1		Annulus	Waterworn/Rounded	1.70	8.00				Ungraded
1	1	Opening	Screen	18.00	30.00			1	
1	1	Opening	Slots - Horizontal	18.00	30.00	55		1	PVC, SL: 12.0mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)		Duration (hr)	Salinity (mg/L)

							Hole Depth (m)		
7.80	30.00	22.20	Unknown	7.80			30.00		

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	8.00	8.00	siltstone	Siltstone	
8.00	9.00	1.00	shale	Shale	
9.00	12.00	3.00	siltstone	Siltstone	
12.00	12.80	0.80	shale	Shale	
12.80	13.40	0.60	coal	Invalid Code	
13.40	30.00	16.60	siltstone/mudstone	Siltstone	

Remarks

***** End of GW078128 *****

NSW Office of Water
Work Summary

GW079892

Licence:

Licence Status:

Authorised Purpose(s):
Intended Purpose(s):

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date:

Final Depth:
Drilled Depth:

Contractor Name:
Driller:
Assistant Driller:

Property:

Standing Water Level (m):

GWMA:
GW Zone:

Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUC	GLOUC.049	
Licensed:			

Region: 20 - Hunter
CMA Map:

River Basin: - Unknown
Area/District:
Grid Zone:
Scale:

Elevation: 6.69 m (A.H.D.)
Elevation Source: Unknown
Northing: 6372257.0
Easting: 366598.0
Latitude: 32°46'46.3"S
Longitude: 151°34'32.0"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments

Remarks

15/02/2000: Form A Remarks:
RZM monitoring bore SK 6560
30/11/2009: Reviewed data - nothing to update.

***** End of GW079892 *****

NSW Office of Water
Work Summary

GW079948

Licence:

Licence Status:

Authorised Purpose(s):
Intended Purpose(s):

Work Type: Bore

Work Status:

Construct.Method:

Owner Type:

Commenced Date:
Completion Date:

Final Depth:
Drilled Depth:

Contractor Name:

Driller:

Assistant Driller:

Property:

Standing Water Level (m):

GWMA:
GW Zone:

Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUC	GLOUC.049	
Licensed:			

Region: 20 - Hunter

CMA Map:

River Basin: - Unknown
Area/District:

Grid Zone:

Scale:

Elevation: 9.87 m (A.H.D.)
Elevation Source: Unknown

Northing: 6372613.0
Easting: 370081.0

Latitude: 32°46'36.2"S
Longitude: 151°36'46.0"E

GS Map: -

MGA Zone: 0

Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments

Remarks

15/02/2000: Form A Remarks:
RZM MONITORING BORE SK 7653
01/12/2009: Reviewed data - nothing to update.

***** End of GW079948 *****

NSW Office of Water
Work Summary

GW080034

Licence:

Licence Status:

Authorised Purpose(s):
Intended Purpose(s):

Work Type: Bore

Work Status:

Construct.Method:

Owner Type:

Commenced Date:
Completion Date:

Final Depth:
Drilled Depth:

Contractor Name:

Driller:

Assistant Driller:

Property:

Standing Water Level (m):

GWMA:
GW Zone:

Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUC	GLOUC.049	
Licensed:			

Region: 20 - Hunter

CMA Map:

River Basin: - Unknown
Area/District:

Grid Zone:

Scale:

Elevation: 5.94 m (A.H.D.)
Elevation Source: Unknown

Northing: 6370959.0
Easting: 365222.0

Latitude: 32°47'27.8"S
Longitude: 151°33'38.4"E

GS Map: -

MGA Zone: 0

Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments

Remarks

15/02/2000: Form A Remarks:
RZM MONITORING BORE SK 8368
01/12/2009: Reviewed data - nothing to update.

***** End of GW080034 *****

NSW Office of Water
Work Summary

GW200414

Licence: 20BL169475
Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE
Intended Purpose(s):

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 09/09/2004
Final Depth: 10.00 m
Drilled Depth: 10.00 m

Contractor Name:
Driller:
Assistant Driller:

Property: N/A 114 CHELMSFORD DRIVE METFORD 2323
Standing Water Level:
GWMA: -
Salinity:
GW Zone: -
Yield:

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.34	1/1001539
Licensed:	NORTHUMBERLAND	MAITLAND	Whole Lot 1//1001539

Region: 20 - Hunter
CMA Map:

River Basin: - Unknown
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6373761.0
Easting: 369960.0
Latitude: 32°45'58.9"S
Longitude: 151°36'41.9"E

GS Map: -
MGA Zone: 0
Coordinate Source: Map Interpretation

Construction
Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	10.00	0			Unknown

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	fill (silty sand, dark brown, medium grained sand, minor medium plasticity clay inclusions without)	Fill	
0.30	0.50	0.20	fill (clayey sand, light brown medium grained sand, medium plasticity clay fines)	Fill	
0.50	1.30	0.80	clay (silty, light grey, orange mottling, low plasticity fines)	Clay	
1.30	2.50	1.20	sandstone (extremely weathered, fine grained, red and grey mottled)	Clay	
2.50	4.00	1.50	sandstone (very weathered, brown orange, fine to very fine grained, trends to siltstone)	Sandstone	
4.00	6.00	2.00	sandstone (moderately weathered, orange brown, fine grained)	Sandstone	
6.00	6.50	0.50	sandstone (fine grained, minor weathering, light grey)	Sandstone	
6.50	8.00	1.50	siltstone (grey, minor unweathered carbonaceous fragments, iron stained bands throughtout)	Siltstone	
8.00	8.20	0.20	coal (black, minor carbonaceous mudstone bands, moderately hard, 90-100% dull, fresh)	Invalid Code	
8.20	10.00	1.80	sandstone (light grey, fine to medium grey, moderately hard)	Sandstone	

Remarks

***** End of GW200414 *****

NSW Office of Water
Work Summary

GW200415

Licence: 20BL169475

Licence Status: ACTIVE

Authorised Purpose (s): MONITORING BORE
Intended Purpose(s):

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 10/09/2004

Final Depth: 20.10 m
Drilled Depth: 20.10 m

Contractor Name:
Driller:
Assistant Driller:

Property: N/A 114 CHELMSFORD DRIVE METFORD 2323
GWMA: -
GW Zone: -

Standing Water Level:
Salinity:
Yield:

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTH	NORTH.34	1/1001539
Licensed:	NORTHUMBERLAND	MAITLAND	Whole Lot 1//1001539

Region: 20 - Hunter
River Basin: Area/District: - Unknown

CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6373738.0
Easting: 369986.0

Latitude: 32°45'59.7"S
Longitude: 151°36'42.9"E

GS Map: -
MGA Zone: 0
Coordinate Source: Map Interpretation

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	20.10	0			Unknown

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.30	1.30	clay (silty, sandy, light to dark brown, low plasicity, fine to medium grained sand. Some grey orange mottling)	Clay	
1.30	1.50	0.20	clay (sandy silty, orange grey mottled)	Clay	
1.50	4.00	2.50	sandstone (medium grained, light grey, moderately weathered with orange brown mottling near top)	Sandstone	
4.00	6.50	2.50	sandstone (fine to very fine grained, tends to siltstone, orange, moderately weathered)	Sandstone	
6.50	7.00	0.50	coal (black, tends to claystone in part, minor weathering)	Invalid Code	
7.00	9.00	2.00	siltstone (grey, tends to fine sandstone, minor carbonaceous traces)	Siltstone	
9.00	15.00	6.00	sandstone (light grey, white, fine to medium grained, moderately hard, not weathered, minor siltstone bands)	Sandstone	
15.00	17.00	2.00	sandstone (with siltstone, interbedded, light grey, fine to medium grained sandstone, grey siltstone, minor carbonacous)	Sandstone	
17.00	20.10	3.10	sandstone (fine to medium grained, light grey/white, fresh, hard)	Sandstone	

Remarks

***** End of GW200415 *****

Peer review comments and responses on the Groundwater Impact Assessment report.

Type of comment	Page number	Reviewer	Date	Comment	Responder	Response	Action
Text	10	Peter	23/04/2018	Does it include Tasman Extension?	KH/GH	Yes. Confirmed in HS comment log	no response required
Text	10	Peter	23/04/2018	Mention approved but not yet started Tasman Extended.	KH/GH	Added in "Tasman underground mine (closed, extension planned)"	text amended
Text	17	Peter	23/04/2018	The reports cited in this paragraph are not listed in references. Check for other omissions as well.	ZC/GH	HS 2015 reference included in the updated June 2018 report.	HS 2015 reference added. 2016 reference omitted from text.
Text	18	Peter	23/04/2018	Note - no simulation of Bloomfield without the modification??	KH/GH	Noted and explained in HS comment log	no action required
Text	21	Peter	23/04/2018	Reference should be AGC. AGE was not founded until 1997, and is a different company.	KH	Amended here and in references	
Text	21	Peter	23/04/2018	permeabilities	ZC	Noted	Changed spelling to permeabilities
Text	21	Peter	23/04/2018	Probably should mention that groundwater can also occur in shallow unconsolidated material (regolith - ie localised alluvium, as well as colluvium and decomposed rock) away from the main creeks. This unconsolidated material away from the creeks and swamps has negligible resource value, but is important in the groundwater recharge process. All unconsolidated materials comprise Layer 1 in the groundwater models.	GH	Noted	text added as suggested
Text	21	Peter	23/04/2018	I'm not sure this is the case. The water table is topography influenced, whereas, the potentiometric surface is more controlled by regional recharge/discharge - with recharge occurring at or near outcrop (ie to the north) and discharge somewhere way to the south?? There is one low-lying location beside Pambalong Nature Reserve where the potentiometric surface for the Donaldson Seam pre-mining was 20+m above the ground surface (C081A), whereas the water table was below surface (C081B). Mining impact has since taken C081A water level well below surface, whereas C081B WL is still just below surface and has not been affected by mining.	GH	Noted	text added as suggested
Text	21	Peter	23/04/2018	Reference should be AGC. AGE was not founded until 1997, and is a different company.	ZC	Noted- checked with a 2000 EA document, references AGC for this paper	Changed to AGC
Text	22	Peter	23/04/2018	Except around the Donaldson Open Cut. Not in alluvium, but in regolith or colluvium, which is obviously not alluvium, but is nevertheless part of model layer 1. Need to also acknowledge that alluvium/weathered Permian can become hydraulically interconnected with deeper coal measures close to open cuts, and within fractured strata in the subsidence zones above underground mines.	GH	Noted	clarification in the text made
Text	22	Peter	23/04/2018	... in some locations ...	ZC	Noted	Added in 'in some locations'
Text	22	Peter	23/04/2018	... multi-level ...	ZC	Noted	Added in multi level before vibrating wire piezometers
Text	23	Peter	23/04/2018	What catchment benefits from the other 10hA (ie 103 - 52 = 51)?	GH	reference to the AECOM surface report noted	clarification in the text made
Text	23	Peter	23/04/2018	Include comment on any bores that are not monitoring bores.	GH	Noted	Comment added
Text	28	Peter	23/04/2018	NB: Drawdown of 100m is not possible in Layer 1 which has a maximum thickness of just 10m.	GH	HS report amended	text altered to be consistent with revised HS report
Text	28	Peter	23/04/2018	bore numbers are the same. One must be wrong?	ZC	Yes, the correct is GW078123 and GW078124	Changed one of them to GW078123
Text	28	Peter	23/04/2018	Need to include model layer details in Table 10, so the correct drawdowns are used to assess impacts.	GH	Noted	Table 10 had been amenmded and the text altered to clarify the impacts of drawdown
Text	28	Peter	23/04/2018	These are monitoring bores? They are screened in coal measures, not regolith. The 20m and 17m drawdowns apply to Layer 1, and are not real as Layer 1 is 10m thick or less. They are probably screened in Layer 13, 15, 17, 19 or deeper. Drawdowns for these layers are not 20m 0r 17m.	GH	the monitoring wells in the text don't match the predicted drawdown in thediscussion.	The text has been amended to clarify drawdown due to the Donaldson Open Cut and final void.
Text	28	Peter	23/04/2018	What will be the lateral extent of drawdown impact (>2m) in Layer 1?	GH	text added based onn Fig D0 of theHS report	text added as suggested
Highlight	29	Peter	23/04/2018		GH	assume this highlight is related to other comments on page 29 that have been already addressed	text amended

Text	29	Peter	23/04/2018	Not all bores below are in Alluvium, eg GW078123 and GW078124, both of which are screened in coal measures. Either only include alluvium bores in the table, or include column showing which model layer each is completed in, then ensure that drawdown shown is for that layer. Also, denote which bores are monitoring bores, as impacts on these are of no real concern."	GH	Table and text have been amended based on HS report and AECOM bore search	text and table amended
Highlight	29	Peter	23/04/2018		GH	assume this highlight is related to other comments on page 29 that have been already addressed	text amended
Highlight	29	Peter	23/04/2018		GH	assume this highlight is related to other comments on page 29 that have been already addressed	text amended
Text	30	Peter	23/04/2018	Unclear whether this is for cumulative impact or just the Bloomfield operation?	GH	reference to HS report	clarification made in text
Text	32	Peter	23/04/2018	I don't understand how the evaporation rates influence the monitoring frequency??	GH	Noted	clarification made in text
Text	32	Peter	23/04/2018	VW8 piezometers show drawdown much greater than predicted in the calibration run. This needs to be explained, or at least mentioned as an unexplained anomaly.	GH	reference to HS report	clarification made in text
Text	35	Peter	23/04/2018	Note - these two bores are no alluvial, but are in coal measures. So they are covered by Table 12, nit Table 11. However, even so, why would mitigation measures be required if the impact is due to Donaldson? Why would they be needed if they are only monitoring bores? How much of the drawdown is due to Bloomfield, if any?	GH	Text removed - not considered relevant as drawdown is not due to Bloomfield	Text removed
Text	40	Peter	23/04/2018	Is the maximum drawdown reached at the same time in all locations within the drawdown region?	GH	noted	clarification made in text
Text	40	Peter	23/04/2018	Not possible, as the surficial aquifer is only 10m thick.	GH	Noted and amended in accordance with changes to the HS report	text amended
Text	40	Peter	23/04/2018	... in the coal measures ...	ZC	Noted	Added in provided text
Text	41	Peter	23/04/2018	Don't the trigger levels have to be in this report?	GH	Trigger levels would be recommended in a groundwater management plan.	Noted and clarification made
Text	41	Peter	23/04/2018	Why?	GH	Noted	text amended
Text	42	Peter	23/04/2018	Australian Groundwater Consultants (AGC), not Australian Groundwater and Environmental Consultants (AGE). AGE was not established until 1007, and is a different company than AGC.	ZC	Noted- checked with a 2000 EA document, references AGC for this paper	Changed to AGC

Peer review comments and responses on the groundwater modelling report (Appendix A to the Groundwater Impact Assessment).

Type	Page No.	Reviewer	Note / highlight	Time Date	Comment / Edit	Response
Text	6	Peter	Sticky Note	23/04/2018, 4:05:45 PM	Is there any physical evidence for this dyke behaving as a barrier, or enhanced conductivity?	Barrier behavious is based on anecdotal evidence from Bloomfield personnel that groundwater level is higher on one side than the other during dewatering events.
Text	8	Peter	Sticky Note	23/04/2018, 4:08:45 PM	... to a lesser extent ...	Adopted.
Text	8	Peter	Sticky Note	23/04/2018, 4:07:46 PM	... in some locations ...	Adopted.
Text	10	Peter	Sticky Note	23/04/2018, 4:12:09 PM	Does the sequencing at Abel and Tasman include only mining up to the time they went onto care and maintenance, or does it allow for resumption of mining? And commencement of the approved Tasman Extension mine in the West Borehole Seam?	Only continuous approved mining is included without any consideration of actual disruption. The adopted mining sequences are shown in Table 5.
Highlight	10	Peter	Highlight	23/04/2018, 4:10:37 PM		
Text	11	Peter	Sticky Note	23/04/2018, 4:13:14 PM	Does this include Tasman Extension?	Yes. Included mines are shown in Table 5.
Highlight	11	Peter	Highlight	23/04/2018, 4:12:43 PM		
Text	12	Peter	Sticky Note	23/04/2018, 4:16:11 PM	This looks like there is a way of determining total Bloomfield impact, but not just the impact of the extension separately from the already approved Bloomfield mine.	That is correct. We found it very difficult to separate out the extension, and took a very conservative view of presenting whole-of-mine impacts, as the mine had not previously been assessed against the Aquifer Interference Policy.
Highlight	12	Peter	Highlight	23/04/2018, 4:16:28 PM		
Text	12	Peter	Sticky Note	23/04/2018, 4:16:47 PM	see above comment	Ditto
Highlight	12	Peter	Highlight	23/04/2018, 4:14:34 PM		
Text	17	Peter	Sticky Note	23/04/2018, 10:11:09 AM	Include comment on outliers/anomalies. Need to explain (if possible) what is reason for poor calibration at specific bores.	Figure 9 now has layer groups and anomalous bore are marked. "For the local Bloomfield area, two bores in layers 17 and 19 are outliers: VW7 and VW8. The poor match at VW7, at the south-western edge of the extension, is due purely to assumed timing of mining, since the hydrographs in Figure B5 and Figure B7 show very good visual matches of trends. VW8 is poorly simulated due to its location close to the edge of old Buchanan Mine workings for which no data were readily available."
Text	18	Peter	Sticky Note	23/04/2018, 10:12:11 AM	ML/a	Corrected.
Highlight	18	Peter	Highlight	23/04/2018, 4:23:35 PM		
Text	18	Peter	Sticky Note	23/04/2018, 4:25:54 PM	Any ideas why the calibration for these two bores is way out? Is it because they are close to a boundary - GHB, RIV, DRN etc. Are they in the correct model layers? Is it because of the dyke?	Due probably to Buchanan Mine workings not being well represented in the model. No DRN condition was imposed, just enhanced K properties. That proved insufficient to account for low observed heads.
Highlight	18	Peter	Highlight	23/04/2018, 4:23:29 PM		
Highlight	18	Peter	Highlight	23/04/2018, 10:11:56 AM		
Text	19	Peter	Sticky Note	23/04/2018, 10:19:33 AM	I don't think so. Water level is declining during the period of Abel mining. If it was a residual effect of Buchanan mine, water levels would be low to start with. and possibly slowly rising. There is likely some connection between VW8 location and the Donaldson seams being mined at Abel.	Accepted - comment added. The model does trend downwards at VW8, probably due to Abel, but the initial levels are too high because of inadequate simulation of Buchanan.
Text	19	Peter	Sticky Note	23/04/2018, 4:30:33 PM	How much of this is Hexham Swamp?	Nearly the lot as indicated in Table 7.
Highlight	19	Peter	Highlight	23/04/2018, 4:30:38 PM		
Text	19	Peter	Sticky Note	23/04/2018, 10:23:43 AM	Better to use non-model evidence for losing/gaining status (eg relative levels). This is because you need to justify the way the streams are simulated in the model. In other words, to confirm the reliability of the model.	We have investigated this but found that the existing monitoring network is of no use in inferring gaining/losing status of streams.
Highlight	19	Peter	Highlight	23/04/2018, 10:17:18 AM		
Text	21	Peter	Sticky Note	23/04/2018, 10:27:44 AM	? for not from ?	Corrected.
Highlight	21	Peter	Highlight	23/04/2018, 10:29:13 AM		
Text	21	Peter	Sticky Note	23/04/2018, 10:29:51 AM	This is unusually high. How much is from Hexham Swamp?	Not assessed separately. Partitioning was done only for water sources for licensing purposes. Nearly the lot would be Hexham Swamp as indicated in Table 7 for the calibration period.

Highlight	21	Peter	Highlight	23/04/2018, 10:27:12 AM		
Text	22	Peter	Sticky Note	23/04/2018, 10:33:48 AM	Drawdown cannot be greater than 10m (max thickness of layer 1). Maybe show area where L1 cells are dry??	Corrected now. Drawdown is now defined as: DD = IF(A>B,A,B)-IF(C>B,C,B) where A=Null water level; B=Bot1 elevation; C=modelled water level. Dry areas are now shown in new Figure D0.
Text	22	Peter	Sticky Note	23/04/2018, 10:35:07 AM	The drawdown responses at VW8 suggest spatial confinement may not be occurring. Is there any evidence that the dyke is a barrier?	VW8 is a long way from the dyke, though mine personnel regard it as a barrier. The VW8 heads are surprisingly low, and the model has not been able to reproduce them.
Highlight	22	Peter	Highlight	23/04/2018, 4:34:17 PM		
Text	22	Peter	Sticky Note	23/04/2018, 4:38:27 PM	Are the drawdowns in Table 11 water table drawdowns (ie Layer 1) or all layers? Is it necessary to include registered bores that are monitoring bores only? If so, they should be denoted such in the table. Also, if any bores is screened in a layer other than 1, the drawdown in that layer should be included (eg GW078123 and GW078124). Note that the drawdowns greater than 10m are not real as thickness of Layer 1 is only 10m max.	Corrected. Table 10 has been split into separate tables (a) and (b) for production and monitoring bores. The correct lithology is now listed and the drawdown in the appropriate layer is reported.
Text	22	Peter	Sticky Note	23/04/2018, 10:37:20 AM	insert words "water table" .	Inserted.
Highlight	22	Peter	Highlight	23/04/2018, 10:34:12 AM		
Highlight	22	Peter	Highlight	23/04/2018, 10:31:51 AM		
Highlight	23	Peter	Highlight	23/04/2018, 4:39:04 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:41:13 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:41:21 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:41:28 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:41:51 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:41:57 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:42:06 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:42:14 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:42:20 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:42:29 PM		
Text	23	Peter	Sticky Note	23/04/2018, 4:43:08 PM	Bore depths greater than about 10m are almost certainly not alluvium. Please check.	Corrected.
Highlight	23	Peter	Highlight	23/04/2018, 4:42:25 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:42:17 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:42:09 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:42:00 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:41:54 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:41:32 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:41:24 PM		
Highlight	23	Peter	Highlight	23/04/2018, 4:41:16 PM		
Text	23	Peter	Sticky Note	23/04/2018, 4:39:56 PM	These 2 bores are not alluvium. They are screened in coal measures.	Corrected.
Highlight	23	Peter	Highlight	23/04/2018, 4:38:57 PM		
Text	24	Peter	Sticky Note	23/04/2018, 10:43:39 AM	Add "Therefore, the model predicts no impact of the Bloomfield operation on Hexham Swamp".	Inserted.
Text	38	Peter	Sticky Note	23/04/2018, 4:52:09 PM	Include some comment in the text about the anomalies:1)the line of points in [a] that have the same simulated head vs variable observed head - which bore was this, and suggest why it doesn't calibrate well under transient conditions;2)groups of points below or able the cluster which show a diversion away from the 45 deg slope (one shooting up, another arcing down).	"Scattergrams are displayed in **Figure 9**. For the local Bloomfield area, two bores in layers 17 and 19 are outliers: VW7 and VW8. The poor match at VW7, at the south-western edge of the extension, is due purely to assumed timing of mining, since the hydrographs in **Figure B5** and **Figure B7** show very good visual matches of trends. VW8 is poorly simulated due to its location close to the edge of old Buchanan Mine workings for which no data were readily available."
Highlight	38	Peter	Highlight	23/04/2018, 4:48:05 PM		

Text	40	Peter	Sticky Note	23/04/2018, 4:55:07 PM	This plot is misleading. A lay person reading it will interpret that the alluvial groundwater will be lowered by up to more than 100m in some locations. I know it is what the model predicts, but drawdowns greater than about 10m or so are not possible due to the limited thickness of Layer 1.	Replaced figure.
Highlight	40	Peter	Highlight	23/04/2018, 4:52:29 PM		
Highlight	54	Peter	Highlight	23/04/2018, 10:49:55 AM		
Text	54	Peter	Sticky Note	23/04/2018, 4:58:47 PM	Comment on possible reasons for poor calibration at VW8. SP2-1 is not a worry, as the model is predicting greater drawdown than has been observed therefore it is conservative. However, in this case the model is grossly under-predicting the impacts. Same with VW8(97m).	Done.
Text	56	Peter	Sticky Note	23/04/2018, 4:59:05 PM	Comment on reason for poor calibration at VW8. See comment above.	Done.
Highlight	56	Peter	Highlight	23/04/2018, 10:50:08 AM		
Text	58	Peter	Sticky Note	23/04/2018, 5:03:08 PM	In all figures in this section, there is an outlier region of deeper water levels in a NE-SW orientation within the western part of the Bloomfield lease. This appears in all Layers. Is it related to the dyke?; past underground mining?; or something else?	This is due to old underground workings that have not recovered.
Highlight	58	Peter	Highlight	23/04/2018, 5:00:39 PM		

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